CURRENT RESEARCH IN THE PLEISTOCENE

Volume 8 1991

A Peopling of the Americas Publication

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From the Editors

This is the eighth year that *Current Research in the Pleistocene* has been published. Each year we see a voluminous amount of material that needs to get out to each researcher—and this year and volume are no exception. This edition contains 63 articles.

This year we moved the production of *CRP* to Northern Arizona University. Dave Meltzer and I are trying to streamline the production. We now have the production system designed to make editing and desktop publishing a reality for *CRP*. However, we now need your help. We need each author who submits a manuscript to follow the *CRP* style guide. You would be surprised at what we receive in the mail as "camera ready" manuscripts. If you are going to submit a manuscript to us for inclusion into *CRP*, please FIRST look at this issue of the journal—and then follow its style for your manuscript. Please also look at the style guidelines printed at the back of this issue. There are a few changes from previous years. Most of all please note that you must (should—please) submit your manuscript both in hard copy and on computer disk (Macintosh, MS DOS/IBM, or Apple II format). Your article should be in both the original word processing format, and as an ASCII disk file. The hard copies I will use to make my editing marks and to send out for peer review. The computer disk file is what we will use for the desktop publishing system to input your manuscript. This will save us loads of time, keep the cost of the volume down, and keep your "camera ready" manuscript as clean as you sent it in to us.

Dave Meltzer's job is to read all archaeological related manuscripts, provide his own review, and determine who should be an outside reviewer for each manuscript. Jim Mead read all manuscripts We also requested the help of Dr. Larry D. Agenbroad and Dr. R. Scott Anderson to help serve as partial reviewers. They read paleontological/geological and ecological manuscripts (respectively) and suggest outside reviewers and provide their own opinions for each manuscript. Dave and Jim want to make *CRP* a peer reviewed journal, but to keep in touch with the "within a year turnaround time.".

The word is becoming streamlined—as *CRP* is trying to do too. In this effort, please follow the 1991style guidelines, provide us with a computer disk file, and get the manuscripts in early. Remember you can use FAX and BITNET to get in touch with Dave.

Jim I. Mead
David J. Meltzer

Archaeology

Diring Yuriak: An Early Paleolithic Site in Yakutia

R. E. Ackerman, and R. L. Carlson

The Diring Yuriak site at 61° 12′ N and 128° 28′ W has yielded good evidence of an early Paleolithic occupation. Mochanov (1988) has directed work at the site since 1982. At his invitation, R. Ackerman, R. Carlson and M. Carlson visited the excavations, Aug. 14-17, 1990, and spent an additional day examining artifacts. The following report is a summary of our observations. The site is situated on the right bank of the Lena River, overlooking a small stream-cut valley (Diring Yuriak), and about 140 km upriver from Yakutsk. At this location, a series of terraces at 10, 70, 90, 105-120, 125-135, and 140-165 m above the Lena have been investigated. The upper terraces from 105-165 m are composed of a series of alluvial/aeolian deposits over a Cambrian limestone formation (Tabagin Terrace). During the excavation of late Neolithic burials, S. Fedoseeva and I. Mochanov discovered a few artifacts of the Diuktai culture and below these a number of broken quartzite cobbles and spalls.

Trenches were then cut across the upper three terraces to determine the site stratigraphy and extensive horizontal excavation was undertaken by bulldozer to expose the underlying cultural horizons. The stratigraphic sequence (by layers) is: (1) Cambrian limestone, (2) sand and quartzite cobbles (source of raw materials used for tools), (3) a distinctive horizon of red, cross-bedded, alluvial sand, (4) sand-filled frost or desiccation wedges in the top of layer 3, (5) artifacts and concentrations of lithic debitage in a deflated sandy zone, and (6-16) layers of sand, sandy loam, and loam with some intermixing due to solifluction. Bore holes on the 125-135 and 140-165 m terraces revealed that layer 5 is 15-40 m below the present surface. The entire depositional sequence was distinct and uncomplicated.

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The lithic materials from layer 5 are clearly artifacts. They occur most frequently in concentrations around a large cobble anvil. Isolated artifacts are uncommon. Impact scars from unsuccessful attempts at fracturing are present on some specimens and many flakes can be refitted to core remnants. Most specimens are classifiable as cores and unmodified flakes and a lesser number as unifacial pebble choppers, core scrapers, and scraper-planes. More advanced tool types are absent. Quartzite is the common raw material. Most specimens show evidence of heavy abrasion by blowing sand. Overall, the most economical interpretation of the site is that it was occupied at a time when the level of Lena River was at the height of the Tabagin terrace and the cultural assemblage is the result of localized lithic reduction along the shore.

We also visited a small excavation (6 by 6 m) on the Tabagin terrace overlooking the mouth of the Buotomo River, 20 km downstream from the Diring site. The cultural deposit consisted of the same quartzite industry—cores, flakes and anvils, but was only 20-30 cm below the present surface and the artifacts appeared to be less sand blasted. The associated soil matrix was a light colored sand underlain by the layer of red sand as at the Diring site. Thirteen additional sites of this complex have been located, but not excavated.

Paleomagnetic age estimates on the layers above and below layer 5 date it between 3.2 and 1.8 million years ago. TL dates on samples sent by Mochanov to the Laboratory of Radiothermoluminscent Dating at the University of Moscow provided the following: layer 4—more than 1.8 Ma [RTHL 454], layer 6—2.9±0.96 Ma [RTHL 424] and more than 1.1 Ma [RTHL 453], layer 15—2,000±1,000 yr B.P. [RTHL 439] and layer 16—7,000±3,500 yr B.P. [RTHL 434]. Implications of the occurrence of human settlement at 61°N at 2-3 Ma on currently accepted models of human evolution have provoked considerable controversy among Soviet scientists. In a discussion with geologist O. V. Grinenko of the Yakut Institute of Geological Sciences, who headed a geological congress which met at the site three weeks before our visit, it was clear that none of the visiting geologists would accept a date earlier than 500,000 yr B.P. and that many felt that layer 5 could be much younger. Further dating of the site by independent agencies is needed.

The Diring Yuriak complex is significant for New World prehistory because of its unspecialized technology, early geological context, general proximity to Bering Strait, and the inferred early arctic adaptation of its occupants. It is the type of complex that fits into models of a very early pre-Clovis occupation of the New World. While we do not believe that any of the proposed pre-14,000 B.P. sites or complexes in the New World can be accepted as unequivocal evidence of such an occupation, the Diring site is a potential ancestor for any that may eventually be validated or that future research may bring to light.

References Cited

Mochanov, I. A. 1988. The Most Ancient Paleolithic of Diring and the Problem of a Non-Tropical Homeland for Mankind. In *Arkheologiia Iakutii: Sbornik Nauchnykh Trudov*, pp. 15-53. Yakutsk: Izd. Iakutskogo Gosuniversiteta.

Folsom Landuse Patterns in the Southern Tularosa Basin

Daniel S. Amick

Surveys of large land tracts on the Fort Bliss Military Installation have produced a significant record of Folsom landuse patterns in the southern Tularosa Basin. Systematic surface survey has been conducted on nearly 1500 square km within the Fort Bliss maneuver areas (Whalen 1977, 1978; DeGarmo 1983; Carmichael 1986). Numerous prehistoric occupations including 5 Folsom sites and 39 isolates have been recorded in this Chihuahuan desert grassland located between El Paso, TX and Orogrande, NM (Krone 1975; Whalen 1978; Carmichael 1986). The Fort Bliss Folsom collections were recently studied to investigate regional patterns of artifact distribution.

The occurrence of Folsom artifacts near El Paso has been discussed by numerous local avocational archaeologists (Quimby and Brook 1967; Brook 1968; Russell 1968; Davis 1975; Krone 1975). Concentrations of Folsom artifacts are reported within the central portion of the Tularosa Basin north and east of Fort Bliss. These localities are often associated with playas and prominent landmarks. Wimberly (1973) has briefly described the Lone Butte site assemblage which may represent a series of Folsom killsites and camps. However, similar Folsom camps with high artifact densities have not yet been found at Fort Bliss. Nonetheless, there does appear to be geographic patterning within the Fort Bliss data which contributes to understanding regional Folsom landuse patterns.

Judge and Dawson (1972; Judge 1973) have presented a model of Paleoindian settlement technology in the central Rio Grande Valley. The data from the southern Tularosa Basin expand our knowledge about Folsom landuse in environments that lie southwest of the Great Plains. Unfortunately, all of the Folsom artifacts from Fort Bliss are isolates or mixed with later components. Consequently, this study has focused on comparing the distribution of Folsom and Midland projectile points and preforms only. This assemblage includes 3 Midland points, 40 Folsom points, and 22 Folsom preforms.

The use of local raw materials for tool manufacture predominates within the Fort Bliss Folsom collections. A variety of cherts and altered metamorphic and volcanic rocks occur in the surrounding mountains (Banks 1990). The alluvial fans along the margins of the basin contain chert, chalcedony, and obsidian

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originating from the mountains and the ancient Rio Grande axial gravels. The basin floor lacks significant sources of toolstone.

The isolates consist of 2 Midland points, 27 Folsom points and 4 preforms. Isolated points are commonly distal fragments or complete points (n=21, 60%) which suggests that Folsom isolates represent gear that was broken or lost while hunting. About 83% (n=29) of the isolated points exhibit impact damage. The ratio of points to preforms among the isolates is 6.80 (34:5) which is at least four times higher than site assemblages in the central Rio Grande Valley (Judge 1973). The high incidence of isolated Folsom points and distal fragments, impact damage, and points to preforms indicates a pattern of dispersed hunting activities. Manufacture of points and replacement of hunting gear does not appear to have occurred in the field.

Folsom sites are defined as discrete localities where two or more of these artifacts were found. The high proportion of basal point fragments (n=13, 68%) in the site assemblages suggests that repair of broken hunting gear was conducted at camps. All of these basal fragments exhibit impact damage which implies that they were bound within a foreshaft that was usually retrieved and returned to camp. The broken point fragments were then removed from the foreshaft and discarded. Site assemblages exhibit a point to preform ratio of 1.0 (19:19) indicating that manufacture of replacement points also occurred at the camps.

Unfortunately, interassemblage variation among the Folsom collections from the Tularosa Basin is poorly documented. However, the Dona Ana Folsom Camp (FB-1613) located in Fillmore Gap between the Franklin and Organ Mountains contains a relatively large and functionally distinctive assemblage. FB-1613 is situated near a low mountain pass (ca. 1278 m elevation), about 60 m above the Tularosa Basin floor. This location confers numerous strategic advantages: lithic resources, a nearby playa, access to mountain resources, passage into the Rio Grande Valley, and a landscape overview. Recent excavations by Dr. Mark Stiger have produced an assemblage dominated by tool manufacturing debris. The ratio of points to preforms at FB-1613 is 0.40 (6:15) which is less than the average from Judge's armament sites (0.48). While Folsom groups may have occupied the FB-1613 locality for various reasons, toolstone procurement and preform manufacture were particularly important activities at this low mountain pass location.

Thanks to Raymond Mauldin and Dr. Glen DeGarmo at the Environmental Management Office, Directorate of Installation Support, Fort Bliss for assisting this research.

References Cited

Banks, L. D. 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.

Brook, V. 1968. A Folsom and Related Points Found Near El Paso, Texas. The Artifact 6(3):11-15.

Carmichael, D. L. 1986. Archaeological Survey in the Southern Tularosa Basin of New Mexico. Historic and Natural Resources Report 3. Environmental Management Office, Fort Bliss, Texas. Publications in Anthropology 10. El Paso Centennial Museum, The University of Texas at El Paso.

Davis, J.V. 1975. A Paleoindian Projectile Point From Hueco Firing Range, Otero County, New Mexico. The Artifact 13(1):25-29.

DeGarmo, G. D. 1983. The Archaeological Program at Fort Bliss, Texas. Proceedings of the American Society for Conservation Archaeology 1983:32-40.

Judge, W. J. 1973. Paleoindian Occupation of the Central Rio Grande Valley in New Mexico. University of New Mexico Press, Albuquerque.

Judge, W. J., and J. Dawson 1972. Paleoindian Settlement Technology in New Mexico. Science 176:1210-1216.

Krone, M. 1975. A Report on Folsom Points Found in the El Paso Area. The Artifact 13(4):1-19.

Quimby, B., and V. R. Brook 1967. A Folsom Site Near El Paso, Texas. The Artifac t (4):31-47.

Russell, P. 1968. Folsom Complex Near Orogrande, New Mexico. The Artifact 6(2):11-16.

Whalen, M. E. 1977. Settlement Patterns of the Eastern Hueco Bolson. Publications in Anthropology 4. Centennial Museum of Anthropology, University of Texas at El Paso.

Whalen, M. E. 1978. Settlement Patterns of the Western Hueco Bolson. Publications in Anthropology 6. Centennial Museum of Anthropology, University of Texas at El Paso.

Wimberly, M. 1973. Early Human Occupation of the Tularosa Basin. In, Technical Manual: 1973 Survey of the Tularosa Basin, Human Systems Research, pp. 225-244. Las Cruces, New Mexico.

Paleoindian Occupation Greater than 11,000 yr B.P. at Tule Lake, Northern California

John M. Beaton

Recent test excavations in rockshelter deposits on the western shores of Tule Lake, Siskyou County, California indicate an occupation history dating to at least 11,450±340 yr B.P. (Beta-39545). The ^{14}C determination was made on a sample of burned wood charcoal from a small fire pit excavated at -215 to -220

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cm below the surface of the shelter deposit. The date is interpreted to indicate the age of an anthropogenic cooking or warming fire which marks an incident of shelter use by Paleoindian foragers who were exploiting the lakeshore/marsh resources of Tule Lake.

Modern Tule Lake, which sits adjacent to the California-Oregon border is a shallow remnant of Pleistocene Tule Lake, which was one of a complex of extensive marshlands associated with the Klamath River, its tributaries and distrubutaries east of the Cascade Range. The area shares biogeographic (and ethnographic/ethnohistorical) elements with the plateau region to the north, the basin and range province to the east, and riverine-montane California province to the west and south. Earlier archaeological work in the area includes the Lower Klamath lake studies of Cressman (1942) and McGuire (n.d.). Grayson (1973, 1976) has done extensive studies of the Lower Klamath archaeofauna. While these studies have clearly indicated the importance of wetlands to foragers of the Holocene, and the likelihood of earlier occupations, no ^{14}C dates have been obtained which would suggest occupations earlier than ca. 7,000 years ago. As part of a research program into the "colonization" (i.e. strategic selection) of lakeside-marsh habitats by foragers, a small crew from University of California, Davis sampled selected rockshelter sites at Tule Lake in 1989 and 1990.

The archaeological sites along the western shore include approximately 15 sheltered deposits and a similar number of surface indications (Squier and Grosscup n.d.) of forager activity. The archaeological site (Ca-Sis-218) from which the comparatively early date was taken is situated at the foot of a basalt cliff which overlooks the western shore of the lake, well above Holocene lake levels. This site was chosen for preliminary testing because it satisfied several research considerations, including (1) its close association to lakeshore and marsh resources of the Pleistocene and Holocene, (2) its apparently high rate of sediment accumulation (and therefore potentially good chronostratigraphic separation), (3) its sheltered micro-environment, and (4) its evident lack of disturbance or post-depositional turbation.

Test excavations, amounting to approximately 10 m^3, differentially sampled the somewhat more than 2 m deep deposit, with only slightly more than two cubic meters having been excavated from below -1.0 m. Upper levels in the site were comprised of an expectable stratigraphic record in which Gunther series projectile points were succeeded by small sidenotched varieties. Milling equipment occurred in upper levels of the site and one mano-like muller with clear evidence of ochre pigment grinding was recovered from -110 cm. This implement may be associated with petroglyphy, some of which is in evidence on the walls of shelters on the lakeshore.

The date reported here is the first from the site. It was collected as part of a small feature, a fire-pit at -210 cm. The small fire pit was ca. 18 cm in diameter and had a maximum thickness of 5 cm. It was comprised of ash, small fragments of burned wood, and the heavily degraded bones of fish. In close horizontal proximity to this feature were found chips of obsidian, high quality silicious toolstone chips, and a single unifacial base.

Although bifacially worked pieces, including apparent mid-sections of knives or points occurred in stratigraphic association with the dated feature, no potentially time-diagnostic pieces were recovered.

Importantly, sediments containing the 11,450 yr B.P. date estimation overlay approximately 20 cm of cultural deposit which, in our small sample, lacked easily datable features. However, the lowest sediments (-220 to -240 cm) contained artifacts including bone tools, bifacially worked pieces and flaking debitage which were associated with fragmentary bones of fish, birds and mammals. These attest to further and possibly somewhat older cultural deposits. Attempts to accurately date this lower part of the deposit are planned.

Although the research program is in its early stages, preliminary results suggest that fish and waterfowl, rather than terrestrial fauna, were the important flesh elements in this early forager diet. On first indications, the shelter deposits do not suggest large sedentary occupations, but rather the periodic use by small lakeshore-focused groups which employed economic strategies directed toward the taking of fish and waterfowl. Further analyses of recently excavated material, and additional work at this site, and at other nearby sites, are planned.

This research was sponsored by a University of California, Davis, Faculty Research Grant D-2068. Additional support was received from the Bureau of Reclamation (Grant No. 9-FG-20-08800). Permission to excavate was granted by the US Department of Fish and Wildlife. I particularly thank my UCD students for their effort, G.J. West (Bureau of Reclamation) and Anan Raymond (USFWS) for encouragement, and J. F. O'Connell for introducing me to the archaeology of northeastern California.

References Cited

Cressman, L. 1942. Archaeological Researches in the Northern Great Basin. *Carnegie Institution of Washington Publication* 538.

Grayson, D. K. 1973. *The Avian and Mammalian Remains From Nightfire Island.* PhD dissertation, University of Oregon.

Grayson, D. K. 1976. The Nightfire Island Avifauna and the Altithermal. In Ecological Change in the Great Basin. *Nevada Archaeological Survey Research Reports.* 6.

McGuire, Kelly. n.d. *Test Excavations at Sheepy East 1, Lower Klamath Lake, Siskyou County, California.* Unpublished manuscript. Bureau of Reclamation, Sacramento.

Squier, R., and G. Grosscup. n.d. *An Archaeological Survey of the Lava Beds National Monument, California,* 1952. Unpublished manuscript. National Park Service, San Francisco.

The Johnson Site: A Dated Clovis-Cumberland Occupation in Tennessee

John B. Broster, David P. Johnson, and Mark R. Norton

The Johnson site (40Dv400) was recorded as part of the Tennessee Division of Archaeology's continuing state-wide Paleoindian site survey (Broster 1989; Broster and Norton 1990). The site is a large multi-component habitation located on the Cumberland River in East Nashville. It was first observed as a dense scatter of lithic materials on the edge of the river (at low pool). Projectile points, bifaces, preforms, unifacial tools, and a high density of bifacial reduction flakes were noted. Diagnostic artifacts which were recovered included three Clovis preforms and the following projectile point/knife types (number of specimens): Cumberland (3), Dalton (1), Harpeth River (3), Greenbrier (2), LeCroy (2), Kirk Serrated (6), and Kirk Corner-Notched (51).

A series of dark, culturally derived lenses can be observed in the riverbank. There appears to be at least four major occupations represented. Ranging in depth from the surface to approximately 50 cm below surface are materials affiliated with the Mississipian period (500 to 950 yr B.P.). This occupation is represented by a very sparse scatter of lithic and ceramic artifacts (six sherds and one projectile point).

At 3 to 4 m below surface there is a thin stratum of burned sandy clay and charcoal which produced MacCorkle Stemmed and LeCroy projectile points. These types have been dated in the Little Tennessee River valley at between 8,000 and 9,000 yr B.P. (Chapman 1976; Broyles 1971).

Directly below this component at a depth of 5 to 6 m below surface is a dark, organically stained, silty clay level containing Kirk Corner-Notched projectile points and numerous fragmented bifaces. The level seems to have a downward slant toward the west and ranges from 10 to 40 cm in thickness. Kirk Corner-Notched points have been dated on the Little Tennessee River at between 8,900 and 9,600 yr B.P. (Chapman 1976; Chapman 1977).

A fourth cultural level is located at 20 to 30 cm below the Early Archaic occupation. The deposit varies from 50 to 96 cm in thickness, and the top of the stratum measures approximately 6.5 to 8.0 m below the ground surface. At this preliminary stage of investigation, no internal stratigraphy has been observed within the level.

A shallow basin feature, with a slightly rounded bottom, is evident in the upper level of this deposit. The basin is 33 cm deep and 62 cm wide, with the

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upper 20 cm characterized by a light brown silty clay with sparse lithics. The bottom 13 cm consist of a dark gray ash mixed with charcoal, burned bone, and numerous bifacial reduction flakes. A carbon sample was taken from the feature, and profile drawings constructed. It was felt that the majority of the feature should be left intact for future study. The date produced from this feature was 12,660±970 yr B.P. (Tx-6999). It is believed that there is very little chance of sample contamination, however, future plans call for complete excavation of this possible hearth to obtain an additional sample(s) for dating.

Another carbon sample was taken from the lower portion of the same level about 20 m to the west of the feature. The sample was taken 30 cm from a Clovis preform which was cemented in the brown silty matrix. A date of 11,700±980 yr B.P. (Tx-7000) was obtained. Below the location where this sample was taken (near river's edge), a Cumberland projectile point, two Clovis preforms, and a unifacial scraper were recovered. Unfortunately, these specimens were located out of context, but probably had washed down from the dated deposit (Figure 1).

These cultural deposits are being constantly eroded by the river and it is feared that much of the site has already been washed away. Due to the infrequent location of intact Paleoindian components, it is felt that this site is extremely important to our understanding of Paleoindian occupation in the Central Basin of Tennessee. The Division of Archaeology proposes further fieldwork in 1991 in hope that a series of dates can be run from the levels containing Paleoindian and Early Archaic deposits. Two additional sites on the Cumberland River have been reported which may have the potential for yielding comparable dates. The Division of Archaeology will also be undertaking research on these sites during the next field season.

Figure 1 was drawn by Gary Barker.

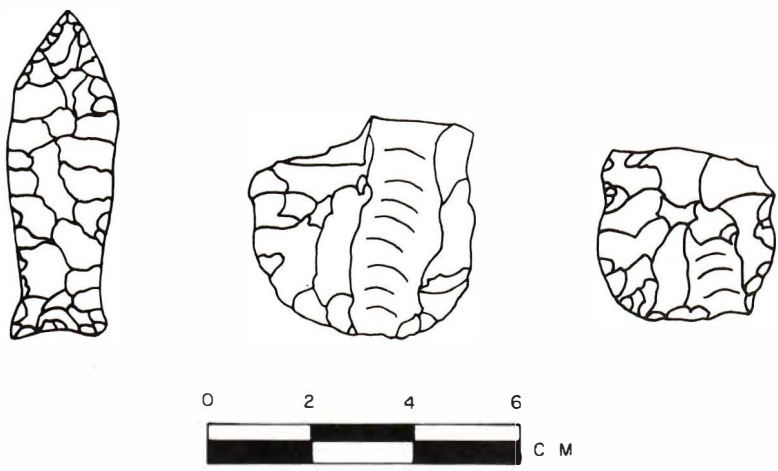

Figure 1. Site 40Dv400; Cumberland projectile point; Clovis preforms.

References Cited

Broster, J. B. 1989. A Preliminary Survey of Paleoindian Sites in Tennessee. *Current Research in the Pleistocene* 6:29-31.

Broster, J. B., and M. R. Norton 1990. Paleoindian Fluted Point and Site Survey in Tennessee: The 1989 Season. *Current Research in the Pleistocene* 7:5-7.

Broyles, B. J. 1971. Second Preliminary Report: The St. Albans Site, Kanawha County, West Virginia. *West Virginia Geological and Economic Survey Report, Archaeological Investigations* 3.

Chapman, J. 1976. The Archaic Period in the Little Tennessee River Valley: The Radiocarbon Dates. *Tennessee Anthropologist* 1(1):1-12.

Chapman. J. 1977. Archaic Period Research in the Lower Little Tennessee River Valley. *University of Tennessee, Department of Anthropology, Report of Investigations* 18.

Clovis and Cumberland Sites in the Kentucky Lake Region

John B. Broster, Mark R. Norton, and Richard Anderson

The Kentucky Lake region, which forms the boundary between west and middle Tennessee, has been known to produce large numbers of fluted Paleoindian projectile points and uniface tools. Local collectors have kindly made their points available for study over the years. Additionally, the Nuckolls site (40Hs60) was extensively tested by archaeologists from the University of Tennessee in the late 1950s (Nuckolls 1958; Lewis and Kneberg 1958). The Nuckolls site has produced at least 13 Clovis, 6 Cumberlands, and 1 Redstone, as well as Beaver Lake, Quad, and Dalton projectile points.

We decided to concentrate our survey efforts in the lake district, due to this past history of investigations and the availability of collections for study. Prior to our research of the last season, only nine archaeological sites from the lake area were known to have produced significant Paleoindian assemblages. Our examinations have added 14 sites to the state survey files. Of these sites, 12 have fluted point components (Clovis, Cumberland, and Redstone). The number of fluted points is rather low as compared to the numbers for late Paleoindian and early Archaic from the same sites. Whether this represents an increase in population or some other cultural process remains an open question at this stage of research.

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A total of 85 Clovis, 28 Cumberland, and 2 Redstone have been documented on 12 of the 23 Paleoindian sites from the region. Within these same sites, metric data has been obtained from 864 late Paleoindian projectile points (122 Beaver Lakes, 39 Quads, 244 Daltons, 72 Harpeth Rivers, 384 Greenbriers) and 27 late Paleoindian preforms. Two Clovis, four Cumberlands, and seven late Paleoindian projectile points were recorded as isolated finds (see Figure 1).

Three of the newly recorded sites have also produced large numbers (+100 per site) of uniface tools. Unfortunately, these sites are all highly deflated by wave action, making it nearly impossible to distinguish between fluted and later Paleoindian assemblages. A local variety of Dover chert constitutes some 85 to 95% of all lithic raw materials on these sites. Potential quarry pits (40Hs202) have been recorded on the eastern bank of the lake in proximity to the old Tennessee River channel. The material from these quarries is the same high quality Dover chert as is found on the Paleoindian sites.

Occupation during the Clovis and later Cumberland times appears to be represented by light to moderate scatters of lithic materials, with numerous fluted preforms being recognized on most of the sites. Tool manufacture and maintenance of hunting equipment are suggested as very important functions for the early occupations. The number of large uniface knives and sidescrapers probably denote some butchering activities taking place on the sites. The fluted point sites are located on the mouths of tributary streams on well drained terrace remnants adjacent to the old Tennessee River channel. These maintenance/manufacturing camps are possibly associated with kill and butchering sites located at lower elevations along the old channel. Unfortunately, such sites, if they exist, are covered by some 13 to 16 m of water.

Before the creation of the lake, these Paleoindian site locations were generally situated at relative short distances from low swampy areas. The locations on major river terraces would have provided Paleoindians with relatively dry elevated areas proximate to probable watering and fording localities for large herd animals. Aquatic resources may also have been important in these locations.

Several hundred artifacts are presently being measured and studied. Reports are being prepared on two of the more extensively occupied sites, 40Hs23 and 40Hs200. Both sites contain Clovis and Cumberland, late Paleoindian, and early Archaic components. A third site, 40Hs173, has been tested and a report will soon be published (Broster and Norton 1990).

It is hoped that this large body of information will be useful in understanding changes from early to later Paleoindian occupations, and as important to the study of the dramatic differences in projectile point styles between the Paleoindian and the early Archaic. Our objective has been to document metric and raw material data from the numerous collections from the region, and to generate accurate provenience determinations for the materials. We have been very fortunate to work with a supportive group of private citizens and amateur archaeologists, and any progress made has been due to their help and encouragement. We plan to continue the recording of collections and site locations for several more years, with the ultimate goal of providing a

solid data base for future researchers interested in the Clovis and later Paleoindian occupations of Tennessee.

Figure 1 was drawn by Gary Barker.

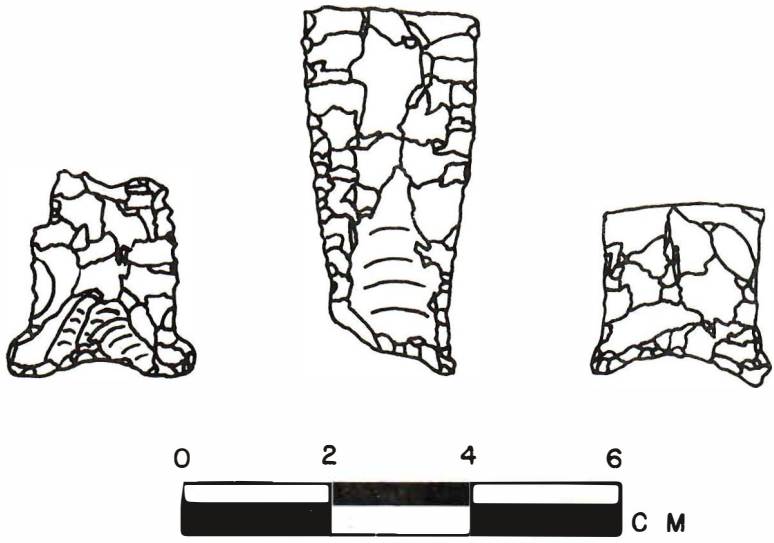

Figure 1. Site 40Hs173: Quad, Cumberland, and Beaver Lake projectile points.

References Cited

Broster, J.B., and M. R. Norton 1990. Lithic Analysis and Paleoindian Utilization of the Twelkemeir Site (40Hs173). *Tennessee Anthropologist* 15. In press.

Lewis, T. M. N., and M. Kneberg 1958. The Nuckolls Site: A Possible Dalton-Meserve Chipping Complex in the Kentucky Lake Area. *Tennessee Anthropologist* 14:61-79.

Nuckolls, J. B. 1958. Paleo and Early Chipped Flint Artifacts. *Tennessee Archaeologist* 14:25-26.

Engraved Cobbles from Early Archaeological Contexts in Central Texas

Michael B. Collins, Thomas R. Hester, David Olmstead, and Pamela J. Headrick

Site 41BL323 in southernmost Bell County, Central Texas, has been the subject of attention intermittently for at least 62 years. It was first trenched by Dr. J. E. Pearce of the University of Texas in 1929 (who dubbed it the Gault Site and believed it to be in Williamson County). Since then, parts of the site have been dug by relic collectors, especially since 1980. Digging by the latter has revealed dense archaeological remains more or less continuously over an area roughly 700 by 200 m. Branches of upper Buttermilk Creek transect the site; permanent springs and seeps feed the creeks at the locality. Most digging has concentrated on the dense midden deposits of early Archaic to late Prehistoric age, but a significant number of artifacts with Paleoindian affiliation have been found (projectile points classifiable as Clovis, Plainview, Folsom, Midland, Hell Gap, Scottsbluff, Angostura, and possibly Golondrina). Over most of the site, these materials are found from the surface to depths of 1.5 m or less. Extensive outcrops of high quality Edwards chert and protective bluffs, in addition to the springs, were probably important factors in the prehistoric uses of the locality.

In one area of the site, digging to a depth of ca. 2.5 m has revealed complex stratigraphy and brought to light at least 4 Clovis points, 10 engraved cobbles, a retouched flake of quartz crystal and numerous chert objects (including cores, flakes, blades, bifacial preforms, a burin spall, fragmentary bifaces, and a unifacial Clear Fork tool). One of us (DO) found two of the engraved cobbles (Figure 1c) with one of the Clovis points (Figure 1b) sandwiched between them. No controlled excavation has yet been conducted in this area of the site and the full context of this find is unknown. Two of us (MBC and TRH) recovered four engraved cobbles from backdirt in this area of the site (Figure 1e). The setting, stratigraphy, and some of the materials recovered in this area of the site are the subject of this note.

The intriguing finds discussed here were made in a restricted area where springs emanate from the base of the valley wall. A thin, transitional Archaic to late Prehistoric midden overlies multiple, interstratified lenses of (1) colluvial, (2) valley fill, and (3) spring deposits, respectively of (1) irregular pebbles to boulders of limestone, (2) silts, sands, and clays, and (3) tufa. A

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calcium carbonate cement separates the base of the midden from underlying deposits. Plainview, Scottsbluff and other early artifact forms occur in conjunction with the calcium carbonate, suggesting that underlying deposits may be earliest Holocene to latest Pleistocene in age. It was from the deepest penetrated lens (apparently of valley alluvium) that the four Clovis points and 10 engraved stones are believed to have originated. We have closely examined only two of the Clovis points.

The larger Clovis point of these two (Figure 1a) is of grayish-tan, patinated (Edwards?) chert, measures 88 by 31 by 9 mm and has recurvate lateral edges. The smaller (Figure 1b), which was found nested between two engraved stones,

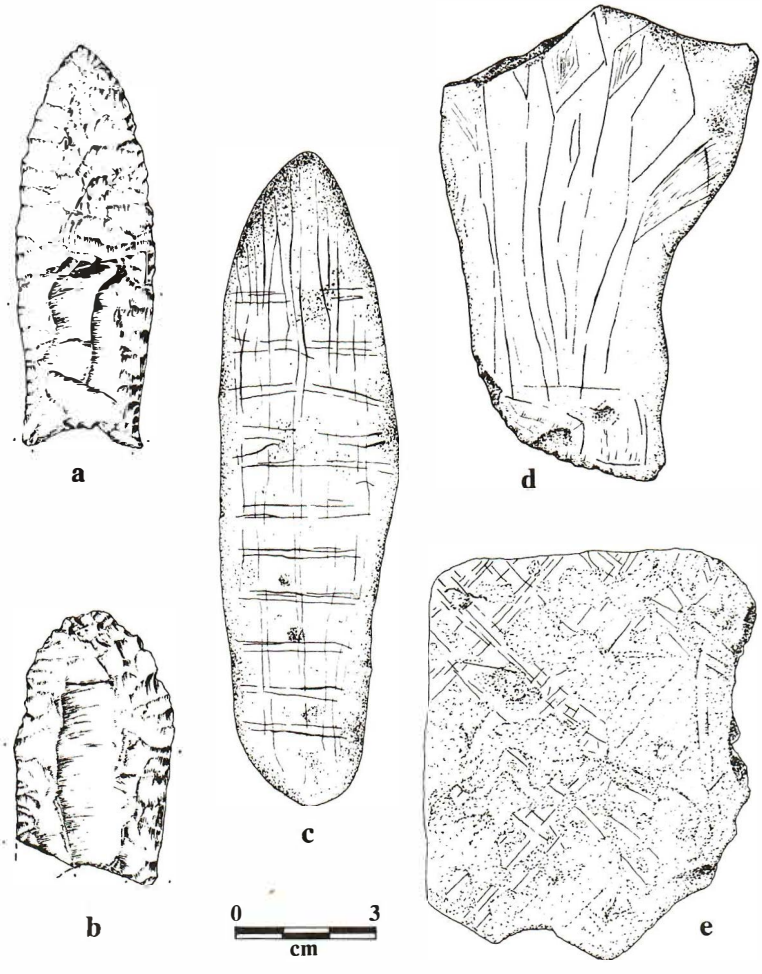

Figure 1. Artifacts from 41BL323. a. Clovis point of Edwards (?) chert; b. Clovis point of Alibates agatized dolomite (dots indicate extent of lateral-edge grinding); c, d, e. Engraved limestone cobbles found at the same depth as the Clovis points.

is of Alibates chert, measures 57 by 33 by 10 mm and has been heavily resharpened.

The 10 engraved stones are all smooth limestone pebbles and cobbles ranging in length from 4.5 to 16.0 cm. Two are broken. Two are engraved bifacially. The engraving consists of fine lines evidently produced with a sharp-edged flake. Straight lines predominate. On four stones, parallel line sets intersect similar sets at various angles to form rectilinear or diamond-shaped grids (Figure 1c, e). Complex patterns of intersecting straight and curving lines dominate on two stones; an animal is depicted as part of one of these. One stone (Figure 1d) has diamond-shaped motifs at the ends of straight lines. Three stones are either too eroded or too carbonate-encrusted for adequate viewing of the engraved patterns.

On the basis of very limited evidence, these engraved stones seem to occur in the same depositional unit as four Clovis points, the only diagnostics found there to date. This unit is well below the calcium carbonate cap which seems to be of very early Holocene age; however, given the presence of active springs, mixing may be a factor in the apparent associations. A controlled excavation is being planned under the auspices of the Texas Archeological Research Laboratory to more fully investigate these occurrences.

At the Wilson-Leonard Site (41WM235), 40 km southwest of the Gault Site, a large chert flake with a rectilinear grid engraved on its cortical exterior in a pattern like that illustrated here (Figure 1 c, e) was found in the deepest cultural zone in association with Midland points.

Casts of six of the specimens have been made possible in part by a grant to Hester form the University Research Institute at the University of Texas at Austin. We also thank Mr. Elmer Lindsey for permission to visit the site. Gratitude is also expressed to Pete Bostrom, Troy, IL, for bringing the materials to Hester's attention. Dr. Frank A. Weir of the Texas State Department of Highways and Public Transportation is thanked for permission to cite the Wilson-Leonard find.

Paleoindian Component at the Linn Woods Site, Sussex County, Delaware

Jay F. Custer and Glen Mellin

The Linn Woods Site is located in the Coastal Plain of southern Delaware on a low knoll overlooking an extensive estuarine marsh complex in the Indian River drainage. Application of local sea level rise curves, soils data, and pollen data indicate that during late Pleistocene times the site was located adjacent to freshwater wetlands within a pine-spruce forest setting.

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Spatial distribution of artifacts at the site indicate two activity areas. One is a cobble reduction area consisting of a debitage concentration over an area of nine square meters. The second activity area consists of a very light artifact scatter extending over 21 m^2 adjacent to the cobble reduction area. The bifaces and core were found within this light artifact scatter and the second activity area probably represents a general habitation/work area distinct from the core reduction area.

The Paleoindian occupation at Linn Woods seems to represent a transient camp at which tool kits were refurbished using local cryptocrystalline cobbles. The presence of a multi-function flake tool and projectile points suggests processing of game animal and plant resources from the local wetlands. The use of Paleoindian sites with low knolls near interior freshwater wetlands shown by the Linn Woods Site are patterns of Paleoindian adaptations seen at a number of sites on the Delmarva Peninsula (Custer 1989; Lowery 1989; Lowery and Custer 1990).

References Cited

Custer, J. F. 1989. Prehistoric Cultures of the Delmarva Peninsula: An Archaeological Study. University of Delaware Press, Newark.

Lowery, D. 1989. The Paw Paw Cove Paleoindian Site Complex, Talbot County, Maryland. Archaeology of Eastern North America 17:143-164.

Lowery, D., and J. F. Custer 1990. Crane Point: An Early Archaic Site in Maryland. Journal of Middle Atlantic Archaeology 6:75-120.

Reappraisal of the MacHaffie Site Paleoindian Occupational Sequence

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Archaeological excavations in 1951 at the famous MacHaffie (24JF4) Paleoindian open-air campsite, southeast of Helena, Montana, documented stratified, in situ Folsom and Cody (Scottsbluff) complex occupations (Forbis and Sperry 1952). The site had been occupied intermittently from early

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Paleoindian to late Middle Period times. In the decades following excavation, the small, culture-bearing peninsula had been severely vandalized, raising doubt concerning site survival. The original MacHaffie artifact and faunal collections were not available for detailed follow-up study.

The MacHaffie site assessment project was initiated in 1989 by three weeks of summer excavation, followed by month-long excavation in 1990. Fieldwork was guided by four objectives: a) to test for extant Paleoindian deposits; b) to perform geoarchaeological studies and detailed pollen and phytolith analyses to permit reconstruction of local paleoecology; c) to obtain and radiocarbon date in situ organic samples from recognized cultural strata; and d) to obtain artifacts and ecofacts from each discerned cultural stratum for analysis and Museum interpretation.

The MacHaffie site is situated on the northwest flank of the Elkhorn Mountains, a major, northwest to northeast trending range composed largely of intrusive and extrusive igneous rocks of Cretaceous age. The site, at an elevation of ±1,280 m, is contained within the center of the narrow alluvial floor of a northwest draining, spring-fed, ephemeral stream valley, tributary to Prickly Pear Creek from the east. In 1989, a 13.0 m long, ±2.3 m deep trench was emplaced across this non-eroded "island", just upgrade from the original excavation area. The basal 1.2 m thick alluvial unit contains three A-C horizons; the early Holocene was evidently a time of geomorphic stability. Evidence for four Paleoindian occupational events is enveloped within specific alluvial deposits. The upper three are marked by discrete, layered accumulations of lithic and bone detritus. The lowermost, which lacks clear stratification but is traceable in parallel with overlying occupational strata, is contained within a nonpedogenic, micaceous clayey sand and gravel unit of unknown depth.

The affiliations of the four recognized Paleoindian cultural strata are identified provisionally: Stratum I (Folsom ?), Stratum II (Folsom), Stratum III (Scottsbluff ?), and Stratum IV (Scottsbluff). While two broken bifaces were recovered from Stratum I and two broken bifaces were found in Stratum IV (one steeply marginally retouched flake, and one elongate end scraper with a graver-type spur), the only diagnostic recovered during both seasons is a chalcedony channel flake from Stratum II. Locally quarried chert and chalcedony dominate these lithic assemblages. The section through the peninsula, sampled in 1989 and expanded along the south bank in 1990, is considerably thicker, at ±2.3 m, than the originally excavated section adjacent but downslope to the west. The increased depth of the section at that upgrade location probably explains stratigraphic separation and the doubling of culture-stratigraphic entities indicated by current research.

Analysis of pollen samples recovered in 1989 from the entire section indicate that sagebrush (*Artemisia*) steppe predominated in this locality throughout the Holocene. The valley floor itself was covered by riparian vegetation prior to ca. 8,280 yr B.P. Increases in sagebrush pollen immediately thereafter mark the onset of mid-Holocene Altithermal conditions. At an as yet undated

interval within the overlying colluvial unit, an explosive increase of pine (*Pinus* sp.) pollen records the onset of Medithermal conditions.

MacHaffie Stratum II yielded small amounts of fragmentary, unidentifiable bones, and a first phalanx from a large canid (*Canis* sp., cf. *Canis lupus*). Stratum IV yielded the proximal end of a shed deer (*Odocoileus* sp.) antler and forelimb and hindlimb bones of a minimum of one bison (*Bison* sp.). The size of the bison bones compares favorably with adult male bison from Cody complex sites such as Horner (48PA29) (Todd 1987) and Finley (48SW5) (Bedord 1974) in Wyoming. Horner site bison are identified as *Bison* sp., cf. *B. antiquus* (Walker 1987). The absence of axial elements suggests selective use of carcass parts, while cut marks and probable impact scars (hammerstone) present on several long bones indicate meat removal and probable marrow extraction.

$^{13}C/^{12}C$ corrected radiocarbon ages were obtained on archaeological bone and carbonized wood samples collected in 1989 from specific cultural provenances within the profile at the south end of the trench: unidentifiable, unburned bone from Stratum I, 9,340±120 yr B.P. on apatite carbon (GX-15150-A-AMS); unburned bone scraps from Stratum II, 9,130±550 yr B.P. on apatite carbon (GX-15151-A) and 9,000±130 yr B.P. on bone collagen (GX-15151-G-AMS); wood charcoal flecks from Stratum III, 8,620±200 yr B.P. (GX-15152-AMS); and part of an unburned *Bison* sp. vertebral process from Stratum IV, 8,280±120 yr B.P. on bone collagen (GX-15153-G-AMS) and 7,905±435 yr B.P. on apatite carbon (GX-15153-A). The original solid carbon method age obtained from carbonized wood, of 8,100±300 yr B.P. (L-578A) for the Scottsbluff stratum (Forbis 1962), is consistent with the Stratum IV AMS ages.

The re-dating of Stratum II, using charcoal extracted from carbonaceous sediments in 1990 in order to test the low magnitude of the AMS age, yielded an (unacceptable) age of 8,019±136 yr B.P. (UGA-6309). A $^{13}C/^{12}C$ radiocarbon age obtained from charcoal particles contained in carbonaceous sediments of Stratum III in 1990, of 8,403±109 yr B.P. (UGA-6307), effectively corroborates the age of 8,620 yr B.P. previously determined for that occupation.

The radiocarbon age series for the MacHaffie Paleoindian horizons is overall systematically younger than expected, although the relative time-stratigraphic order test is met by that array. The Stratum II (Folsom) ages of 9,130 and 9,000 yr B.P. are significantly too recent, given established precedent. However, the possibility that MacHaffie Folsom is that recent is supported indirectly by the apparent lengthening of Folsom complex duration, as hinted by ages of 9,950 and 9,770 yr B.P. reported for Folsom at the Rattlesnake Pass site (48CR4520) in south-central Wyoming (and elsewhere as recent as 10,060 yr B.P.) (Smith and McNees 1990). A possibly relevant age of 9,380±110 yr B.P. (TO-1097) was obtained on seeds from a silty clay zone below the Cody complex bone bed (*Bison* sp.) at the Fletcher site (DjOw-1) in southern Albert (Vickers and Beaudoin 1989). That age is equivalent to the 9,340 yr B.P. age for Stratum I below the Cody complex occupation or occupations at MacHaffie. Given the MacHaffie situation, the overlying Cody stratum at Fletcher may not be as old as may be expected. In any case, efforts to establish an accurate radiocarbon chronology for the MacHaffie Paleoindian occupations, by testing for local

contaminants and the fine-grained collection and dating of additional organic samples, and to recover diagnostic artifacts will continue in 1991.

Ongoing research at MacHaffie, one of several "First Montanans Search Program" Paleoindian projects underway, is funded by the Kokopelli Archaeological Research Fund administered by the MSU Foundation and was also supported by the Office of the President and the Office of the Vice President for Research at Montana State University. We are also grateful to Pamela Bompart, property owner, for permitting research access to this important National Register heritage site.

References Cited

Bedord, J. N. 1974. Morphological Variation in Bison Metacarpals and Metatarsals. In *The Casper Site: A Hell Gap Bison Kill in the High Plains*, edited by G. C. Frison, pp. 199-240. Academic Press, New York.

Forbis, R. G. 1962. Comments on Ronald J. Mason's The Paleo-Indian Tradition in Eastern North America. *Current Anthropology* 3:252.

Forbis, R. G., and J. D. Sperry 1952. An Early Man Site in Montana. *American Antiquity* 18:127-133.

Smith, C. S, and L. M. McNees 1990. Rattlesnake Pass Site: A Folsom Occupation in South-Central Wyoming. *Plains Anthropologist* 35:273-289.

Todd, L. C. 1987. Taphonomy of the Horner II Bone Bed. In *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by G. C. Frison, and L. C. Todd, pp. 107-198. Academic Press, New York.

Vickers, R. V, and A. B. Beaudoin 1989. A Limiting AMS Date for the Cody Complex Occupation at the Fletcher Site, Alberta, Canada. *Plains Anthropologist* 34:261-264.

Walker, D. N. 1987. Horner Site Local Fauna: Vertebrates. In *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by G. C. Frison, and L. C. Todd, pp. 327-345. Academic Press, New York.

The Lake Chapala First Mexicans Project Jalisco, Mexico

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The search for the New World's first immigrants is often guided by tantalizing clues and teasing circumstantial evidence (Lynch 1990; Meltzer 1989). The Lake Chapala First Mexicans Project is no different.

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For many years, researchers from Guadalajara aided by local residents have been collecting fossils from in and around the Lake Chapala and Lake Zacoalco basins high in the mountains just south of Guadalajara in the state of Jalisco, Mexico. The collections housed at the University of Guadalajara and the Museo Regional de Guadalajara now consist of over one half million Pleistocene mammalian fossils. The specimens range from tiny fragments to complete skeletal elements and include bear (*Arctodus pristinus*), bison (*Bison* sp.), camel (*Camelops* sp.), capybara (*Noechoerus*), coyote (*Canis latrans*), deer (*Cervus* sp., *Odocoileus hemionus, O. virginianus*), glyptodon (*Glyptodon* sp.), panoathere armadillo (*Holmesina* sp.), horse (*Equus* sp.), jaguar (*Panthera* sp.), llama (*Lama* sp.), mammoth (*Mammuthus* sp.), ground sloth (*Eremotherium* sp.), ground sloth (*Nothrotheriops* sp.), sabertooth (*Smilodon californicus*), wolf (*Canis lupus*) and others. The collection localities which cover several square kilometers are flat seasonally dry clay pans at the lowest elevations of the two internal drainage basins. In all likelihood, the localities contain thanatcoenose (transported death) assemblages. The presence of both mammoth and mastodon as well as numerous late prehistoric artifacts at the same collection locations support that contention.

At the same collection localities, a number of other objects were recovered. They include bone and antler fragments that appear to have been modified by humans into various tool forms (Solórzano 1990). These possible tools were made on bone and antler elements tentatively identified as camel, deer, horse, and mammoth. Also, human skeletal remains, mostly skull and jaw fragments and teeth, were found. They were mineralized to a high degree and highly fragmentary. The mineralization is most interesting in that local variants in ground water minerals shows up in the human remains and mammalian fossils. Both the human and other mammalian fossils from the Chapala Basin are a black to charcoal gray color while those from Zacoalco, a few kilometers to the west, are a muddy brown to gray tan color.

In May 1990, the authors conducted a brief survey of the Chapala/Zacoalco region on the assumption that most if not all of the materials that had been redeposited in the basins were being washed down by the rapid runoffs and flash floods that accompany the annual rainy seasons (May to July). Work began on locating and mapping the remnant Pleistocene Lake Chapala strand lines. Concentrating on the north shore of present day Lake Chapala, Pleistocene beaches were found one to three kilometers from the modern beach. It is likely remnants will be found and recorded in the other quarters as well. We concentrated on these beaches since if humans coexisted with Pleistocene fauna, any remains of that interaction would most likely be located above Pleistocene water levels.

A more controlled survey of the northern shore of Lake Chapala is planned for the 1991 season. The goal is to locate primary deposits, sites that contain evidence of a human presence in western Mexico during the late Pleistocene. It is expected that the First Mexicans Project will take five years to complete and involve a multi-disciplinary team of at least four specialists (one each in archaeology, paleontology, geology, and physical anthropology). In addition

to the archaeological aspect, the First Mexicans Project will focus on the late Pleistocene climate and environment of western Mexico.

The 1991 season will take place between late July and early September. At that point, detailed maps of the Pleistocene beaches will be drawn and artifact and fossil collections described. It is entirely possible that the circumstantial association of Pleistocene fauna and humans will be seen as a spurious one. If that is the case, we will still have learned something. Our hypotheses that humans were present in western Mexico during the late Pleistocene will be rejected but we will have accomplished two goals: 1) we will have gained an understanding of the late Pleistocene climate/environment in that area, and 2) another body of potential First Americans data will have been examined and eliminated from the First Americans inventory. The remaining data can only be the clearer for our efforts.

References Cited

Lynch, T. F. 1990. Glacial-Age Man in South America. *American Antiquity* 55:12-36.

Meltzer, D. J. 1989. Why Don't We Know When the First People Came to North America? *American Antiquity* 54:471-490.

Solórzano, F. A. 1990. Pleistocene Artifacts from Jalisco, Mexico: A Comparison with Some Pre-Hispanic Artifacts. In *Bone Modification*, edited by R. Bonnichsen, and M. H. Sorg, pp. 499-514. The Center for the Study of the First Americans, Orono.

Early Holocene Archaeological Sites in Mono Basin, East-Central California—Southwestern Nevada

M. C. Hall

Recent investigations along the California-Nevada border revealed apparent early Holocene archaeological deposits at two adjacent sites on the northeastern margin of Mono Basin. Situated 13 km east-northeast of the northeastern shore of Mono Lake, CA-MNO-473 and CA-MNO-474 appear to have been first recorded in 1960 by the late E. L. Davis. Whether any artifacts were removed at that time is not known. Surface artifacts are scattered over a 95 by 180 m area at MNO-473, 10 by 45 at MNO-474. The MNO-473 fieldwork involved 1130 m^2 of systematic surface collection, and excavations amounting to

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15.7 m^3 (24 units, 336 m^2); surface collection at MNO-474 encompassed 457 m^2 excavations totaling 9.2 m^3 (12 units, 28 m^2). Select surface artifacts were retrieved outside formal collection units at each site.

Both MNO-473 and MNO-474 sit atop gravelly benches separated by a 60-80 m-wide, 10 m-deep intermittent drainage emanating from uplands immediately to the northeast. These benches represent terraces related to Pleistocene Lake Russell (ancestral Mono Lake) or low-gradient, distal remnants of basin-margin alluvial fans of like age. The two sites lie between 3 m above and 44 m below the variously estimated maximum surface elevation reached by Lake Russell (cf. Gilbert et al. 1968; Lajoie 1968; Mifflin and Wheat 1979; Russell 1889). However, the lack of geochronological data on relict strand lines precludes assessment of local lacustral conditions attending early Holocene human occupations of MNO-473 and MNO-474. Mantling the bench landforms to varying depths are mixtures of tephra, other pyroclastic debris, and eolian-redeposited lacustrine sediments. Though airfall deposits are massive and thick in places, archaeological remains at each site (excepting those associated with two confined historic features) were found mainly in the highly bioturbated eolian/lacustrine sediments that tend to underlie the volcanic strata or resting on lake terrace/alluvial fan gravels wind-stripped of small particles.

Affording chronological perspectives of MNO-473 and MNO-474 are hydration-rind measurements on obsidian artifacts and the recovery from each location of presumed early Holocene projectile point forms. Relevant carbon suitable for radiometric assay was not found at either site. Comprising the latter are Great Basin Stemmed or Western Stemmed (18 at MNO-473, one at MNO-474) and Great Basin Concave-base or Western Clovis (one at MNO-474) types generally attributed ages greater than ca. 7,500 yr B.P. (cf. [among others] Basgall 1988; Carlson 1983; Heizer and Hester 1978; Holmer 1986; Pendleton 1979; Tuohy and Layton 1977; Warren and Phagan 1988; Willig and Aikens 1988). Geochemical analysis distinguished five different kinds of obsidian among the hydration samples drawn (Jackson 1990), sources occurring within 20 to 50 km of the subject sites (cf. Ericson et al. 1976). The MNO-473 sample included 10 pieces of flaking detritus and 9 stemmed points, all yielded hydration values in excess of 7 microns -- a measurement threshold surpassed rarely in hydration profiles of obsidian artifacts elsewhere in the Mono Basin region. Briefly, values of 7.7-10.4 microns were obtained for eight specimens of Mt. Hicks geologic origin (four flakes, four points), 7.1-10.4 for six Truman-Queen specimens (four flakes, two points), 8.3-9.3 for two Bodie Hills specimens (points), 9.6-10.1 for two Casa Diablo specimens (flakes), and 10.6 microns for the lone specimen of Glass Mountain material (point). The most reliable hydration rate available for Casa Diablo obsidian (Hall 1984; Hall and Jackson 1989) provides age estimates of 8,100 and 8,800 yr B.P. for the two MNO-473 samples of this glass. While comparable rates are not yet developed for the other obsidians, studies indicate that they are unlikely to be strikingly divergent (Hall 1983; Meighan 1981; Tremaine 1990). This, in turn, suggests ages exceeding seven millennia for the Mt. Hicks, Truman-Queen, Bodie Hills, and

Glass Mountain artifacts from MNO-473. As for the MNO-474 samples, both points from the site (already noted) are made of Casa Diablo glass. Using the rate cited above, hydration values of 9.5 and 9.8 microns for these specimens convert to 7,900 and 8,400 yr B.P. Nine waste flakes from MNO-474 were analyzed as well, the measurements falling between 7.9 and 10.1 microns (glass types: five Truman-Queen, three Mt. hicks, one possible Bodie Hills). Hence, coupled with the stemmed and concave-base points recovered, the MNO-474 hydration data ascribe substantial antiquity to the archaeological remains at this location.

All told, relatively depauperate artifact assemblages were acquired from each site: under 800 items at MNO-473, barely over 150 at MNO-474. Flaked stone dominates both assemblages, consisting primarily of chipping debris (93-94%). Along with the aforementioned projectile points, specific implements from MNO-473 include 11 bifaces, 2 formed flake tools (keeled, scraper-like devices), and 21 simple, or casually modified flake tools; the MNO-474 specimens include 4 bifaces, 3 similar formed flake tools, and 1 simple flake tool. Of note is the fact that the MNO-473 assemblage contains five millingslab fragments, milling equipment being reportedly an uncommon element in early Holocene archaeological deposits. The meager quantities of material encountered at both sites are consistent with those seen at other early post-glacial localities in the general region, and imply fairly ephemeral episodes of settlement activity. Albeit overall sample sizes are quite limited, hydration measurement ranges leave open the distinct possibility of multiple occupations of each site over a perhaps not inconsiderable span of time. Additionally, obsidian source diversity in the analyzed artifacts bespeaks of geographically wide-ranging land-use systems at the outset of the post-glacial period (cf. Basgall 1989). Much subsurface exploration remains to be done at these Mono Basin sites, particularly since large areas of each are blanketed with thick layers of volcanic airfall. Inasmuch as formal investigation of a clearly early Holocene cultural deposit has been undertaken at only one other location in the region, CA-MNO-679 35 km to the south in Long Valley (Basgall 1988), it is hoped opportunities arise to pursue further the structure, content, and meaning of MNO-473 and MNO-474.

Work at the Mono Basin sites was conducted by Archaeological Research Services, Inc., Virginia City, Nevada, under contract to the Oxbow Geothermal Company, Reno, Nevada, on order to evaluate the National Register-eligibility of these 2 and 21 other sites impacted by installation of a powerline between central Nevada and eastern California (Hall 1990). Hydration samples were processed by the author using facilities provided by R. E. Taylor, Archaeometry Laboratory, University of California, Riverside. V. L. Clay assisted in stratigraphic characterizations. M. E. Basgall and T. B. Snyder supplied the stressing but needed critical comment.

References Cited

Basgall, M. E. 1988. The Archaeology of CA-MNO-679: A Pre-Archaic Site in Long Valley Caldera, Mono County, California. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface*, edited by J. A. Willig, C. M. Aikens, and J. L. Fagan, pp. 103-119. Nevada State Museum Anthropological Papers 21.

Basgall, M. E. 1989. Obsidian Acquisition and Use in Prehistoric Central Eastern California: A Preliminary Assessment. In *Current Directions in California Obsidian Studies*, edited by R. E. Hughes, pp. 111-126. University of California Archaeological Research Facility Contributions 48.

Carlson, R. L. 1983. The Far West. In *Early Man in the New World*, edited by R. Shutler, Jr., pp. 73-96. Sage Publications.

Ericson, J. E., T. A. Hagan, and C. W. Chesterman 1976. Prehistoric Obsidian in California, II: Geologic and Geographic Aspects. In *Advances in Obsidian Glass Studies: Archaeological and Geochemical Perspectives*, edited by R. E. Taylor, pp. 218-239. Noyes Press.

Gilbert, C. M., N. M. Christensen, Y. Al-Rawi, and K. R. Lajoie 1968. Structural and Volcanic History of Mono Basin, California-Nevada. In *Studies in Volcanology: A Memoir in Honor of Howell Williams*, edited by R. R. Coats, R. L. Hay, and C. A. Anderson, pp. 275-329. Geological Society of America Memoir 116.

Hall, M. C. 1983. Late Holocene Hunter-Gatherers and Volcanism in the Long Valley-Mono Basin Region: Prehistoric Culture Change in the Eastern Sierra Nevada. PhD dissertation, University of California, Riverside.

Hall, M. C. 1984. Obsidian, Paleoeconomy, and Volcanism in the Eastern Sierra Nevada. Paper presented at the Biennial Meeting of the Great Basin Anthropological Conference, October, Boise.

Hall, M. C. 1990. The Oxbow Archaeological Incident: Investigations at Twenty-three Locations Between Owens Valley, Eastern California, and Walker Basin, Southwestern Nevada. Report on file, Inyo National Forest, Bishop.

Hall, M. C., and R. J. Jackson 1989. Obsidian Hydration Rates in California. In *Current Directions in California Obsidian Studies*, edited by R. E. Hughes, pp. 31-58. University of California Archaeological Research Facility Contributions 48.

Heizer, R. F., and T. R. Hester 1978. Great Basin. In *Chronologies in New World Archaeology*, edited by R. E. Taylor and C. W. Meighan, pp. 147-199. Academic Press, New York.

Holmer, R. N. 1986. Common Projectile Points of the Intermountain West. In *Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings*, edited by C. J. Condie and D. D. Fowler, pp. 89-115. University of Utah Anthropological Papers 110.

Jackson, T. L. 1990. Obsidian Geochemical Source Determinations. In *The Oxbow Archaeological Incident: Investigations at Twenty-three Locations Between Owens Valley, Eastern California, and Walker Basin, Southwestern Nevada*, by M. C. Hall, pp. B1-B12. Report on file, Inyo National Forest, Bishop.

Lajoie, K. R. 1968. Late Quaternary Stratigraphy and Geologic History of Mono Basin, Eastern California. PhD dissertation, University of California, Berkeley.

Meighan, C. W. 1981. The Little Lake Site, Pinto Points, and Obsidian Dating in the Great Basin. *Journal of California and Great Basin Anthropology* 3:200-214.

Mifflin, M. D., and M. M. Wheat 1979. Pluvial Lakes and Estimated Pluvial Climates of Nevada. *Nevada Bureau of Mines and Geology Bulletin* 94.

Pendleton, L. S. 1979. Lithic Technology in Early Nevada Assemblages. MA thesis, California State University, Long Beach.

Russell, I. C. 1889. Quaternary History of Mono Valley, California. *Eighth Annual Report of the United States Geological Survey*, 1887:261-394.

Tremaine, K. 1990. A Relative Dating Approach for Bodie Hills and Casa Diablo Obsidians Derived from Accelerated Hydration Experiments. Paper presented at the Annual Meeting of the Society for California Archaeology, April, Foster City.

Tuohy, D. R., and T. N. Layton 1977. Toward the Establishment of a New Series of Great Basin Projectile Points. *Nevada Archeological Survey Reporter* 10(6):1-5.

Warren, C. N., and C. Phagan 1988. Fluted Points in the Mojave Desert: Their Technology and Cultural Context. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface*, edited by J. A. Willig, C. M. Aikens, and J. L. Fagan, pp. 121-130. Nevada State Museum Anthropological Papers 21.

Willig, J. A., and C. M. Aikens 1988. The Clovis-Archaic Interface in Far Western North America. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface*, edited by J. A. Willig, C. M. Aikens, and J. L. Fagan, pp. 1-40. Nevada State Museum Anthropological Papers 21.

Pavo Real: An Early Paleoindian Site in South-Central Texas

Jerry Henderson and Glenn T. Goode

From June 1979 to January 1980, the Texas State Department of Highways and Public Transportation excavated the Pavo Real Site (41BX52), a stratified multicomponent site on the east bank of Leon Creek in northwest San Antonio, Bexar County, Texas (Henderson 1980). A discrete early Paleoindian component, isolated both above and below by alluvial gravel deposits, was discovered at the site. The Paleoindian deposit occurred 50 to 70 cm below the present-day ground surface in a paleosol averaging 15 to 20 cm in thickness. Contained

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within this paleosol was a depositional lens having a thickness of ca. 3 to 5 cm. Clovis and Folsom artifacts were concentrated in a narrow band within this lens.

The lithic assemblage includes several major tool and debitage categories found at other early Paleoindian sites, such as Blackwater Draw (Hester et al. 1972), the Hanson Site (Frison and Bradley 1980), Lindenmeier (Wilmsen and Roberts 1978), and Shifting Sands (Amick et al. 1989). Recovered diagnostic artifacts include two reworked Clovis points, a small basal fragment of a third Clovis point, seven Folsom points including three small unfluted bifaces, and six Folsom preforms—some broken in manufacture.

A variety of scrapers constitutes the largest tool category in the assemblage. There are approximately 40 end scrapers, some with beaks and/or trimmed lateral edges; about half of this group are made on blades. Several side scrapers are made on flakes, and at least 10 to 12 flakes and blades have minor trimming and/or use modification of lateral and distal edges.

Among the debitage categories there are more than a dozen biface fragments, 8 to 10 cores, and the first core tablet flake found with an early Paleoindian component (D. Stanford, pers. comm. 1985). Included in the broken bifaces is a knife preform, 55 mm wide by 5 mm thick, and two possible blanks for Clovis points. The debitage sample is in the range of 15,000 specimens.

Paleoindian lithic technology at Pavo Real exploited an immediately available and abundant Edwards chert of variable quality. Some of this raw material was found on and near the site, and the large amount of debitage, including cores, cortex flakes, and shatter spall, indicates that the site was a quarry workshop as well as a campsite.

Preliminary analysis of the assemblage permits some observations about early Paleoindian lithic technology in south-central Texas. Aside from the fluting and pressure-flaking of Folsom (and possibly Clovis) points, lithic technology was based predominantly, but not exclusively, on hard-and-soft-hammer direct percussion. Clear evidence of this is seen in the platforms of many specimens in the tool and/or blade categories, as well as in core and flake debitage.

The direct percussion method is particularly evident among the platforms of 15 to 20 straight to moderately curved blades. However, because most of these blades are initial removals from cores, they are not representative of the total sample. Some initial blades have cortex, and a few have edge modification. Blade tools, on the other hand, are extensively modified. Although platforms have been removed from most blade tools, a few exhibit the marked curvature of some Blackwater Draw (Green 1963) and Kevin Davis (Young and Collins 1989) cached blades.

A bison (*Bison* sp.) tooth and three small unidentifiable bone fragments were the only faunal remains recovered. Two apparent hearth localities were present. Each was a small circular area, about 30 cm in diameter, consisting of burned soil, flecks of charcoal, and small pebbles. In apparent association with one of these hearths were three beaked scrapers and two large flakes with trimmed lateral edges.

Since the Paleoindian material assemblage at Pavo Real is a mixture from the encampments of both Clovis and Folsom people, efforts to separate the Folsom artifacts from the Clovis will be one of the more critical, and challenging, aspects of the analysis. Preliminary examinations by several archaeologists have yielded varying opinions concerning the cultural affiliation of the site's blade industry. These fall into three groups: those who suggest a decided Clovis affiliation, those who suggest a primarily Folsom affiliation, and those who ascribe both Clovis and Folsom affinities to blade making.

Based on the number and variety of tools present, as well as patterning of features and artifact concentrations, it is believed that Pavo Real represents a multiple-activity, repeated seasonal encampment. Proximity to water and the availability of an abundant chert source were probably critical factors in selecting this location. The finding of a single bison tooth is not grounds for much speculation, but the campsite is located directly opposite a high limestone bluff that could have served as a bison jump. The bluff, along which Leon Creek flows today, forms the western wall of the narrow creek valley. It stands about 75 m west of the campsite.

The authors wish to thank Dennis Stanford, Robert J. Mallouf, and Michael B. Collins for technical advise and support.

References Cited

Amick, D. S., J. L. Hofman, and R. O. Rose 1989. the Shifting Sands Folsom-Midland Site in Texas. *Current Research in the Pleistocene* 6:1-3.

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

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

Henderson, J. 1980. A Preliminary Report of Texas Highway Department Excavation at 41BX52—The Paleo Component. *Texas Archeology* 24:14-15.

Hester, J. J., E. L. Lundelius, Jr., and R. Fryxell 1972. *Blackwater Locality No. 1: A Stratified, Early Man Site in Eastern New Mexico*. Southern Methodist University, Dallas, and Fort Burgwin Research Center, Rancho de Taos, New Mexico.

Wilmsen, E. N., and F. H. H. Roberts, Jr. 1978. *Lindenmeier, 1934-1974, Concluding Report on Investigations*. Smithsonian Institution Press, Washington.

Young, B., and M. B. Collins 1989. A Cache of Blades with Clovis Affinities from Northeastern Texas. *Current Research in the Pleistocene* 6:26-28.

Clovis Occupation in Oklahoma

Jack L. Hofman and Don G. Wyckoff

During the past two decades we have been collecting information on Paleoindian artifacts found throughout Oklahoma. In part as a result of this continuing survey, 90 Clovis points are now documented from Oklahoma. Although this survey has been opportunistic rather than systematic, and the documentation of Oklahoma Clovis material is in no sense complete, we believe that the present sample provides a useful source for beginning study of Clovis technology in the state. These data may serve as an initial basis for comparing and contrasting Clovis technology with other Paleoindian records in the region and with Clovis samples from elsewhere (e.g., Brown and Logan 1987; Copeland and Fiske 1988; Hester 1972; Huckell 1982; Meltzer 1987).

At present, information on the Clovis occupation in Oklahoma is limited to brief usually site-specific reports (e.g., Baker, 1957; Gettys 1984; Hammatt 1969; Thurmond 1990; White 1987) and to the well documented Domebo site finds (Leonhardy 1966). The only radiocarbon dates for Clovis in Oklahoma are from Domebo (Leonhardy 1966; Stafford et al. 1987). This paper is an initial step toward a broader and more integrated documentation of Oklahoma Clovis material.

Typological problems cannot be addressed here, but mention should be made of the difficulty in differentiating between heavily reworked Dalton and Clovis points and small basal fragments from central and eastern Oklahoma. Many Dalton points from the region are well fluted, but Clovis points are usually not beveled. This problem is further exacerbated by the extreme variability in basal form and degree of fluting which is exhibited by Clovis material having good contextual control (Frison and Todd 1986; Haury et al. 1959; Hester 1972; Leonhardy 1966). The problem with distinguishing between Clovis and Dalton in eastern Oklahoma and between Clovis and Plainview in western Oklahoma is unquestionably a factor limiting the number of documented Clovis points from Oklahoma. Problematic specimens are not included here.

Clovis points are documented from extreme western to eastern and northern to southern Oklahoma (Figure 1). This distribution is, however, uneven. Only three Clovis points are now recorded from the forested region of eastern Oklahoma while 38 are documented from the dissected prairie plains region and 30 from the western high plains region. The Cross Timbers or oak savanna

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area of Oklahoma currently has 17 Clovis points with most from the Arkansas and Red River areas. The highest frequencies per county occur in Cimarron, Texas, and Caddo counties thanks largely to the close cooperation of avocational archaeologists residing there. The spotty nature of this initial Clovis distribution map indicates that there are undoubtedly many unrecorded finds. The current dirth of information on Clovis material from north central and central Oklahoma is perhaps the result of limited archaeological activity in the former area and the deeply buried late Pleistocene valley fills in the latter area. Only 21 of Oklahoma's 77 counties have documented Clovis points.

The mean length of 57 specimens is 6.37 cm, mean maximum width (n=79) is 2.58 cm, mean basal width (n=68) is 2.29, and mean thickness (n=60) is 0.71 cm. the range in length is from 3.6 to 15.7 cm.

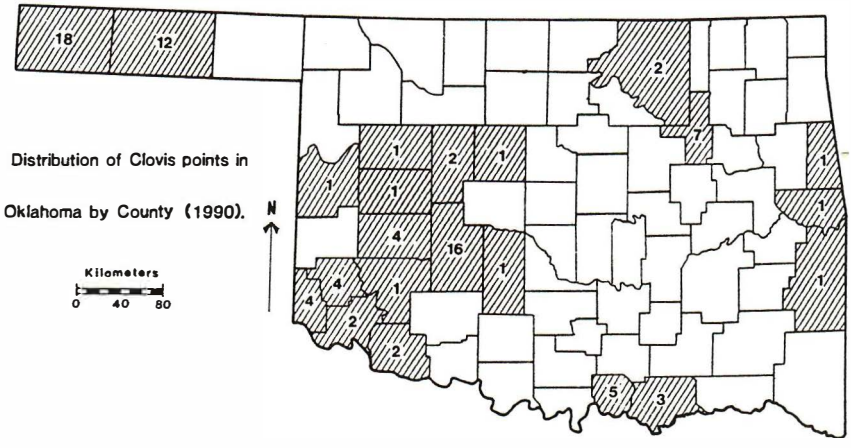

Figure 1. Frequency distribution of documented Clovis points in Oklahoma by county as of 1990.

Raw material utilization is in sharp contrast to that known for Oklahoma Folsom (Hofman 1987). The predominant material is Alibates (n=28; 31%), followed by Edwards chert (n=19; 21%), quartzites including Tecovas and Dakota (n=15; 16.6%), unidentified cherts (n=11; 12.2%), and a variety of materials represented by three or fewer specimens including crystal quartz, Florence, Boone, Johns Valley, Niobrara, and Oolagah cherts. Unidentified agate and chalcedony are also represented. One Clovis from Texas County appears to be made from Flattop Chalcedony (with its source in northeastern Colorado). Some interesting patterns are beginning to appear in the distribution of raw materials. Edwards chert is rare as Clovis points in the Panhandle region (n=2) where most pieces are made from Alibates and quartzites. Edwards chert Clovis points are primarily from southwestern and southcentral Oklahoma. The Florence, Oolagah, and Boone chert Clovis points occur in the general areas of their sources. The Niobrara jasper specimen is from Roger Mills County in westcentral Oklahoma.

Reported points are dominated by complete specimens (n=52; 57.7%), nearly complete pieces (n=13; 14.4%), and bases (n=20; 22.2%). Probable impact breaks are evident on 24 (n=26.6%) of the specimens and 9 of these were reworked after breakage. Lateral resharpening is also common. As samples for study increase it will be interesting to evaluate the possibility that impact breakage versus lateral resharpening may vary in different ecological regions. Much remains to be learned about Clovis in Oklahoma, but the initial summary provided here documents the potential this data set has in contributing to the general study of the Clovis occupation in North America.

We deeply appreciate the many individuals who have aided in documenting these artifacts. Among those providing substantive information are R. E. Bell, T. Spivey, L. Neal, P. Thurmond, R. Drass, C. Wallis, E. Craft, T. Nowka, R. Patterson, R. White, C. Rhoton, G. and L. LeVick, J. and A. Bullard, D. Coley, J. Cox, S. Sumner, B. Splawn, L. Thomason, I. Stout, F. Freeze, A. and J. J. Rogers, F. Bright, R. Schuermann, F. Newkumet, K. Saunders, R. Crabtree, B. Ramsey, and G. Ottinger.

References Cited

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

Brown, K., and B. Logan 1987. The Distribution of Paleoindian Sites in Kansas. In *Quaternary Environments of Kansas,* edited by W. C. Johnson, 189-195. Kansas Geological Survey Guidebooks Series 5. Lawrence.

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

Frison, G. C., and L. C. Todd 1986. *The Colby Site: Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming.* University of New Mexico Press, Albuquerque.

Gettys, M. 1984. Early Specialized Hunters. In *Prehistory of Oklahoma*, edited by R. E. Bell, pp. 97-108. Academic Press, Orlando.

Haury, E., E. B. Sayles, and W. W. Wasley 1959. The Lehner Mammoth Site, Southeastern Arizona. *American Antiquity* 25:2-30.

Hammatt, H. H. 1969. Paleoindian Projectile Points from the Domebo Canyon. *Bulletin of the Oklahoma Anthropological Society* 18:39-41.

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

Hofman, J. L. 1987. The Occurrence of Folsom Points in Oklahoma. *Current Research in the Pleistocene* 4:57-59.

Huckell, B. 1982. The Distribution of Fluted Points in Arizona: A Review and an Update. *University of Arizona, Arizona State Museum, Archaeological Series* 145.

Leonhardy, F. C. (ed.) 1966. *Domebo: A Paleo-Indian Mammoth Kill on the Prairie Plains.* Contributions of the Museum of the Great Plains 1. Lawton.

Meltzer, D. J. 1987. The Clovis Paleoindian Occupation of Texas: Results of the Texas Clovis Fluted Point Survey. *Bulletin of the Texas Archaeological Society* 57:143-153.

Stafford, T. W., Jr., A. J. T. Jull, K. Brendel, R. C. Duhamel, and D. Donahue 1987. Study of Bone Radiocarbon Dating Accuracy at the University of Arizona NSF Accelerator Facility for Radioisotope Analysis. *Radiocarbon* 29:24-44.

Thurmond, P. J. 1990. A Small Clovis Assemblage from Western Oklahoma. *Plains Anthropologist Memoir* 35:291-297.

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.

Howard Gully: A Terminal Pleistocene Record from Southwestern Oklahoma

Jack L. Hofman, Lawrence C. Todd, Russell W. Graham, and Frances B. King

A stratified late Pleistocene site is yielding new paleontological, paleobotanical, stratigraphic, and archaeological evidence dating to about 11,000 yr B.P. Howard Gully (34GR121) is located on a tributary of the North Fork Red River near the western end of the Wichita Mountains in Greer County. Controlled excavation and exploratory trenching during 1989 provided a stratigraphic context for faunal and archaeological remains which had eroded from ponded colluvial deposits.

The initial discovery of a skull and postcranial elements of a fossil bison (*Bison* sp.) and other bones in the early 1970s sparked interest in the deposit. The bones were exposed in the base and side wall of a small gully which had formed in the spillway of a small pond. During construction, an estimated 2 to 4 m of Holocene fill was removed from the spillway area. The bison skull was crushed from pressure of overlying sediments and was not recovered except for some maxillary teeth. Other bison elements collected include an ulna, calcaneus, intermediate carpal, burned metapodial fragments, a third phalange, and unidentified bison-sized bone fragments. Some of these specimens show evidence of rodent gnawing which documents pre-burial surface exposure, or action by gophers. Weathering on most specimens is not severe. During the 1989 fieldwork, additional bison remains including mandible fragments, vertebrae, acetabulum, and a humerus were recovered in place. The MNI for bison is one.

The bison at Howard Gully is large with the size of the ulna (measurements UL3 and UL8 of Todd 1987) directly comparable (161 mm and 112 mm, respectively) to "males" from the Folsom-age Lipscomb bonebed (Todd et al. n.d.: figure 10). Other faunal remains, primarily collected during the 1970s, include a canid mandible, small mammal bones, and at least two genera of turtles including the extinct giant tortoise (*Geochelone crassiscutata*). All of the

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surface remains were found eroding from the gully wall stratigraphically at or immediately above a radiocarbon dated level.

Two radiocarbon dates have been obtained for Howard Gully. The first is based on organic-rich sediments collected in 1987 from a cleaned profile at the head of Howard gully below the present gully floor (Hofman 1989). This sample is from the lower of two organically-rich lenses. An attempt was made to remove charcoal from the sediment and derive both a sediment and charcoal date for the deposit. Only a sediment AMS date was possible, however, and it is 11,060±220 yr B.P. (Beta-20359/ETH-2934). Because this date documented the relevance of the deposit to late Pleistocene studies in the area, further investigations were conducted in 1989. During the 1989 fieldwork, we again sampled the lower charred botanical layer at the head of Howard Gully and collected charcoal fragments from within 20 cm of the sediment date at the same stratigraphic level. This AMS date on charcoal was 10,810±110 yr B.P. (NZA-1461). These dates are in relatively good agreement, overlapping at one sigma between 10,840 and 10,920 yr B.P.

The dates provide a maximum age for the faunal remains from Howard Gully because the bones occur above the organic lenses, but in the same stratigraphic unit. This provides an important terminal age for *Geochelone crassiscutata* in this region. The *G. crassiscutata* material from Howard Gully has been compared directly to specimens of *G. wilsoni* and *G. crassiscutata*. The Howard Gully shell fragments compare well with *G. crassiscutata* and are much larger than *G. wilsoni*. A large portion of the plastron and carapace fragments are represented and the likelihood of redeposition is thought to be small.

Occurrences of *G. crassiscutata* have been summarized by Graham (1986), and terminal Pleistocene occurrences are extremely rare outside of Florida. Wisconsin records of *G. crassiscutata* are known from Florida, Mississippi, Texas, and now from Oklahoma. This species is also reported from Lubbock Lake, Texas (Johnson 1987), but its age there is uncertain. Fragments of *Geochelone* cf. *crassiscutata* are also documented from the Meriweather site (34CD304) in Caddo County, Oklahoma, but the age of that deposit has not been determined. The smaller *G. wilsoni* has been reported from the Clovis age Domebo site (Leonhardy 1966), also in Caddo County and from other Clovis sites on the Southern Plains (Moodie and Van Devender 1979).

Howard Gully provides an opportunity to study paleoecological and cultural processes at the end of the Pleistocene, a time of extinctions and of the appearance of the Clovis and Folsom cultural complexes. The occurrence of several delicate gravers and a Folsom point preform fragment from the eroded surface deposits at Howard Gully lend potential significance to the burned bone fragments which have been collected. The Folsom preform (Figure 1) represents a basal corner which was broken during manufacture and is made of Edwards chert. The Winters archaeological site, located 400 m upstream from Howard Gully, is a multicomponent campsite with a significant Folsom component (Hofman and Wyckoff 1987). Later archaeological materials are also documented from the vicinity, but these have been found on the eroded surface

of an ancient terrace at the Winters site, and on sandy Holocene deposits stratigraphically above the dated unit at Howard Gully.

The charred wood dated at Howard Gully has been identified as honey locust (*Gleditsia triancanthos*). Although the western limit of honey locust is generally central Oklahoma (Fowells 1965), there are several small outliers in western Oklahoma and Texas which suggest that it may have been more common further west at some time in the past.

To date, fine screening of sediments produced few snails or micro-mammal remains. Study of flotation samples is not complete and analysis of pollen and phytoliths from the deposits is underway. Future work at Howard Gully will focus on recovery of additional paleoenvironmental information from stratigraphically controlled contexts. The variety of information to be gained through continued work at Howard Gully is of significance in comparing this locality in extreme southwestern Oklahoma with better documented terminal Pleistocene localities on the eastern Prairie margin (Ferring 1990; Leonhardy 1966) and on the High Plains to the west (Johnson 1987).

We appreciate the assistance and contributions of Lawrence and Gene LeVick who first brought this site to professional attention and who have supported our work there in many ways. Also, thanks to Roger LeVick, the Winters Family, Jerry Brooks, Brian Carter, Peggy Flynn, Walter Klippel, and Don Wyckoff for their contributions to this effort. Thanks to Ernest Lundelius and Rick Toomey for providing Geochelone specimens for comparison. The fieldwork was made possible through a grant from the University of Oklahoma Associates Research Fund and the inspired efforts of Anthony Dolan, Tamara Harper, Matthew Hill, Lorren Jackson, and Lara Prihodko.

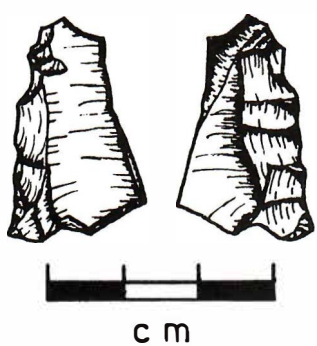

Figure 1. Fluted Folsom point preform broken during manufacture and subsequently thermally spalled. Found on the surface at Howard Gully in 1989.

References Cited

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

Fowells, H. H. 1965. *Silvics of Forest Trees of the United States.* U.S. Department of Agriculture Handbook 271. Washington.

Graham, R.W. 1986. Plant-Animal Interactions and Pleistocene Extinctions. In *Dynamics of Extinction*, edited by D. K. Elliott, pp. 131-154. John Wiley & Sons.

Hofman, J. L. 1989. Late Pleistocene and Early Holocene Deposits in Western Oklahoma: Archaeological Implications. Paper prepared for the South-Central Section of the Geological Society of America Meeting, March 12-14. Arlington, Texas.

Hofman, J. L., and D. G. Wyckoff 1987. Folsom Components at the Winters and Beckner Sites, Southwestern Oklahoma. *Current Research in the Pleistocene* 4:10-11.

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

Leonhardy, F. C. (ed.) 1966. *Domebo: A Paleo-Indian Mammoth Kill on the Prairie-Plains.* Contributions of the Museum of the Great Plains 1. Lawton.

Moodie, K. B., and T. R. Van Devender 1979. Extinction and Extirpation in the Herpetofauna of the Southern Plains with Emphasis on *Geochelone wilsoni* (Testudinae). *Herpetologica* 35:198-206.

Todd, L. C. 1987. Bison Bone Measurements. In *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by G. C. Frison and L. C. Todd, pp. 371-402. Academic Press, Orlando.

Todd, L. C., J. L. Hofman, and C. B. Schultz n.d. Faunal Analysis and Paleoindian Studies: The Lipscomb Bison Bonebed. ms submitted for publication.

The Miami Site Revisited: A Clovis Mammoth Kill in the Texas Panhandle

Vance T. Holliday, C. Vance Haynes, Jack Hofman, and David J. Meltzer

The Miami site (41RB1; also known as the Cowan Ranch site) is on the extreme northeast end of the Southern High Plains (Llano Estacado). It was discovered in 1933 and tested by local amateurs in 1934. Extensive excavations took place in 1937 under the direction of Glen L. Evans, working with E. H. Sellards and the Texas Memorial Museum (The University of Texas at Austin). The partial remains of five mammoth (*Mammuthus columbi*) (Sellards 1938; Saunders 1980)

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were recovered along with three Clovis projectile points and a non-diagnostic stone tool. Miami was the third reported find of a Clovis mammoth kill, after Dent (Wormington 1957) and Blackwater Draw Locality 1 (the Clovis type site) (Cotter 1937). However, archaeologists did not fully recognize the Clovis type to be temporally or technologically distinct from other fluted points until after further research at the Clovis site by Sellards, Evans, and co-workers in 1949 and 1950 (Sellards 1952; Wormington 1957).

The site is on the flat, open surface of the Llano Estacado, but within 60 m of the heavily dissected terrain which marks the eastern margin of the Llano. When the site was first discovered there was no obvious topographic indication of the site; bone was simply being exposed due to plowing in a flat field. The excavations showed that the bone bed was in a small depression that filled with organic-rich silt (Sellards 1938, 1952). The bone bed was completely excavated and then the site was backfilled.

In July, 1990, the authors met to relocate the Miami site, determine its condition, and re-evaluate the stratigraphy and geomorphology in light of over 50 years additional geoarchaeological research on the High Plains. Upon our return we found the same situation that greeted Sellards and Evans: a flat field with no topographic indication of the site, but with numerous mammoth bone fragments at the surface. The site was relocated by first mapping the area of exposed bone in relation to a permanent datum set in the fence line southeast of the site. Fragments of bone and teeth plate enamel (n=336) were recovered over an area 60 m north-south by 40 m east-west. Most of the mammoth teeth fragments (35 of 49) are <2 cm maximum dimension. The largest piece of bone is 17 cm by 7 cm and weighs 439 g. During the collecting and mapping of bone fragments, two small bifacial thinning flakes of Alibates agate were found and mapped along the northeast margin of the bone concentration.

A trailer-mounted Giddings hydraulic soil-coring device was used to locate the filled depression. Seventeen cores were drilled in a t-shaped pattern through the area of the bone concentration. We essentially confirmed the stratigraphy reported by Sellards and can provide additional details on the soils and sediments. The bone bed was originally in a circular depression about 20 m diameter and a maximum 2.5 m deep. The depression is inset into a yellowish red (5YR 5/6, moist) silt loam with a well-expressed soil profile (Paleustoll); Sellards' (1938) "red sandy clay bedrock". The lithologic, stratigraphic, and pedologic characteristics of this unit are typical of the Blackwater Draw Formation, a layer of eolian sediment deposited episodically across the Llano Estacado throughout the Quaternary (Reeves 1976; Holliday 1989). Most of the sediment that filled the depression is a very dark gray (10YR 3/1, moist) silt loam referred to by Sellards as "dark [blue] sandy clay", "fine silt colored by organic matter", and "dark clays". A layer of dark grayish brown (10YR 4/2, moist) silt up to 10 cm thick, Sellards' "loess" zone, occurs 5-10 cm below the bone level and pinches out toward the margins of the depression. The bone level occurred 5-10 cm above the loess and was encased in another layer of black silt loam. Today the uppermost 30-40 cm of fill in the depression is backdirt from the excavation, a jumbled mixture of red and black silt loam. The

contact between the backdirt and the black silt loam marks the level of the bonebed.

The paleo-depression at Miami was almost certainly an ephemeral-lake basin or "playa", a very small scale version of thousands of such basins that dot the High Plains landscape (Walker 1978). This interpretation is based on the morphology of the depression and on the lithology of the basin fill. Though ubiquitous, the age and origin of these features is largely unknown, but long debated (e.g., Judson 1950; Reeves 1966; Osterkamp and Wood 1987). The presence of a Clovis occupation in the upper portion of the fill, however, shows that this basin was present for some time before 11,000 yr B.P. Several other Paleoindian sites are also reported from small playas elsewhere on the Llano Estacado (Roberts 1942; Johnson et al. 1987).

Samples for a variety of analyses were collected during the coring project. Sedimentological and pedological analyses are in progress. Soil samples for radiocarbon dating were collected from the bottom of the basin fill, from the fill just below the silt layer, and from just above the silt layer. The largest bone fragment is undergoing chemical analysis to determine its suitability for dating. These studies and additional field work will provide valuable data for understanding Clovis activities, and the evolution and paleoenvironmental significance of small playas and their fills. In particular, dating and further understanding of the "loess" layer is important because it may be a local manifestation of a Clovis period drought proposed by Haynes (1991).

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References Cited

Cotter, J. L. 1937. The Occurrence of Flints and Extinct Animals in Pluvial Deposits near Clovis, New Mexico, Part IV - Report on Excavation at the Gravel Pit, 1936. *Proceedings of the Philadelphia Academy of Natural Sciences* 90: 2-16.

Haynes, C. V., Jr. 1991. Geoarchaeological and Paleohydrological Evidence for a Clovis Age Drought in North America and its Bearing on Extinction. *Quaternary Research,* in press.

Holliday, V. T. 1989. The Blackwater Draw Formation (Quaternary): A 1.4-plus M.Y. Record of Eolian Sedimentation and Soil Formation on the Southern High Plains. *Geological Society of America Bulletin* 101:1598-1607.

Johnson, E., V. T. Holliday, R. W. Ralph, R. Knudson, and S. Lupton 1987. Ryan's Site: A Plainview Occupation on the Southern High Plains, Texas. *Current Research in the Pleistocene* 4:17-18.

Judson, S. 1950. Depressions of the Northern Portion of the Southern High Plains of Eastern New Mexico. *Bulletin of the Geological Society of America* 61:253-274.

Osterkamp, W. R., and W. W. Wood 1987. Playa-Lake Basins on the Southern High Plains of Texas and New Mexico: Part I. Hydrologic, Geomorphic, and Geologic Evidence for their Development. *Geological Society of America Bulletin* 99:215-223.

Reeves, C. C., Jr. 1966. Pluvial Lake Basins of West Texas. *Journal of Geology* 74-269-291.

Reeves, C. C. Jr 1976. Quaternary Stratigraphy and Geological History of the Southern High Plains, Texas and New Mexico. In *Quaternary Stratigraphy of North America,* edited by W. C. Mahaney, pp. 213-234. Dowden, Hutchinson and Ross, Inc., Stroudsburg, Pennsylvania.

Roberts, F. H. H. 1942. Archaeological and Geological Investigations in the San Jon District, Eastern New Mexico. *Smithsonian Miscellaneous Collections* 3:1-39.

Saunders, J. J. 1980. A model for man-mammoth relationships in Late Pleistocene North America. In The Ice-Free Corridor and Peopling of the New World, edited by N. W. Rutter, and C. E. Schweger. *Canadian Journal of Anthropology* 1:87-98.

Sellards, E. H. 1938. Artifacts Associated with Fossil Elephant. *Geological Society of America Bulletin* 49:999-1010.

Sellards, E. H. 1952. *Early Man in America.* University of Texas Press, Austin.

Walker, J. R. 1978. Geomorphic Evolution of the Southern High Plains. *Baylor Geological Studies, Bulletin* 35. Baylor University, Waco, Texas.

Wormington, H. M. 1957. *Ancient Man in North America* (4th Edition). Denver Museum of Natural History, Popular Series 4.

Recent Excavations at the Munson Springs Site, a Paleoindian Base Camp in Central Ohio

Bradley T. Lepper and Jeffrey B. Gill

Continuing excavations at the Munson Springs site (Frolking and Lepper 1990) in the Racoon Creek drainage of central Ohio have uncovered further evidence for a stratified series of prehistoric occupations beginning with, what may prove to be, a single episode of occupation by a small band of Paleoindian hunter-gatherers. During the summer of 1990, the Licking County Archaeology and Landmarks Society, working with the Ohio State University Department of Anthropology and the archaeological field school from Bloomsburg University,

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excavated a series of test units at the site. Many of these units were placed away from the small mound (Locus A) tested previously (Frolking and Lepper 1990) in order to look for undisturbed deposits. Unfortunately, several of these outer units also evidenced considerable disruption of the deeper occupation levels as a result of the activities of subsequent site occupants. For example, in one unit a domestic pig (*sus*) burial was encountered. However, in general, a remarkably consistent sequence of occupations was established which, to a limited extent, mirrors what was documented in the profile of the initial test trench (Frolking and Lepper 1990).

The upper 8 to 10 cm were a uniform medium brown silt loam. A light scatter of historic artifacts overlay, and to some extent, were mixed in with, a prehistoric component consisting of flint debitage, ceramics, and fire-cracked rock. A second stratum of light brown silt loam extended to between 14 and 20 cm below the surface. Small amounts of debitage and fire-cracked rock were concentrated in the uppermost portion of this stratum. These artifacts likely relate to an early Woodland occupation.

A third stratum, described as light yellow-brown silty clay loam, yielded a very light scatter of flint debitage and fire-cracked rock within the upper 2 to 3 cm of this stratum. The next 8 to 10 cm were virtually sterile. Between 28 and 30 cm below surface, a second light scatter of debitage and fire-cracked rock was observed in association with two possible postmolds or small pit features each 28 cm in diameter and respectively, 22 and 36 cm in depth. These two distinct deep components are of undetermined cultural affiliation. It is possible, however, that the deepest component corresponds to the Paleoindian occupation floor defined in previous, non-contiguous excavations. The overlying flint scatter may, therefore, relate to an early or later Archaic occupation. Further testing will be required to establish the precise number of components at the site and their chronological and cultural relationships.

Minute fragments of scattered hickory (*Carya*) charcoal, recovered in apparent association with the fluted preform reported previously, have yielded dates which are unrelated to the Paleoindian occupation. Two accelerator radiocarbon dates have been obtained for this charcoal. Beta Analytic reported a date of 2,445±60 yr B.P. (Beta-34437/ETH-6064) and the University of Arizona reported a virtually identical date of 2,445±65 yr B.P. (AA-5061). Therefore, this charcoal dates a single burning event associated with the construction of the early Woodland mound at Locus A. The early Archaic projectile points recovered from strata overlying this charcoal presumably are redeposited remnants of a formerly intact series of early Holocene occupations at the site.

The results of the test excavations conducted to date offer limited support for the interpretation of the Munson Springs Paleoindian component as a small winter base camp. It is located within a sheltered, south-facing hollow in close proximity to two natural springs. The two large diameter postmolds found in the lowest stratum beyond the mound area suggest that a substantial structure might have been present during the Paleoindian occupation. Such a structure could represent a relatively substantial, and therefore semi-permanent, winter

habitation for a small group, perhaps a nuclear or extended family. The predominant raw material represented in the Paleoindian tools and debitage is local Flint Ridge Flint and the debitage represents retouch from late stage bifaces.

The unfortunate, but not unexpected, absence of bone from the early levels of the site limits the potential for directly addressing questions of Paleoindian subsistence in this region. However, the indications of small group size, semi-permanent seasonal occupation, and small home range do not support notions of midwestern Paleoindians as highly mobile, specialized big-game hunters (e.g., Tankersley 1989).

References Cited

Frolking, T. A., and B. T. Lepper 1990. The Late Pleistocene-Early Holocene Occupation of the Munson Springs Site (33-Li-251), Locus A, Licking County, Ohio. *Current Research in the Pleistocene* 7:12-14.

Tankersley, K. B. 1989. Patterns in Lithic Exploitation and Human Settlement in the Midwestern United States. *Current Research in the Pleistocene* 6:38-39.

The Archaeological Investigation of a Series of Early Paleoindian (Clovis) Sites in the Little River Region of Christian County, Kentucky

Edward E. Smith, Jr. and Andrea K. L. Freeman

Archaeological investigations at a series of four Clovis period Paleoindian sites in the Little River region of Christian County, Kentucky were conducted during the summer of 1990. The Little River is a tributary of the Cumberland River, and lies in the karstic portion of western Kentucky. The sites investigated comprise the Little River Paleoindian Site Complex, and include the Adams site (15Ch90), the Boyd (Ledford) site (15Ch236), the Ezell site (15Ch483), and the Roeder site (15Ch482) (Figure 1). Previous investigations of lithic material from these sites were conducted by Sanders (1983, 1988), and Tankersley (1987, 1989a, b, 1990). These sites were utilized at least in part for the procurement and reduction of Hopkinsville chert, a high quality cryptocrystalline lithic resource available locally in the Ste. Genevieve limestone. All of these sites have produced numerous diagnostic Paleoindian

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artifacts, including fluted points and preforms. A blade technology figures prominently in the assemblages from these sites. The purpose of the research was to investigate the subsurface integrity of these sites and to assess their potential for addressing a variety of questions concerning Paleoindian lifeways in the region.

Much of the work focused on intensive, controlled surface collection and subsurface testing at the Ezell site (15Ch483). Preliminary analyses indicate that some activity patterning is discernible, despite intensive collection by local artifact collectors. Approximately nine sq m of the site was excavated. One limited area of the site produced subplowzone cultural deposits of an as yet unspecified nature, perhaps a filled natural depression. A series of stratigraphic profiles were obtained from the Boyd site (15Ch236) by means of

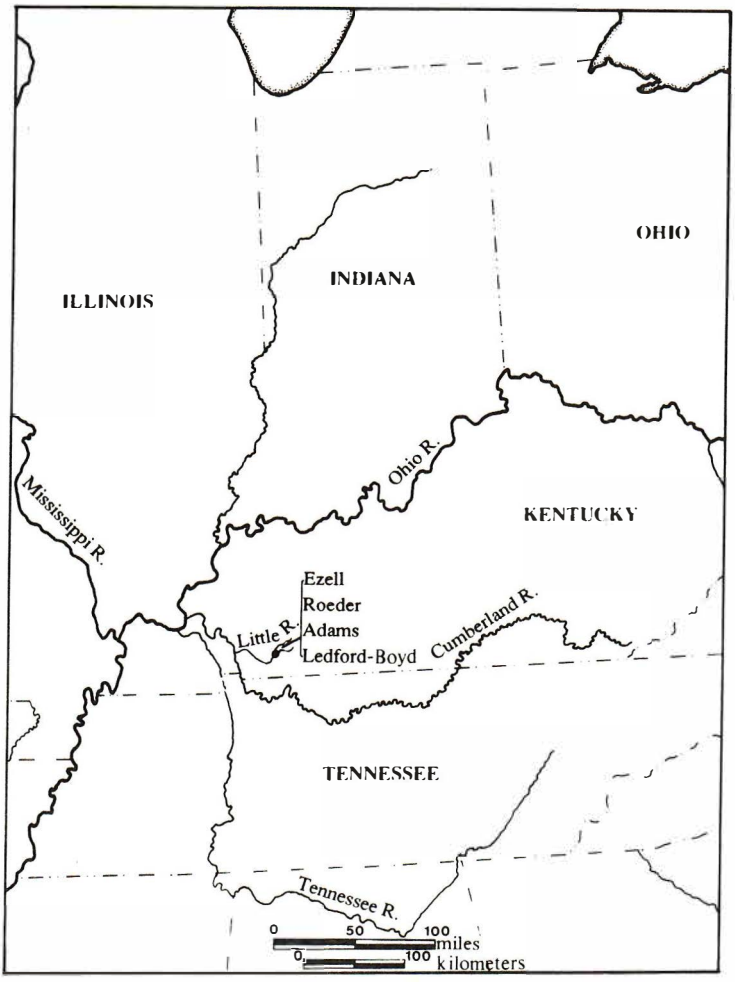

Figure 1. Location of the Little River Paleoindian Site Complex.

a hand auger. These cores suggest the presence of late Pleistocene deposits underlying Holocene alluvium. These deposits are located downslope from the Paleoindian component exposed on the surface.

Limited surface collecting and test excavations were also conducted at the Roeder site (15Ch482). One radiocarbon sample from the Ezell site and two from the Boyd site have been submitted for TAMS dating. Future research in the region will include stratigraphic testing for the purpose of reconstructing the fluvial history of the Little River, and locating sealed Paleoindian components.

Sediment samples were obtained from McGaughey Swamp to assess the potential for the preservation of pollen and other organic remains in order to address the paleoenvironmental history of the region. Unfortunately, there was no pollen preserved in the samples. A number of other locales for the extraction of sediment samples have been indentified, and additional palynological investigations are planned.

These investigations were conducted jointly by the Glenn A. Black Laboratory of Archaeology, Indiana University, and the Department of Anthropology, University of Arizona, and were sponsored by the Kentucky Heritage Council. The authors wish to thank C. Vance Haynes, Christopher S. Peebles, Thomas Sanders, and Kenneth B. Tankersley for their insight, and Mr. Carl Yahnig for the use of his collections. The illustration was prepared by Rachel Freyman, GBL, IU.

References Cited

Sanders, T.N. 1983. The Manufacturing of Chipped Stone Tools at a Paleo-Indian Site in Western Kentucky. Masters thesis, Department of Anthropology, University of Kentucky.

Sanders, T. N.. 1988. The Adams Site: A Paleoindian Manufacturing and Habitation Site in Christian County, Kentucky. In *Paleoindian and Archaic Research in Kentucky*, edited by C. D. Hockensmith, D. Pollack, and T. N. Sanders, pp. 1-24. Kentucky Heritage Council, Frankfort.

Tankersley, K. B. 1987. The Paleoindian Period in Kentucky: Directions of Research-Past, Present, & Future. Report Prepared for the Kentucky Heritage Council. Glenn A. Black Laboratory of Archaeology, Indiana University, *Reports of Investigations* 87-17.

Tankersley, K. B. 1989a. A Close Look at the Big Picture: Early Paleoindian Lithic Resource Procurement in the Midwestern United States. In *Eastern Paleoindian Lithic Resource Use*, edited by C. J. Ellis, and J. C. Lothrop, pp. 259-292. Westview Press, Boulder.

Tankersley, K. B. 1989b. *Late Pleistocene Lithic Exploitation and Human Settlement in the Midwestern United States*. PhD dissertation, Department of Anthropology, Indiana University.

Tankersley, K. B. 1990. Late Pleistocene Lithic Exploitation in the Midwest and Midsouth: Indiana, Ohio, and Kentucky. In Early Paleoindian Economies of Eastern North America, edited by K. B. Tankersley, and B. L. Isaac, pp. 259-299. *Research in Economic Anthropology*, Supplement 5.

Paleoenvironments and Delaware River Basin Stratigraphy

Michael Stewart

Archaeological and sedimentary stratigraphies from alluvial settings of the major river systems in Pennsylvania have been complied under the auspices of the Bureau for Historic Preservation of the Pennsylvania Historical and Museum Commission (Vento et al. 1990). The work establishes a basis for relating sedimentary sequences to paleoenvironmental change, and identifies a number of recurring paleosols which are interpreted as the fingerprint of specific regional events. The framework employed is that of genetic stratigraphy, a concept derived from marine studies and elaborated upon by Vento and Rollins (1989) for use in terrestrial archaeological investigations in the Middle Atlantic Region of the Eastern United States. Each of the three river basin studies (Ohio, Susquehanna, and Delaware) provides a data set useful for inferring the nature of the environmental contexts in which prehistoric societies existed, a means of identifying chronostratigraphic units, and a predictive tool for designing excavation strategies in specific alluvial settings. The applicability of the Delaware River Basin portion of this endeavor (Stewart 1990) to the study of early Native American cultures is summarized below.

Four to five terraces representing Illinoian and Wisconsin glacial outwash, and Holocene alluvium characterize the middle and upper sections of the basin to heights up to 42 m above current stream levels. This generally corresponds with the scheme developed by Peltier (1949, 1959) and subsequently refined by Vento and Rollins (1989) for the Susquehanna River. Definition of the entire terrace system of the lower valley are not as straightforward due to the effects of sea level rise and tidal influence, although Illinoian and Wisconsin deposits have been mapped to some degree for this area (Peltier 1959). The bulk of post-15,000 yr B.P. alluvial sediments are found on landforms from 1.5 to 8.5 m above stream level. The most deeply stratified sequences occur on terraces from 4.5 to 8.5 m above stream levels and conform to what has been defined as Valley Heads terrace. Holocene sedimentary sequences representing potentially habitable landforms range from 2.4 to 4.8 m in thickness.

Pre-10,000 to 8,000 yr B.P. floodplains were such dynamic settings that preserved sediments and contexts pertaining to the Paleoindian and early Archaic periods in the basin are unlikely to be broadly distributed. The Delaware River had stabilized in its near-present channel sometime between

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10,000 and 8,000 yr B.P. Stratified and relatively complete late Pleistocene through Holocene sedimentary sequences (and related archaeological deposits) are not a typical feature of remnant floodplains and terrace settings of the Delaware system. This parallels the evolution of the Susquehanna River system as described by Vento and Rollins (1989).

Somewhat complete sequences are known, however, with the Shawnee Minisink (McNett et al. 1985) and Upper Shawnee Island (Stewart et al. in press) sites being the best examples. The location of additional such localities can be predicted and their potential for furthering studies of Paleoindian and early Archaic cultures is inestimable. The problem remains that because of the transformation and destruction of many early contexts by natural processes, we may never be able to adequately gauge the full range of the initial prehistoric use of floodplain environments.

References Cited

McNett, C. W. (ed.) 1985. Shawnee Minisink: A Stratified Paleoindian - Archaic Site in the Upper Delaware Valley of Pennsylvania. Academic Press, New York.

Peltier, L. C. 1949. Pleistocene Terraces of the Susquehanna River, Pennsylvania. Pennsylvania Geological Survey, Fourth Series, Bulletin G23.

Peltier, L. C. 1959. Late Pleistocene Deposits. In Geology and Mineral Resources of Bucks County, Pennsylvania, pp. 163-184. Pennsylvania Geological Survey, Fourth Series, Bulletin C9.

Stewart, R. 1990. Archaeology, Sedimentary Sequences, and Environmental Change in the Delaware River Basin. In Genetic Stratigraphy, Climate Change, and the Burial of Archaeological Sites Within the Susquehanna, Delaware, and Ohio River Drainage Basins, edited by F. Vento, and H. B. Rollins. Report submitted to the Grants Office of the Pennsylvania Historical and Museum Commission, Harrisburg.

Stewart, R. M., J. F. Custer, and D. Kline in press. A Deeply Stratified Archaeological and Sedimentary Sequence in the Delaware Valley of the Middle Atlantic Region, Eastern United States. Geoarchaeology.

Vento F. J., and H. B. Rollins 1989. Development of a Late Pleistocene-Holocene Genetic Stratigraphic Framework as It Relates to Atmospheric Circulation and Climate Change in the Upper and Central Susquehanna River Drainage Basin. Unpublished manuscript. Bureau for Historic Preservation, Pennsylvania Historical and Museum Commission, Harrisburg.

Vento F. J., H. B. Rollins, R. M. Stewart, P. Raber, and W. Johnson 1990. Genetic Stratigraphy, Climate Change, and the Burial of Archaeological Sites Within the Susquehanna, Delaware, and Ohio River Drainage Basins. Report submitted to the Grants Office of the Pennsylvania Historical and Museum Commission, Harrisburg.

Underwater Excavations at Spring Lake: A Paleoindian Site in Hays County, Texas

Paul R. Takac

The San Marcos Springs emerge from the Balcones Fault escarpment near San Marcos, Texas. The springs were apparently utilized from Paleoindian to Late Prehistoric times. A dam constructed sometime before A.D. 1880 drowned the springs and adjacent land and created a small empoundment known as Spring Lake.

Underwater excavations of the modern lakebed began in 1978 at the Ice House site (41HY161), below the dam, under the direction of Joel Shiner (1979). Subsequent excavations at the Terrace locality (41HY147), within Spring Lake, were conducted intermittently from 1979 until Shiner's death in 1988. Although over 200 m^2 were excavated and artifacts, debitage, and bone fragments totaling several hundred thousand specimens were recovered, only brief reports have been published (Shiner 1981, 1983). The author obtained possession of the notes and collections of this material in late 1989 in order to complete the analyses, conduct further excavations, and publish the results. Several dry-land localities around the lake have also been excavated (Garber et al. 1983; Garber and Orloff 1985; James Garber pers. comm. 1991).

Paleoindian projectile points recovered from the Terrace locality include three Clovis, one Folsom, and over 40 others including San Patrice, Dalton, Meserve, Golondrina, Plainview and Angostura. It should be noted that not all of the points previously identified as Paleoindian (Shiner 1983) are included here and that additional specimens may yet be located in the scattered collections. Preliminary analysis suggests that most of the points are made of local Edwards chert which outcrops along the Balcones Fault. Fragments of mammoth (*Mammuthus*), mastodon (*Mammut*) and bison (possibly *Bison antiquus*) teeth have also been found. The bone recovered exhibits a remarkable degree of fragmentation, probably due to various taphonomic processes. The virtual absence of non-enamel megafaunal elements makes it difficult to determine whether or not the Terrace locality is a kill-site. Species identification and MNI counts are not yet available but the assemblage appears to be representative of known Pleistocene and Holocene faunal communities in central Texas.

Nearly all of this material was recovered from either the lakebed surface or from disturbed deposits. Shiner reported that the deposits initially excavated were deflated and disturbed (1983, pers. notes), but that in a 50 m^2 area further

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upstream and nearer the escarpment intact deposits, which approximate those reported 200 m to the east (Garber et al. 1983), were sampled. Examination of this exposed area supports Shiner's assessment. The exposed strata appear well-bedded and undisturbed. At this time, however, the stratigraphy of the Terrace locality is unknown.

There are three objectives of the fieldwork now underway. First is the generation of a section map of the >2 m deep Terrace deposits. This presents significant difficulties due to the overlying water mass which typically collapses any vertical sediment exposure. To counteract this, a combination of planum or "cumulative section" (Barker 1986) and photomosaic techniques will be employed whereby excavations will proceed, step-wise, back down into the extant pit. A section drawing may then be constructed while recovering additional material with better provenience control.

The second objective is stabilizing the walls of the exposed excavation area and removing slumped deposits. Finally, an accurate map of the topography of the pre-inundation lakebed will be drafted in order to determine the relationship of the Terrace locality to nearby landforms. The modern lakebed has an artificially level appearance due to a blanket of recent silt and organic debris. A plan map is currently being made utilizing a floating 1,600 m^2 grid and metal "sounding pole". Preliminary results suggest that the Terrace locality is a relatively level area separating the escarpment and a former spring-fed channel. These results will be verified by randomly selected core samples.

Once these objectives are accomplished it will be possible to undertake further excavation in order to address the controversial interpretation of Spring Lake as an area where Paleoindian groups "maintained an almost sedentary hunting and gathering existence" (Shiner 1983:2) in close proximity to a large, stable spring and the flora and fauna it supported. It has been argued elsewhere (Takac 1990) that late Pleistocene/early Holocene central Texas may have been attractive to hunter-gatherer populations not only in terms of raw material availability (Johnson and Holliday 1984; Meltzer 1986; Shiner 1984) but environmental diversity as well (Bryant and Holloway 1985; Graham 1979, 1984). However, questions of Paleoindian settlement strategy and duration of occupation at Spring Lake must be addressed in the future with well provenienced archaeological data.

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References Cited

Barker, P. 1986. Understanding Archaeological Excavation .Batsford, London.

Bryant, V. M. Jr., and R. G. Holloway 1985. A Late-Quaternary Paleoenvironmental Record of Texas: An Overview of the Pollen Evidence. In *Pollen Records of Late-Quaternary North American Sediments*, edited by V.

M. Bryant Jr. and R. G. Holloway, pp. 39-70. American Association of Stratigraphic Palynologists Foundation, Dallas.

Garber, J. F., and M. D. Orloff 1985. Excavations at 41HY137: An Archaic Site on the Balcones Escarpment in San Marcos, Texas. *La Tierra* 11(3).

Garber, J. F., S. Bergman, B. Dickinson, J. Simpson, R. Hays, and J. Stefanoff 1983. Excavations at Aquarena Springs, San Marcos Texas. *La Tierra* 10(2).

Graham, R. W. 1979. Paleoclimates and Late Pleistocene Faunal Provinces in North America. In *Pre-Llano cultures of the Americas: Paradoxes and Possibilities,* edited by R. L. Humphrey and D Stafford, pp. 49-69. Anthropological Society of Washington.

Graham, R. W. 1984. Paleoenvironmental Implications of the Quaternary Distribution of the Eastern Chipmunk (*Tamias striatus*) in central Texas. *Quaternary Research* 21:111-114.

Johnson, E., and V. T. Holliday 1984. Comments on "Large Springs and Early American Indians" by Joel L. Shiner. *Plains Anthropologist* 29:65-70.

Meltzer, D. J. 1986. The Clovis Paleoindian Occupation of Texas: Results of the Texas Clovis Fluted Point Survey. *Bulletin of the Texas Archaeological Society* 57:27-68.

Shiner, J. L. 1979. *Survey and Testing of the Ice House Site, San Marcos, Hays County Texas.* Report to the Texas Antiquities Commission, Permit 194, Austin.

Shiner, J. L. 1981. History, Economy and Magic at a Fresh Water Spring. In *The Realms of Gold, Proceedings of the Tenth Conference on Underwater Archaeology,* edited by W. A. Cockrell, pp. 202-203. Fathom Eight, San Marino, California.

Shiner, J. L. 1983. Large Springs and Early American Indians. *Plains Anthropologist* 28:1-7.

Shiner, J. L. 1984. A Reply to Johnson and Holliday. *Plains Anthropologist* 29:71-72.

Takac, P.R. 1990. "Homebases" and the Paleoindian/Archaic Transition in Central Texas. Paper presented at 55th Annual Meeting of the Society for American Archaeology, Las Vegas.

Bostrom: A Paleoindian Site in Southcentral Illinois

Kenneth B. Tankersley and Michael D. Wiant

The Bostrom site is a low density, multicomponent deposit located in St. Clair County, Illinois. It is situated on a 16.2 h ridge spur, which overlooks the confluence of Ogles and Silver creeks, tributaries of the Kaskaskia River. Paleoindian artifacts, fluted bifaces (projectile points, knives, and preforms) and unifacial tools, are scattered over the surface.

In July 1990, the authors learned that the site is threatened by subdivision expansion. Therefore, the Illinois State Museum, with volunteer assistance from the Illinois Association for the Advancement of Archaeology, began efforts to salvage the site's Paleoindian components. These efforts include shovel testing, controlled surface surveys, and test excavations.

Initially, we excavated 170, 92-cm^3 shovel tests along a east-to-west transect across one ridge crest. Shovel testing provided pedologic information, a coarse-grained vertical distribution of the cultural deposits, and an evaluation of site disturbance by recent tillage. The site was then plowed and a controlled pedestrian survey was conducted at five-meter intervals. Artifact locations were marked by pin flags, mapped, and identified by type and location. Three concentrations of Paleoindian artifacts were identified. The area containing the largest density of Paleoindian artifacts was selected for excavation. Preliminary excavations consisted of five 4 by 4 m units, subdivided into four 2 m squares.

These investigations have identified a large assemblage of Paleoindian tools (Figure 1). This assemblage includes 31 fluted bifaces (12 broken or exhausted fluted projectile points and 19 fluted point preforms), 4 channel flakes, and 174 unifacially retouched specimens (4 prismatic blades, 6 limaces, 3 gravers, 32 spurred end scrapers, 25 trianguloid end scrapers, 5 ovate end scrapers, 14 side scrapers, and 85 miscellaneous flake knives and scrapers). Typologically, the fluted bifaces fall into three distinct styles: Clovis, Gainey, and Holcombe-like points. All of the chipped stone tools are manufactured from non-local and exotic sources of lithic raw material including: Kaolin, Dongola, and Ste. Genevieve cherts (southcentral Illinois); Burlington chert (central Mississippi and lower Illinois valley); Attica chert (westcentral Indiana); and Knife River Flint (southwestern North Dakota).

The presence of three temporally distinct fluted point styles and a large assemblage of unifacial tools, all manufactured from non-local raw materials, suggests that Bostrom was an intermittently occupied habitation site between

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ca. 11,200 to 10,200 yr B.P. (Haynes et al. 1984; Deller and Ellis 1988). The presence of broken and exhausted fluted points, broken fluted point preforms, and channel flakes suggests that the site was also used as a workshop. The typology of the fluted points, the assemblage of unifacial tools, and the quantity of non-local lithic materials are similar economic patterns found on Paleoindian sites located in northern latitudes (Ellis and Lothrop 1989; Tankersley and Isaac 1990).

This investigation was made possible through funds, equipment, and staff provided by the Illinois State Museum. Volunteer field and laboratory assistance was provided by the Illinois Association for the Advancement of Archaeology. The time and expertise provided by Larry Kinsella, Frances Knight, Marjorie Schroeder, Norman Rossen, Julie Morrow, and Jenny Tankersley were invaluable. We especially thank Pete and Rob Bostrom, who discovered the site in 1975.

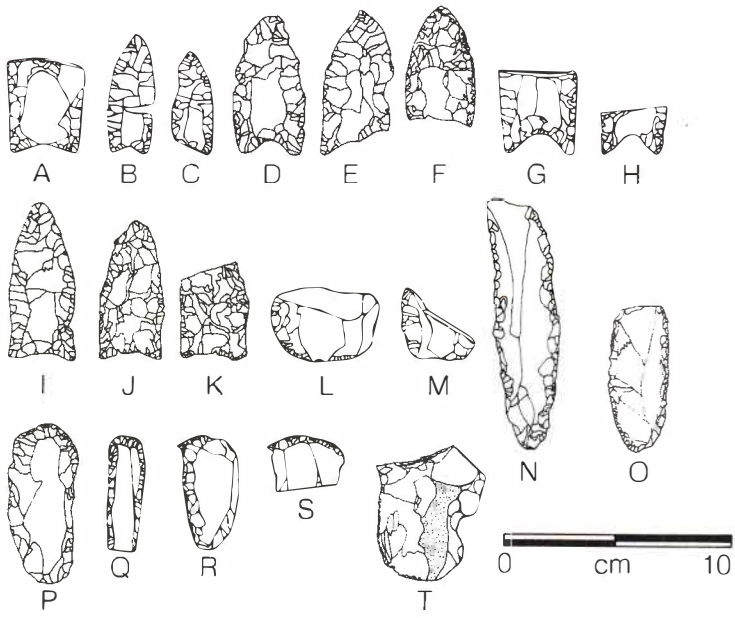

Figure 1. Early Paleoindian artifacts from the Bostrom Site: A-K fluted projectile points; L-M fluted point preforms; N-O prismatic blades; P-Q limaces; R-S spurred end scrapers; and T an end scraper manufactured from Knife River Flint.

References Cited

Deller, D. B. , and C. J. Ellis 1988. Early Palaeo-Indian Complexes in Southwestern Ontario. In, *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region,* edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 251-263, Bulletin of the Buffalo Society of Natural Sciences 33.

Ellis, C. J., and J. C. Lothrop (eds.) 1989. *Eastern Paleoindian Lithic Resource Use.* Westview Press, Boulder.

Haynes, C. V., D. J. Donahue, A. J. T. Jull, and T. H. Zabel 1984. Application of Accelerator Dating to Fluted Point Paleoindian Sites. *Archaeology of Eastern North America* 12:184-191.

Tankersley, K. B., and B. L. Isaac (eds.) 1990. *Early Paleoindian Economies of Eastern North America.* Research in Economic Anthropology, Supplement 5, JAI Press, Greenwich.

Cody Complex Occupation in the Black Rock Desert, Nevada

Steve Wallmann and Daniel S. Amick

The potential for Paleoindian occupations to be found in the Black Rock Desert of northwestern Nevada was noted by Clewlow in 1968. Since that time, there have been few systematic archaeological studies of the area. However, numerous avocational archaeologists have actively surveyed the Black Rock Desert. Evidence provided by avocational archaeologists led to excavation of a partial bison (*Bison*) skeleton which was associated with a Scottsbluff point (Figure 1, SW-580). Dansie et al. (1988) described this find, known as the Wallmann Bison (26Hu58), which was radiocarbon dated at 5,240±230 yr B.P. (UCR-1436). However, the dated bone contained "little organic fraction." Poor preservation of this bone from the desert surface probably precludes a reliable radiocarbon date (i.e., Stafford et al. 1987).

Recently, the Desert Research Institute in cooperation with the Winnemucca District of the BLM initiated further studies of the Wallmann Bison locality. Interest developed through reports of a widespread scatter of "Square Based" points near this locality. Examination of private collections from this area has produced over 200 Paleoindian points so far (Figure 1). These Square Based points are morphologically and technologically identical to Scottsbluff, Eden, and other "Cody complex" artifacts (e.g., Frison and Todd 1987). Thurmond (1990) suggests a minimal estimate of 8,500-10,000 yr B.P. for the Cody complex.

Collections from this locality also contain numerous Great Basin Concave and Stemmed types. Pendleton (1979) has described both of these early point series from Nevada. Obsidian hydration evidence from the Komodo Site in the Central Sierras suggests a date of at least 9,000 years for Great Basin Concave

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points (Basgall 1988). The Great Basin Stemmed Series may be slightly younger in age (Rusco and Davis 1987).

Despite the apparent variety in these associated artifact types, it is possible that some of them may be synchronous. Thurmond (1990) and Johnson (1989) have noted a pattern on contemporaneous diversity in late Paleoindian assemblages on the Southern Plains. While it is tempting to correlate stylistic diversity with ethnic diversity, its meaning remains enigmatic. Nevertheless, stylistic diversity is a convincing empirical pattern of the late Paleoindian archeological record of the Plains and may also be likely in the Black Rock Desert.

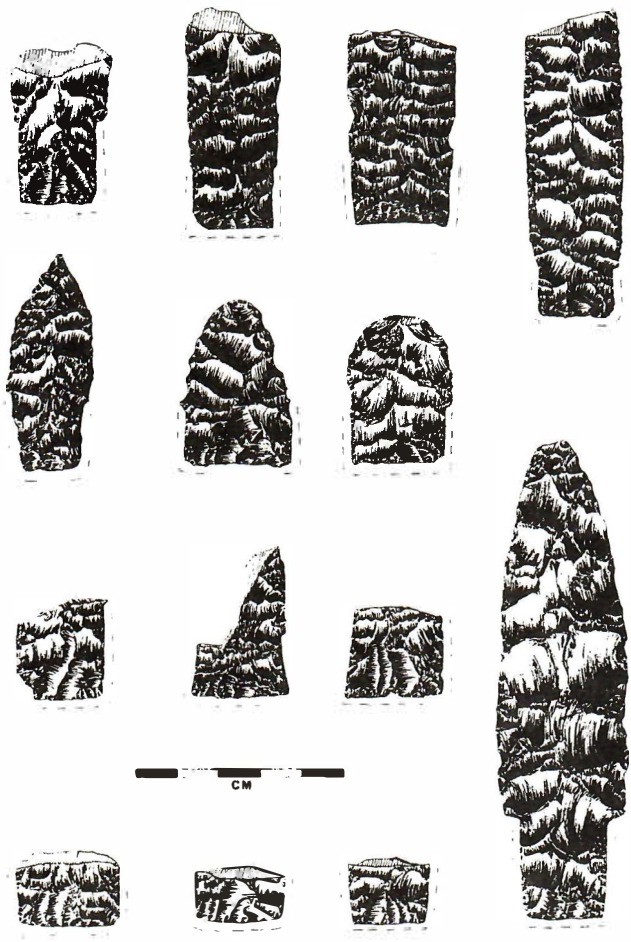

Figure 1. Cody complex projectile point/knives (PP/Ks) from the Black Rock Desert. Dashed lines indicate edge grinding. Identifications from left to right. Top row: private collection, SW-534, SW-584, SW-582; Second row: SW-581, private collection, SW-583; Third row: SW-555, SW-506, SW-556; Bottom row: SW-541, SW-545, SW-539, SW-580.

Johnson (1989) has discussed evidence for expansion of late Paleoindian groups from the Great Plains in to the Eastern Woodlands of Texas and Oklahoma. It seems likely that similar expansion into the northwestern Great Basin may be represented by the Cody complex points of the Black Rock Desert. While the surface association of Cody artifacts with bison bones and early Great Basin point types is intriguing, the subsistence and settlement patterns of these groups and the timing and nature of their interaction with indigenous peoples remain to be determined. In any case, the presence of Cody complex groups about 800 km west of the Continental Divide may provide significant additional evidence for population movement out of the North American Great Plains during the late Paleoindian period.

This paper is dedicated to the late Jonathan O. Davis who recognized the significance of the Cody complex materials in the Black Rock Desert and supported the collaboration that resulted in this study.

References Cited

Basgall, M. E. 1988. Archaeology of the Komodo Site, an Early Holocene Occupation in Central-Eastern California. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface,* edited by J. A. Willig, C. M. Aikens, and J. L. Fagan, pp. 103-119. Anthropological Papers 21. Nevada State Museum, Carson City.

Clewlow, C. W., Jr. 1968. Surface Archaeology of the Black Rock Desert, Nevada. *Reports of the California Archaeological Survey* 73:1-93.

Dansie, A. J., J. O. Davis, and T. W. Stafford, Jr. 1988. The Wizards Beach Recession: Farmdalian (25,500 yr B.P.) Vertebrate Fossils Co-occur with Early Holocene Artifacts. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface,* edited by J. A. Willig, C. M. Aikens, and J. L. Fagan, pp. 153-200. Anthropological Papers 21. Nevada State Museum, Carson City.

Frison, G. C., and L. C. Todd 1987. *The Horner Site: The Type Site of the Cody Cultural Complex.* Academic Press, New York.

Johnson, L., Jr. 1989. *Great Plains Interlopers in the Eastern Woodlands During Late Paleoindian Times.* Office of the State Archeologist Report 36. Texas Historical Commission, Austin.

Pendleton, L. S. 1979. *Lithic Technology in Early Nevada Assemblages.* M A thesis, Department of Anthropology, California State University, Long Beach.

Rusco, M. K., and J. O. Davis 1987. Studies in Archaeology, Geology, and Paleontology at Rye Patch Reservoir, Pershing County, Nevada. *Anthropological Papers* 20. Nevada State Museum, Carson City.

Stafford, T. W., Jr., A. Jull, K. Brendel, R. C. Duhamel, and D. Donahue 1987. Study of Bone Radiocarbon Dating Accuracy at the University of Arizona NSF Accelerator Facility for Radioisotope Analysis. *Radiocarbon* 29:24-44.

Thurmond, J. P. 1990. Late Paleoindian Utilization of the Dempsey Divide on the Southern Plains. *Plains Anthropologist* 35, Memoir 25.

Physical Anthropology

Aleut Kayak-Hunter's Hypertrophic Humerus

W.S. Laughlin, S.B. Laughlin, and S.B. Beman

The upper arm bones (humeri) of an Aleut (Unangan) man interred in an Aleutian mummy cave excavated in 1990, exemplify the hypertrophy of the humerus common to Aleut kayak hunters.

In Figure 1 the right humerus of the Aleut is compared with the right humerus of an 18th century Russian, a member of the Medvedev party massacred by Aleuts at Umnak Island, A.D. 1764. The Aleut is over 60 years of age, the Russian is closer to 35 years of age. The Russian was much taller (maximum femoral length 432 mm) than the Aleut (415) mm, and the humerus is accordingly longer: Russian 316 mm, Aleut 301 mm. The Aleut humerus however, is much more massive in its shaft dimensions, and in its large epicondylar breadth of the distal end of the humerus. In the Aleut all the areas for muscle attachments are larger and more rugose. The Deltoid tuberosity and the area for the Teres major, are exceptionally well developed. The bicipital groove is deeper in the Aleut humerus only at the superior end for the rugose areas for muscle insertions encroach onto the floor of the groove.

Hrdlicka prefaces his study of 172 male and 174 female Aleut humeri with the observation: "The bones of the arm in the Aleuts may well be anticipated to show some interesting conditions, for there were no people in the Far Northwest who, in the males at least, used the arms more intensively. They were fisherman and maritime hunters. This necessitated frequent and often protracted trips in their kayaks, involving a great deal of paddling, often of a strenuous nature, which was followed from late childhood to old age [Hrdlicka 1945:533]."

The first observation of this humeral hypertrophy in Aleuts is provided by Tarenetzky (1900), who illustrates the humeri of two Aleut males and includes the cross sectional areas.

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Further studies of pre-Russian humeri, together with related elements, may designate the unique complex of muscle groups involved in double-blade single hatch kayak paddling, in which the paddler is seated and the pulling arm is alternately lower than the pushing arm.

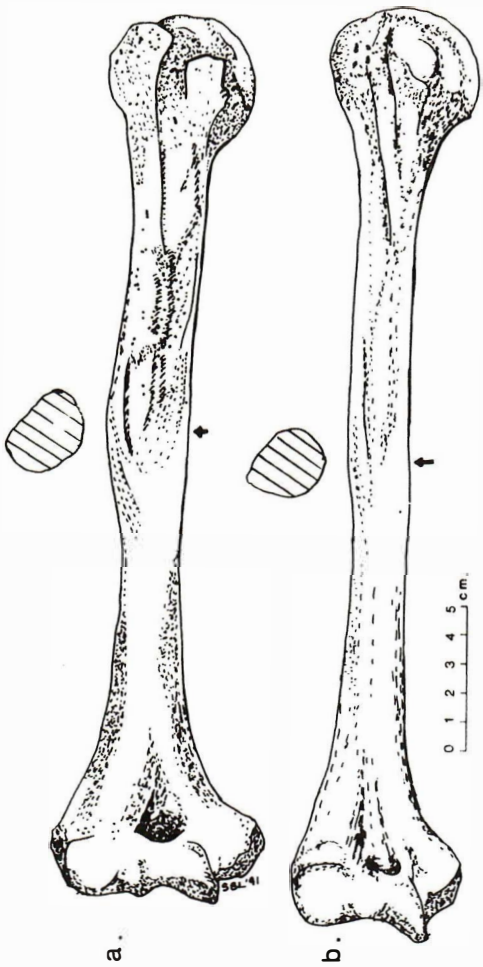

Figure 1. Anterior view right humeri. a) Aleut male kayaker b) Russian male non-kayaker.

References Cited

Hrdlicka, A. 1945. *The Aleutian and Commander Islands and Their Inhabitants.* Wistar Institute of Anatomy and Biology, Philadelphia.

Tarenetzky, A. 1900. Beitrage zur Skelet- und Schaedelkunde *Der Aleuten, Konaegen, Kenai und Koljuschen Mit Vergleichend Anthropologischen*

Bemerkunge. Memoires de L'Académie Impériale des Sciences de St.-Pétersbourg, 8-e series, classe phys.-math.

Human Skeletal Remains Recovered from the Bonner Springs Locality, Northeastern Kansas

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More than 50 human skeletal specimens have been recovered from channel bars along 19 km of the Kansas River near Bonner Springs, Kansas, and incorporated in the Kansas Museum of Natural History collections. A wide range of Pleistocene fauna, including mammoth (*Mammuthus.*), mastodon (*Mammut americanum*), bison (*Bison antiquus* and *Bison bison*), woodland musk ox (*Symbos cavifrons*), and stagmoose (*Cervalces* sp.) have been recovered from the bars along with numerous Holocene faunal remains. The present report is based upon 58 human specimens curated or loaned to the Kansas Museum of Natural History (KMNH) in September, 1990.

While there are no reliable chronometric dates for the assemblage, human remains from this locality are thought to be late Pleistocene or early to mid-Holocene in age, based on the stratigraphy and antiquity of nearby deposits. Near the locality of the channel bars at Bonner Springs, Pleistocene gravels are overlain by sediments of the Newman terrace fill, a lithostratigraphic unit dated 10,430±130 yr B.P. (Beta-2931) to 8,940±90 yr B.P. (DIC-3210) (Johnson 1987; Johnson and Logan 1990). ESR (election spin resonance) data indicate that some of the human remains can be differentiated from the recent Holocene fauna recovered from the bars, and appear more similar in antiquity to the late Pleistocene or earlier Holocene remains.

The 58 human skeletal elements from the locality are represented predominantly by large, durable bones: 19 femora, 12 parietals, 10 frontals, 5 mandible fragments, 4 occipitals, 3 humeri, 2 temporals, and 2 tibiae. One intact subadult calvarium was also present in the sample. Preliminarily, each human element was assigned to one of three grades of fossilization based upon degree of staining and mineralization. Grade 1 specimens (n=22) appeared to be uniformly mineralized with darkly stained cortical bone, dark brown to black in color. Staining and mineralization in Grade 1 human bone resembled that noted in

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some of the Pleistocene and early Holocene fauna but was not seen in late Holocene fauna. Grade 2 elements (n=33) appeared less mineralized and the stain on the cortical bone was restricted to the external surface while the interior bone remained a lighter shade of brown or tan in color. Grade 3 specimens (n=3) were not mineralized and were a light brown color to chalky white color, the exterior and interior cortical bone being more equally stained. The state of preservation in Grade 3 specimens is similar to middle or late Holocene human remains from the Great Plains. There was no association between the grade of mineralization and a particular point bar.

Eleven Grade 1 specimens exhibited minor to extensive water and grit abrasion. Minimal water abrasion was noted in one Grade 2 specimen. Two explanations can account for the taphonomic difference between grades. Water damage and bone mineralization may be a function of time, with older specimens accumulating more damage and chemical alteration. Alternatively, the damage and mineralization in Grade 1 elements may be due to a longer period of direct exposure to water rather than because of their greater antiquity. The presence of only large, heavy skeletal elements with minimal wear and the sharp angularity of gravel clasts at the Bonner Springs locality, suggests that high velocity, short distance transport of gravel and bone took place (Johnson and Logan 1990; Johnson 1987; Holien 1982).

The MNI of humans represented by the complete sample was 11, based on the number of frontal bones. If the grades of mineralization and staining represent human remains of different antiquity, an MNI of 14 is indicated: four Grade 1 individuals (three adult frontals and one subadult humerus), eight Grade 2 individuals (seven adult left femora and one subadult calvarium), and two Grade 3 individuals (two adult left femora). Since we can not confirm the grades represent relative differences in antiquity, the most conservative MNI is 11.

Of those 11 frontals for which age could be determined two were early adolescent (12 - 15 years) (KMNH 54011 and 87790), two younger adults (20 - 30 years) (KMNH 94002 and 54038), five adults (20 - 50 years) (KMNH 87716, 87728, 97032, 54039, 87869), and one old adult (50 plus years) (no catalogue number). Accurate estimates of sex were impossible for most elements, but marked differences in size and robusticity of some elements indicated that both sexes were present.

Indications of the physical appearance of individuals from the locality were limited. The intact Grade 2 calvarium (KMNH 88790), a late child or early adolescent, is dolichocranic (long-headed). Five frontals (KMNH 54088, 87716, 87869, 94002 and one uncataloged), all Grade 2 preservation, exhibit low rising foreheads suggesting these individuals would have been characterized by low as well as long heads. These five frontals also exhibit marked flattening due to some form of cultural modification. It appeared that the flattening did not resemble frontal flattening seen in some Late Prehistoric agriculturalists, but rather a type of deformation caused by the use of a tumpline or similar devise for carrying loads.

One Grade 1 femur (KMNH 103409), was 459 mm in length, suggesting the individual was 170±3.4 cm tall assuming the robust femur represents a male

(based upon Genoves' (1967) corrected formulae; Bass 1987). The mean platymeric index (index of flatness) for 14 Grade 1 and Grade 2 femora was 80.7, indicating extreme lower body muscularity for these individuals. A well developed gluteal tuberosity was present in seven femora with extreme flattening.

Several medical disorders were present. Periostitis was documented for one Grade 1 mandible (KMNH 103634), but no caries were documented in the assemblage. Evidence of an evulsed internal pterygoid muscle was present on one Grade 1 mandible (KMNH 103605). A projectile point was found embedded in the ventral side of one Grade 1 femoral neck (KMNH 103409). Unhealed hairline fractures radiating from this wound were also visible.

Postmortem cultural modification, indicated by fine cut marks were noted on the posterior aspect of one Grade 2 proximal left femur (KMNH 87726) between the lesser trochanter and femur head. The cut marks on this specimen are similar to those associated with the dismemberment of the body for secondary burial.

In summary, the Bonner Springs human bone assemblage, or a portion there of, represents potentially one of the earliest and largest late Pleistocene/early-mid Holocene human assemblages recovered from the Central Plains, and provides us with a unique view of early North American populations in this region.

References Cited

Bass, W. M. 1987. Human Osteology: A Laboratory and Field Manual of the Human Skeleton. 3rd ed. Missouri Archeological Society, Columbia.

Genoves, S. 1967. Proportionality of Long Bones and Their Relation to Stature Among Mesoamericans. American Journal of Physical Anthropology 26:67-78.

Holien, C. W. 1982. Origin and Geomorphic Significance of Channel-Bar Gravel of the Lower Kansas River. Masters thesis. University of Kansas, Lawrence.

Johnson, W. C. 1987. Stop 15B -- Bonner Springs site. In Quaternary Environments of Kansas, Kansas Geological Survey Guidebook Series 5, edited by W. C. Johnson, pp. 41-52. Kansas Geological Survey, Lawrence.

Johnson, W. C., and B. Logan 1990. Geoarchaeology of the Kansas River basin, central Great Plains. In Archaeological Geology of North America, Geological Society of America Centennial Special Volume 4, edited by M. P. Lasca, and J. Donahue, pp. 267-299. Geological Society of America, Boulder.

Lithic Studies

Relationships Between Fluted and Stemmed Points in the Mojave Desert

Mark E. Basgall and M.C. Hall

That Clovis-like, basally-thinned or fluted projectile points exist in the Mojave Desert is well known, but the sporadic occurrence of such implements has hindered attempts to clarify their temporal and cultural parameters. This also underlies a long debate over relationships between fluted and late Pleistocene/early Holocene stemmed points (cf. Willig,et al. 1988), variously labelled Lake Mohave, Silver Lake, Great Basin or Western Stemmed, and the like. Part of the problem is that nearly all fluted points in the region are surface finds, another the lack of precise provenience and compositional detail on the other kinds of cultural materials (if any) present at fluted point locations visited by early researchers. Work during the past decade at Fort Irwin, a 2,650 km^2 military installation in the Mojave Desert, has enlarged considerably the sample of fluted and stemmed points from well-documented contexts. Investigations in the last two years almost doubled the fluted point count and recovered many additional stemmed forms, bringing current totals of each to 17 and 259 specimens, respectively (Basgall 1991; Basgall and Hall n.d.; Hall n.d.; Jones 1991). Offered below are observations on the fluted-stemmed question in light of the Ft. Irwin distributional data.

The eight recently acquired fluted points derive from Nelson Basin in the northwestern portion of the fort; all conform to the definitional criteria of Warren and Phagan (1988), and are morphologically similar to fluted variants elsewhere in the Great Basin. One was an isolated find, the other seven come from two large sites (SBR-2355, SBR-2356) containing abundant, diverse assemblages of artifactual debris including numerous stemmed points, characteristics common to many of the Mojave Desert locations where fluted points have been encountered. Mean hydration values of 14.7 (n=18, sd = 1.5) and

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13.0 (n = 16, sd = 1.7) microns on artifacts of Coso obsidian from the Nelson Basin sites, when compared to regional hydration profiles for this glass type, attest strongly to the substantial antiquity of the two localities.

Historically, there are three fundamental scenarios on fluted-stemmed point relationships in western North America: (1) these point forms are of different ages; (2) they are essentially comparable in age but have entirely separate cultural origins; and (3) they both belonged to the same, broader adaptive system known by such appellations as the Lake Mohave Complex or Western Pluvial Lakes Tradition. Despite years of effort, though, clear resolution of these alternative reconstructions continues to be evasive. Benefits of examining the Ft. Irwin distributions are the facts that large tracts of the post have been surveyed intensively and excavations, often extensive, have been conducted at many of the identified locations. Patterns at Ft. Irwin, therefore, are almost certainly representative of that area and probably applicable to the general desert region.

Including the Nelson Basin examples, isolated finds originally accounted for three of the 17 Ft. Irwin fluted points, 14 occurred at seven sites. One site, however, comprises an immense (0.8 by 2.6 km), discontinuous scatter of prehistoric stone quarrying debris along a series of washes. Since the two fluted specimens found here fell outside main quarry loci, it seems more appropriate to consider both as isolated finds. The other six fluted point sites feature significant accumulations of residential remains and all produced stemmed points, usually in large numbers. Five (29.4%) of the fluted points, hence, can be classified as "isolates", 12 (70.6%) as deriving from "site"contexts. Contrawise, only four (1.5%) of the stemmed points from the fort constitute isolated finds, 33 sites having yielded 255 (98.5%) of the total 259 specimens. At Ft. Irwin, then, fluted points alone have not been found at any sites and, where associated spatially with occupational debris, always co-occur with stemmed forms; meanwhile, 82% of the sites (33) that have yielded either point form produced only the stemmed variety. Viewed another way, isolates make up 46% of the fluted point as opposed to 11% of the stemmed point locations. Equally marked is the contrast in mean specimen counts per location: 1.5 for fluted vs 7.0 for stemmed. It seems apparent that distinctly different processes where responsible for the deposition of these point forms.

This is further encouraged by variability in the types of stone used to manufacture such artifacts (cf. Warren and Phagan 1988). For example, three fourths of the fluted points (76.4%) are cryptocrystalline, the others being felsite (11.8%), obsidian (5.9%), or quartz (5.9%). Conversely, just a fourth of the stemmed points (26.1%) are cryptocrystalline, while well over half are basalt (43.6%), rhyolite (10.9%), or felsite (8.2%); accounting for the remainder are obsidian (10.9%) and quartz (0.4%) pieces.

The divergent depositional and material profiles outlined have two likely behavioral explanations, emerging either through the actions of independent cultural systems, or as a consequence of extreme functional differentiation within a single technological complex. In the first instance, the sometime spatial convergence of fluted and stemmed points is fortuitous, reflecting

multiple occupations of a location. With regard to the second possibility, it may be that the greater dispersion of fluted points and their propensity to occur as isolates relates to a specialized role in off-site hunting, while the tendency for stemmed artifacts to occur strictly in residential contexts may imply a more generalized processing orientation (serving as projectile points, but also for a host of cutting/scraping tasks). This would indicate that the conventional emphasis on stemmed points as hunting weapons is far too restrictive, and could also account for the large numbers of such artifacts at many locations.

Although not conclusive, variation in the overall disposition of fluted and stemmed points in the Mojave Desert is striking enough to suggest associations with different cultural systems, which would, in turn, explain the occasional reports of discrete fluted point accumulations in adjacent parts of the Great Basin (cf. Basgall 1988; Campbell 1949; Pendleton 1979). The alternative seems to dictate a much higher incidence of co-occurrence than seen presently, unless the degree of artifact specialization was truly remarkable. Whether a typical weapon form used to penetrate game or a specific kind of cutting tool, fluted points should be found more frequently with other components of the Lake Mohave tool-kit. Even if, as appears plausible, fluted and stemmed points were produced by entirely different systems, this does not endorse the traditional view of stemmed bifaces exclusively as projectile points. Any of several factors militate against such a characterization: the tremendous morphological variability evident in extant stemmed point assemblages; their superabundance at many of the sites where they occur (a 7.7 average per site exceeding that for any other point series at the fort); and, more indirectly, emerging faunal data that downplay the importance of large game in early Holocene subsistence patterns across Ft. Irwin. With the continued accumulation of specimens from protected, buried contexts, more refined use-wear studies and greater morphological controls will quite probably lead to recognition of significant functional variation among stemmed points in the Mojave Desert.

References Cited

Basgall, M.E. 1988. The Archaeology of CA-MNO-679: A Pre-Archaic Site in Long Valley Caldera, Mono County, California. In: Early Human Occupation in Far Western North America: The Clovis-Archaic Interface, edited by J.A. Willig, C.M. Aikens, and F.L. Fagan, pp. 103-119. *Nevada State Museum Anthropological Papers* 21.

Basgall, M.E. 1991. The Archaeology of Nelson Lake Basin and Adjacent Areas, Fort Irwin, San Bernardino County, California. Report on file, U.S. Army Corps of Engineers, Los Angeles.

Basgall, M.E., and M.C. Hall n.d. Archaeological Investigations at the Awl Site (CA-SBR-4562), An Early Holocene Residential Base in the North-Central Mojave Desert, California. Report in Preparation.

Campbell, E.W.C. 1949. Two Ancient Archaeological Sites in the Great Basin. *Science* 109:340.

Hall, M.C. n.d. Final Report on the Archaeology of Tiefort Basin, Fort Irwin, San Bernardino County, California. Report in Preparation.

Jones, D.A. 1991. Flaked Stone Artifacts from Nelson Basin. In: The Archaeology of Nelson Lake Basin and Adjacent Areas, by M.E. Basgall. Report on file, U.S. Army Corps of Engineers, Los Angeles.

Pendleton, L.S. 1979. Lithic Technology in Early Nevada Assemblages. M.A. thesis, California State University, Long Beach.

Warren, C.M., and C. Phagan 1988. Fluted Points in the Mojave Desert: Their Technology and Cultural Context. In: Early Human Occupation in Far Western North America: The Clovis-Archaic Interface, edited by J.A. Willig, C.M. Aikens, and J.L. Fagan, pp. 121-130. *Nevada State Museum Anthropological Papers* 21.

Willig, J.A., C.M. Aikens, and F.O. Fagan (Editors) 1988. Early Human Occupation in Far Western North America: The Clovis-Archaic Interface. *Nevada State Museum anthropological Papers* 21.

Rhyolite Sources in the Carolina Slate Belt, Central North Carolina

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North Carolina archaeologists have long noted that a primary material used to make stone tools was a very fine-grained metamorphosed volcanic rock called rhyolite from the Carolina Slate Belt in the Eastern Piedmont (North Carolina Geological Survey 1985). Geologically, this rhyolite has a restricted distribution, occurring in a broken band of outcrops in and around the Uwharrie Mountains located in the central portion of the Carolina Slate Belt. Recently, with support from the National Science Foundation (BNS-892164), we have attempted to locate the sources of this stone and to identify its geological variability.

Ultimately, the results of this work will be used to identify the rhyolite types present in a previously unanalyzed portion of the Hardaway site assemblage. The Hardaway site (Coe 1964) is located within the Uwharrie Mountains along the western bank of the Yadkin river in an area of abundant metavolcanic stone. Additionally, raw material variability will be examined from several hundred lanceolate and notched points as part of a wider survey of artifact collections. this projectile point survey will address the geographic

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range of late Pleistocene and early Holocene cultural systems in the Carolina Piedmont (cf. Goodyear 1979; Meltzer 1989).

A preliminary sorting of the stone types present in the Hardaway-Dalton, Palmer, and Kirk components from the Hardaway site suggests that the vast majority of the combined assemblages is composed of rhyolite. It is predominantly a dark gray aphanitic rhyolite, mostly massive and aphyric, but in some cases with scattered phenocrysts and/or flow banding. The remaining minority types include 1) white to clear vein quartz; 2) light green, laminated metasiltstone, commonly called "argillite"; and 3) light to dark grayish-green, extremely fine-grained stone, somewhat chert-like in appearance, and tentatively identified as a metasiltstone. Isolated examples of jasper and various cherts are also present, more so in the debitage than in finished tools. Although jasper may have been obtained from the Piedmont, the chert's sources probably lie in the Ridge and Valley Province to the west, and in the Allendale quarries of the Coastal Plain to the south.

Initial fieldwork was conducted during the winter and spring of 1990 using previous geological (e.g., Conley 1962; Dover 1985) and archaeological (e.g., Cooper and Hanchette 1977; Cooper and Norville 1978; Hargrove 1989; Harmon and Snedeker 1988) work to identify rhyolite quarries or potential rhyolite sources in the vicinity of the Uwharrie Mountains. A total of 11 quarry sites, some of which exhibited spectacular evidence of use, where located and/or revisited and sampled for petrologic analysis.

Based on the results of macroscopic and thin-section analysis, the rhyolite unit mapped by Conley (1962) can be subdivided into distinct types based on color, nature and abundance (or absence) of phenocrysts, grain size, presence of flow banding, and presence of special features such as spherulites. However, we have found that the most consistent and useful basis for subdividing rhyolite types used prehistorically are the nature and percentages of phenocrysts. Accordingly, four subtypes have been identified including 1) aphyric: 2) plagioclase porphyritic; 3) quartz porphyritic; and 4) plagioclase-quartz porphyritic. Our future research will determine if the chemical composition of rhyolites can be used for further detailed characterization and to help in identifying sources.

Our field data and thin-section analyses indicate that the dominant source of the dark-gray, flow-banded, aphyric rhyolite that is so abundant at the Hardaway site is probably from Morrow Mountain. Morrow Mountain also happens to be the most intensively quarried source yet located. We cannot, of course, rule out the possibility that this rhyolite was obtained from quarries outside the surveyed area—this possibility is currently being evaluated by additional fieldwork. However, given that Morrow Mountain is only 8 km south of Hardaway, we feel that is is the most likely candidate.

The sources of the less abundant dark-gray, porphyritic rhyolites in the Hardaway assemblage occur in areas just north of Morrow Mountain and across the Yadkin River to the east of Hardaway. We have found several quarries of these porphyritic rhyolite types located just a few kilometers from the Hardaway sources of the specimens in the Hardaway collection.

The Uwharrie Mountain range was a region of extensive prehistoric quarry use. Virtually every rhyolite-capped mountain appears to have had it stone exploited to some degree during the past. We tentatively conclude that the vast majority of the stone present in the Hardaway assemblage was obtained from quarries not more than 10 km form the site. Most stone probably came from Morrow Mountain, just south of the site and on the same side of the river. The apparently less desirable various porphyritic rhyolites could be obtained even closer, at several sites 4 or 5 km from Hardaway, on both sides of the river.

References Cited

Coe, J.L. 1964. The Formative Cultures of the Carolina Piedmont. *Transactions of the American Philosophical Society* 54.

Conley, J.F. 1962. Geology of the Albemarle quadrangle, North Carolina. *North Carolina Department of Conservation and Development, Division of Mineral Resources, Bulletin 75.*

Cooper, P.P., II, and C. Hanchette 1977. An Historic and Prehistoric Archaeological Resources survey of a certain 5500 acres of the Uwharrie National Forest. Report Submitted to USDA National Forests in North Carolina, Asheville.

Cooper, P.P., II, and C. Norville 1978. An Historic and Prehistoric Archaeological Resources Survey of a Certain 4875 acres of the Uwharrie National Forest. Report Submitted to USDA National Forests in North Carolina, Asheville.

Dover, R.A., Jr. 1 985. *Geology and Geochemistry of Silicified Rhyolites on Lick Mountain, Montgomery county, North Carolina.* Masters thesis, Department of Geology, University of North Carolina.

Goodyear, A.C. 1979. *A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleo-Indian Groups of North America.* Research Manuscript Series No. 156, Institute of Archaeology and Anthropology, University of South Carolina.

Hargrove, T. 1989. An Archaeological Survey in Morrow Mountain State Park, Stanly County, North Carolina. A report submitted to the North Carolina Division of Parks and Recreation by Archaeological Research Consultants, Inc., Raleigh, NC.

Harmon, M.A., and R.J. Snedeker 1988. Cultural resources survey for the proposed Center Church Timber Sale, compartment 10. Report submitted to USDA National Forests in North Carolina, Asheville.

Meltzer, D.J. 1989. Was Stone Exchanged Among Eastern North American Paleoindians? In *Eastern Paleoindian Lithic Resource Use,* edited by C.J. Ellis, and J.C. Lothrop, pp. 11-39. Westview Press, Boulder.

North Carolina Geological Survey 1985. *Geologic Map of North Carolina.* North Carolina Geologic Survey.

The Evant Cores: Polyhedral Blade Cores from North-Central Texas

Glenn T. Goode and Robert J. Mallouf

The discovery of three polyhedral blade cores with probable Paleoindian affinities was brought to the attention of archaeologists in 1990. The find was traced to a plowed and deflated field on the crest of a narrow ridgeline of Cretaceous limestone in Hamilton County, Texas. The cores were found by a landowner among one of numerous residual deposits of Edwards chert that occur across the crest of the ridge. Although uncertainties still exist as to the precise location and date of the discovery, several lines of evidence suggest that the cores were once part of a stone cache that was disturbed and dispersed by plowing.

The three polyhedral cores (Figure 1) are fashioned from two slightly different varieties of locally available, high quality Edwards chert. Two of the cores are heavily patinated, while the third exhibits a spotty to complete patina. Minor plow damage to two specimens reveal interior stone color ranges of light gray to light bluish-gray chert. All three cores are roughly cylindrical with pointed distal ends.

One specimen (Figure 1, A) is a prepared but little-used core nucleus. This core still retains patches of cortex on opposing faces, and it exhibits only one blade scar. Its sub-round platform was prepared by the removal of three successive flakes, followed by trimming of the face and edge. Maximum dimensions: length - 134 mm; platform diameter - 76 mm; core circumference - 235 mm; weight - 792 g.

The second specimen (Figure 1, B) is a near-depleted, final stage polyhedral nucleus. It is the by-product of skillful, large blade production. The final blade removal attempt was unsuccessful, however, and subsequent platform rejuvenation resulted in an imperfect, rectangular-shaped platform surface. One long blade scar on this specimen originates from the opposing, or distal, end of the core. Maximum dimensions: length - 161 mm; platform - 65 by 29 mm; core circumference - 210 mm; weight - 893 g.

The third core (Figure 1, C) is similar to the second in that it represents a very sophisticated level of blade production. The removed blades were smaller,

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finer, and thinner overall—probably demanding a great degree of precision. The rejuvenated platform is circular. Maximum dimensions: length - 147 mm; platform diameter - 55 mm; core circumference - 180 mm; weight 586 g.

All three cores were originally much larger, as attested by an absence of proximal, and scarcity of distal, blade scars. During the process of blade production, damaged or deficient core platforms were repeatedly rejuvenated through the removal of two or three flakes (similar to core tablet flakes) struck from the platform edge, and followed by a series of smaller removals. Platform rejuvenation appears to have been accomplished with direct percussion, and with the intent to create concave, or dished, platform surfaces with slightly protruding, rim-like platform edges. While precluding the use of certain direct percussion techniques, the combination of the rim and adjoining dished platform surface provided an ideal seating for a punch in removing blades through indirect percussion. In addition, this combination of platform features ensured a 75° - 85° platform edge angle, which seems to be critical for efficient indirect percussion blade manufacture. The final reshaped and virtually unused platforms or the Evant cores are good evidence that they were cached for future reuse.

Further clues to Paleoindian blade production are seen in shared traits among the three cores. For example, contouring of the core face was critical for the consistent production of straight, parallel-sided blades. Segments of irregular or too prominent arrises on core faces were sometimes straightened and/or lowered through the removal of clustered small flakes originating from- and perpendicular to-the arrises. In order to complete arris preparation, an oblique removal was then struck from the distal (pointed) end of the core in such a manner as to intersect and undercut the lower party of the problematical arris, thus facilitating proper blade termination (feather or shallow hinge). The blade was then struck off the core at the intersection of the arris with the prepared platform. All three cores exhibit failed blade attempts above arrises prepared in this manner.

Lacking corroborative evidence, the cultural affiliation of the Evant cores cannot be demonstrated irrefutably. However, a comparison with Old and New World blade technologies (e.g., Barnes 1947; Bordaz 1970; Bordes 1968; Green 1963; Hester et al. 1972; Hammatt 1970; Sanger 1968) leaves little doubt that these cores belong to one of the earliest New World cultures, probably Clovis. Methods of core preparation and reduction techniques revealed among the Evant cores are strikingly similar to those of the Old World Paleolithic.

The extreme blade curvature found among cached Clovis blades from the Blackwater Draw (Green 1963) and Keven Davis (Young and Collins 1989) sites is not evident among blade scars of the Evant core assemblage. However, further reduction, which seems to have been intended, could have produced similarly curved blades from at least two of the cores (Figure 1, A and B). The Evant cores were in this case used to produce long, flat-to-moderately curved prismatic blades more like those typically found among utilitarian Clovis assemblages from Blackwater Draw, Pavo Real (41BX52; Henderson 1980) and other Clovis sites—a further testament to the technological flexibility of Clovis knappers.

The authors with to thank Mr. Lloyd Ford for allowing examination of sites on his property, and Bill Metcalf, J.B. Sollberger, Michael B. Collins and David J. Meltzer for their assistance in obtaining the specimens for study, and for technical comments. Pen-and-ink drawings are by Ms. Sharon Roos of Austin, Texas.

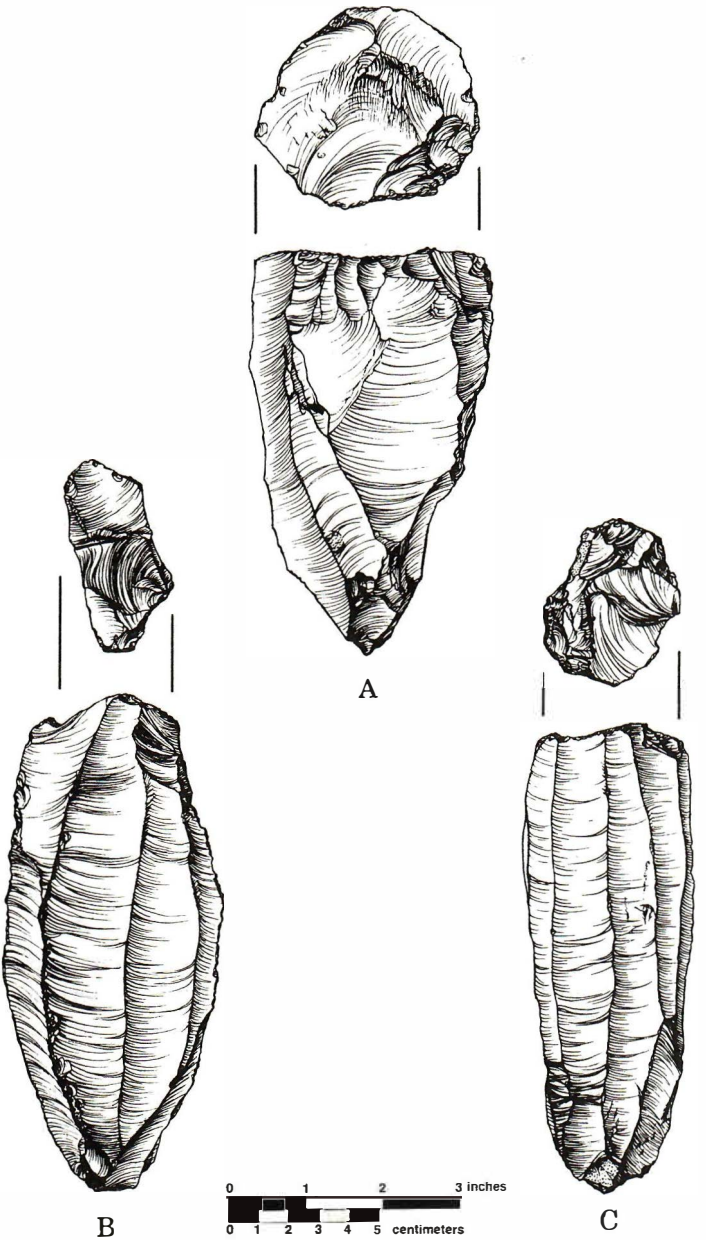

Figure 1. Faces and platform surfaces of three polyhedral cores (Evant Cores) from north-central Texas.

References Cited

Barnes, A.S. 1947. The Technique of Blade Production in Mesolithic and Neolithic Times. Proceedings of the Prehistoric Society for 1947 13:101-113, Cambridge.

Bordaz, J. 1970. *Tools of the Old and New Stone Age.* American Museum of Natural History, Natural History Press, New York.

Bordes, F. 1968. *The Old Stone Age.* World University Library, McGraw-Hill Book Company, New York.

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

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

Henderson, J. 1980. A Preliminary Report of Texas Highway Department Excavation at 41BX52—The Paleo Component. *Texas Archeology* 24:14-15.

Hester, J.J., E.L. Lundelius, Jr., and R. Fryxell 1972. *Blackwater Locality No. 1: A Stratified, Early Man Site in Eastern New Mexico.* Southern Methodist University, Dallas, and Fort Burgwin Research Center, Rancho de Taos, New Mexico.

Sanger, D. 1968. Prepared Core and Blade Traditions in the Pacific Northwest. *Arctic Anthropology* 5:92-120.

Young, B., and M.B. Collins 1989. A Cache of Blades with Clovis Affinities from Northeastern Texas. *Current Research in the Pleistocene* 6:26-28.

The Clarks Flat Site Lithic Analysis

Michael F. Rondeau

The Clarks Flat site is located on the western slope of the Central Sierra Nevada mountains of California. This site, CA-Cal-S342, is one of a number found on Clarks Flat, a relict meander proving a relatively flat terrain of 13 ha in the generally narrow, steep-walled Stanislaus River Canyon at an elevation of 350 m (amsl).

Excavations in 1985 found cultural deposits to a depth of 2.5 m. Four cultural strata were identified. From top to bottom, Stratum I was radiocarbon dated to be more recent than 2,200 yr B.P., Stratum II was radiocarbon dated between 6,750 and 6,250 yr B.P., Stratum III radiocarbon dated between 9,600 and 8,600 yr B.P., and Stratum IV which yielded a radiocarbon date of 11,720±145 yr B.P. (Beta-14299) (Peak and Crew 1990).

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None of the radiocarbon samples were found in direct association with cultural features. The upper portion of Stratum II yielded a series of wide stemmed points named Stanislaus Broad Stemmed which have remarkable similarities to Pinto Series points found elsewhere in the far West. Strata II, III, and IV yielded a variety of Western Stem Series points. Stratum IV, however yielded only limited quantities of flaked stone. Ground stone and a small number of soapstone artifacts were also recovered from Stratum II.

The lithic analysis encompassed 16,402 flaked stone artifacts from the lower three strata (Rondeau and Rondeau 1990). This included the study of 15,322 pieces of debitage, 581 artifacts representing biface manufacturing and use (including 320 classifiable projectile points), 189 whole and fragmentary unifaces, 105 cores, 102 hammerstones, and 12 pointed drill-like specimens.

The biface study indicated that a complete reduction sequence of percussion and pressure biface manufacture was pursued at the site as was the replacement on shafts of broken projectile points. This replacement was suggested by the fact that more than 40% of the point fragments were basal elements. This data, along with numerous point tips exhibiting evidence of rejuvenation, suggests that a substantial number of the recovered specimens came to the site in use damaged form.

The evidence suggests that most of the obsidian arrived at the site in the form of finished or nearly finished bifaces. Of 4,242 specimens, 87.3% of the obsidian debitage was less than one centimeter in maximum dimension while showing technological attributes that result from final shaping and rejuvenation of such pieces. Of the 31 obsidian bifaces, 30 clearly indicated finished pieces. The obsidian hydration analysis (Jackson 1990) suggests that most of the obsidian is no older than the temporal placement of Stratum II.

Although over 79 % of the cores had a unidirectional pattern of flake removals, percussion blade production was not indicated by these specimens or by the debitage. This pattern of core reduction, to the exclusion of most other forms (a few multidirectional and undiagnostic fragments complete the core collection) has not been recognized elsewhere in the Sierra Nevada. This finding may suggest a potential temporal maker for earlier assemblages in the region.

For the unifaces (189), 55.5 % were found to retain use wear. Numerous specimens appear to have been heavily rejuvenated and some appear to have been broken during rejuvenation attempts. The debitage study identified 26 uniface retouch flakes, 4 of which clearly retained use wear.

A total of 123 used specimens (not including the battered hammerstones) were identified by a strict criteria of use rounding, excluding various forms micro-flaking and weathering rounding. These artifacts included 52 unifaces, 49 uniface fragments, 33 edge modified flakes, 6 pointed tools, 4 large percussion shaped unifaces, the 4 uniface, 3 cores, and 2 bifaces. A variety of uses for the hammerstones may be suggested by their varied forms which may included percussion flaking of stone, ground stone shaping, abrading, a pulping or mashing, and perhaps some sort of heavier bashing activity.

The Clarks Flat site has provided the first strong documentation for early Holocene occupation in the region. It has also provided the first archaeologically collected date hinting at human presence in California prior to 11,000 yr B.P.

References Cited

Jackson, R. 1990. Appendix I: Obsidian Hydration Analysis. In *An Archeological Data Recovery Project at CA-Cal-S342, Clarks Flat, Calaveras County, California,* edited by A. S. Peak, and H. L. Crew. Unpublished manuscript. Peak and Associates, Sacramento.

Peak, A.S., and H.L. Crew 1990. An Archeological Data Recovery Project at CA-Cal-S342, Clarks Flat, Calaveras County, California. Unpublished manuscript. Peak and Associates, Sacramento.

Rondeau, M.F., and V.L. Rondeau 1990. Appendix G: An Archeological Study of the Early Flaked Stone Assemblage from Clarks Flat, CA-Cal-S342, Calaveras County, California. In *An Archeological Data Recovery Project at CA-Cal-S342, Clarks Flat, Calaveras County, California,* edited by A. S. Peak, and H. L. Crew. Unpublished manuscript. Peak and Associates, Sacramento.

Methods

The Early History and Archaeology of Nebraska Paleoindian Sites

David J. Meltzer

It has recently been suggested in this journal that a series of "virtually identical discoveries (by paleontologists) of extinct bison in association with projectile points were largely ignored by the archaeological establishment in the early part of the twentieth century" (Rogers and Martin 1986: 43-44), and that the Folsom discovery in 1927 was "neither unique nor decisive in changing perceptions about the existence of Paleoindians," which thus remained controversial until the advent of radiocarbon dating (Rogers and Martin 1987:82). Three Nebraska Paleoindian sites are central to these claims, and so it is appropriate to examine briefly the circumstances surrounding the discovery of those sites, and the reaction (if any) of archaeologists (for a fuller discussion of these and the other sites on which these claims are based, see Meltzer 1991).

The Custer County site is identified as one of the "remarkable...scientific discoveries," made by paleontologists which had "little effect... on the archaeologist of that time" (Rogers and Martin 1986:44). In truth, the discovery had no discernible effect on the *paleontologists* who excavated it. In July 1929, Erwin Barbour, paleontologist and Director of the Nebraska State Museum had C. Bertrand Schultz excavating Pleistocene marls in the South Loop Valley, Custer County.

Schultz later reported that "after an hour of digging to determine whether or not the new find (a bison) was worth collecting, the writer found an artifact (specimen 2-16-7-29), in association with a portion of bison rib" (Schultz 1932:271). The artifact was important "because of its association with the fossil bone, and because it differed greatly from the common arrow-heads of the Plains indians{" (Schultz 1932:271).

Yet Schultz wrote those words two years after the fact. When the artifact was actually found in 1929 it was not accorded any significance: in a detailed

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letter to Barbour, reporting on the day's finds, Schultz made no mention of the point—only a "most beautiful' newly found bison skull (Schultz to Barbour, July 16, 1929, Barbour Papers, Nebraska State Museum, hereafter EHB/NSM). Barbour responded with congratulations on the new skull, but no word of the artifact then or in any subsequent correspondence that field season (Barbour to Schultz, July 18, 1929 EHB/NSM).

In fact, Barbour and Schultz paid attention to the Custer County artifact only *after* archaeologist W.D. Strong, then at the University of Nebraska, learned of its existence in 1930 and, in Schultz's words, "urged further investigation and excavation" (Schultz 1932:272). In September of 1930 Strong accompanied Schultz to the site to help map it and estimate its age (apparently late Pleistocene - Schultz 1932:272).

Perhaps owing to Strong's emphasis on the archaeology, greater attention was paid to artifacts found the following summer at the Meserve site. Bison had been excavated by zoologist F.G. Meserve from the site in 1923. There is no evidence that at the time Meserve recognized the bison as an extinct species, or appreciated the significance of the associated projectile point. The Meserve site originally attracted Barbour's attention as a source for bison bone for museum display (Barbour to Meserve, June 4, 1931, EHB/NSM). The initial correspondence between Barbour and Meserve in the summer of 1931 makes no mention of artifacts.

Barbour sent Schultz to excavate at the Meserve site in the summer of 1931 to recover more bison bone. On July 25, 1931, the crew also found a projectile point, and subsequently learned this was the *second* to come from the bone bed (Barbour and Schultz 1932a). Meserve had found one in 1923, but only after prompting by Barbour in late 1931 learned of its significance (Barbour to Meserve, November 12, 1931, EHB/NSM). Schultz by then appreciated the importance of the artifacts (Schultz to Barbour, late July, 1931, EHB/NSM). All the same, Barbour, who had just spoken with Strong of the find, felt obliged to remind Schultz that "The arrow points are very important. I hope you have saved them and not sold them" (Barbour to Schultz, August 13, 1931, EHB/NSM).

More artifacts would be found with fossil bison at the Scottsbluff site the following summer (1932). It has been reported that when the artifacts were discovered, Loren Eiseley "begged to be sent elsewhere, out of fear of what involvement with Paleoindian site would do to his career as an anthropologist" (Schultz 1983:32). In fact, Rogers and Martin (1986:44, 1987:81) use this colorful vignette as prime evidence that even after the Folsom find Paleoindian sites remained controversial. But, unfortunately, the vignette is untrue.

The Scottsbluff site when discovered was thought to be only a paleontological quarry, and was being worked for bison bone (Barbour and Schultz 1932b). For the first month or so of the 1932 season, no artifacts had been encountered, or where even expected. Eiseley, then on the Scottsbluff field crew, wrote Barbour to say he had received an offer to do archaeological field work in the Southwest, and wished to take it (Eiseley to Barbour, July 16, 1932, EHB/NSM). By return mail, Barbour encouraged him to do so, and almost immediately Eiseley departed for Arizona (Barbour to Eiseley, July 18, 1932,

EHB/NSM). Eiseley left the Scottsbluff excavations before any artifacts were discovered (Barbour and Schultz 1932b:286).

The first artifacts from Scottsbluff were unearthed on August 4, 1932 (Schultz to Barbour, August 4, 1932, EHB/NSM) - over two weeks after Eiseley went to Arizona. The story of Eiseley at Scottsbluff "begging to be sent elsewhere" is therefore untrue, but the observation must also be made that even later Eiseley never displayed any "fear" of becoming involved with this Paleoindian site. He wrote up the Scottsbluff material for his Master's Thesis in Anthropology (Eiseley 1935). And he and Schultz published the results in the *American Anthropologist* (Schultz and Eiseley 1935) - at the time still the major outlet for archaeological papers.

There are ample reasons why Folsom, and none of the earlier discoveries, was decisive in ending the human antiquity controversy (Meltzer 1991). But Folsom surely ended it, and in doing so cast new discoveries (Custer County, Scottsbluff) and old ones (Meserve) in an entirely different light, a fact well appreciated by archaeologists at the time (Kidder 1936). Contrary to Rogers and Martin (1986, 1987), there was widespread recognition and acceptance of Paleoindian sites in the years immediately after Folsom and long before the advent of radiocarbon dating (e.g., Howard 1935; Roberts 1940; Strong 1933). All this is nicely captured in a letter from Schultz who, having shown the Nebraska Paleoindian artifacts a the American Museum of Natural History, happily reported to Barbour that the Scottsbluff find "is regarded as one of the most important scientific finds of 1932. Geologists, Paleontologists and Anthropologists are all interested" (Schultz to Barbour, January 17, 1933, EHB/NSM).

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References Cited

Barbour, E.H., and C.B. Schultz 1932a. The Mounted Skeleton of *Bison Occidentalis*, and Associated Dart-points. *Nebraska State Museum, Bulletin* 32:263-270.

Barbour, E.H., and C.B. Schultz 1932b. The Scottsbluff Bison Quarry and its Artifacts. *Nebraska State Museum, Bulletin* 34:283-286.

Eiseley, L.C. 1935. Review of the Paleontological Evidence Bearing Upon the Age of the Scottsbluff Bison Quarry. Master's thesis, The University of Pennsylvania.

Howard, E.B. 1935. Evidence of Early Man in North America. *The Museum Journal* 24 (2-3).

Kidder, A.V. 1936. Speculations on New World Prehistory. In *Essays in Anthropology*, edited by R. Lowie, pp. 143-151. University of California Press, Berkeley.

Meltzer, D.J. 1991. On "Paradigms" and "Paradigm Bias" in Controversies Over Human Antiquity in America. In *The First Americans: Search and Research,* edited by T.D. Dillehay and D.J. Meltzer. The Telford Press (in press).

Roberts, F.H.H. 1940. Developments in the Problem of the North American Paleoindian. *Smithsonian Miscellaneous Collections* 100:51-116.

Rogers, R., and L. Martin 1986. Replication and the History of Paleoindian Studies. *Current Research in the Pleistocene* 3:43-44.

Rogers, R., and L. Martin 1987. The Folsom Discovery and the Concept of Breakthrough Sites in Paleoindian Studies. *Current Research in the Pleistocene* 4:81-82.

Schultz, C.B. 1982. Association of Artifacts and Extinct Mammals in Nebraska. *Nebraska State Museum, Bulletin* 33:271-282.

Schultz, C.B. 1983. Early Man and the Quaternary: Initial Research in Nebraska. *Transactions of the Nebraska Academy of Sciences* 11:129-136.

Schultz, C.B. , and L.C. Eiseley 1935. Paleontological Evidence for the Antiquity of the Scottsbluff Bison Quarry and its Associated Artifacts. *American Anthropologist* 37:306-319.

Strong, W.D. 1933. The Plains Culture Area in the Light of Archaeology. *American Anthropologist* 35:271-287.

Helminthological Methods for the Studies of Fossil Vertebrate Dung

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When birds and mammals inhabit caves and crevices, deposits of dung and food remnants are often accumulated. Radiocarbon dating of such zoogenous remains from caves confirm Pleistocene, Holocene and modern ages of such deposits. Studies of zoogenic deposits consist of radiocarbon, palynological, botanic, and other methods. To obtain additional information on the paleoecology of various biomes, we use a helminthological method for the study of fossil vertebrate dung deposits.

The paleontological recovery of helminth remnants are rare. Nematodes have been found in amber (Taylor 1935). The eggs of Oxyuridae (nematodes) have been found in feces that presumably belong to a lizard representative of *Tropidurus* (Iguanidae) (Araujo, et al. 1982). These nematodes were recovered

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from dung removed during excavation in a Brazilian cave (radiocarbon dated to approximately 9,000 yr B.P.). Helminth remnants have been found in dung of *Alligator* (alligator) received from the swamps of Florida (Reinhard et al. 1988). Nematodes were found in preserved carcasses of *Spermophilus undulatus* (Arctic ground squirrel; Dubinin 1948), *Equus* sp. (horse; Dubinina 1972), and *Bison* sp. (bison; Shachmatova 1988) from frozen Quaternary deposits. In recent years paleoparasitology of humans has become popular (Horne 1985; Reinhard, et al. 1988).

The application of the helminthological method became possible with the appearance of radiocarbon dating. This radiometric technique permits the solution to a number of problems concerning the interrelations between wild and domestic animals, distribution of helminthoses by domestic animals (i.e., dislocation of migration passages and centers of domestication), the uses of domestic animals and some other problems. We can acquire information about the paleoenvironment because the life cycle of helminths involves intermediate hosts whose requirements are habitat specific. This is especially true for biogelminths.

Naturally, helminthological analysis of fossil dung is also of interest as far as particular helminthological problems are concerned, such as phylogeny, history of their distribution, and the origin of helminthose centers, among others. Apart from the above, helminthological analysis assists in solving a number of applied problems in the studies of deposits of dung.

To examine the occurrence of helminth eggs (via flotation concentration and inspection under a dissecting microscope) in fossil dung, we studied deposits from different regions in the USSR and Mongolia. Eggs belonging to *Nematodirus* were found in the dung pellets of the bovid *Capra sibirca* (goat) from Yaroldzktenian Cave (south Mongolia) (Dinesman et al. 1989). The age of this dung layer is 33,650±1640 yr B.P. (IEMAE-659). Eggs of Oxyuridae were recovered in the Pleistocene (32,210±1130 yr B.P., IEMAE-481) dung of *Alticola* (mountain vole), and in the Holocene (1,100±80 yr B.P., IEMAE-547) dung of *Alticola* and *Ochotona* (pika). Dung of *Ovis* (sheep) from Turkmenia, USSR, dating 690±130 yr B.P. (IEMAE-780) contain eggs belong to *Fasciola*.

From north Osetia (Caucasus) we studied the dung deposits (dating 700±110 yr B.P., IEMAE-710) of sheep and *Capra cylindricornis* (goat) which contained eggs belong to *Dicrocoelium, Fasciola, Trichuris,* and *Trematoda*. Additional dung of *Capra cylindriocornis* dating 810±80 yr B.P. (IEMAE-736) contained eggs of *Capillaria* and *Dicrocoelium*.

These results indicate that the eggs of helminths can be preserved for thousands of years. However, most of the remains are eggs of trematodes and nematodes with dense and thick shells.

References Cited

Araujo, A.G., U.E.C. Confalomeri, and L.F. Ferreira 1982. Oxyurid (Nemotoda) Egg from Coprolites from Brazil. *Journal of Parasitology* 68:511-512.

Dinesman, L.G., N.K. Kiseleva, A.V. Knyazev 1989. The History of a Steppe Ecosystem of Mongolia. Moscow, Nauka. 215 pp. (in Russian)

Dubinin, V.B. 1972. Find of Pleistocene Louse and Nematode in Corposes of Fossil Suslik. Doklady AN SSSR: 62:417-420. (in Russian)

Dubinina, M.V. 1972. Nematode *Alfortia edentata* (Loss, 1960) from Intestines of Late Pleistocene Horse. *Parasitology*: 6:443-44. (in Russian)

Horne, P.D. 1985. A Review of the Evidence of Human Endoparasitism in the Pre-Columbian New World through the Study of Coprolites. *Journal of Archaeological Sciences* 12:299-310.

Knyazev, A.V. 1979. Studies of Cave Zoogenic Deposits for the Elucidation of the History of Biogeocoenoses. Moscow, Nauka. pp. 129-141. (in Russian)

Reinhard, K.J., U.E. Confalonieri, B. Herrmann, L.F. Fiereira, A.J.G. Araujo 1988. Recovery of Parasite Remains from Coprolites and Latrines: Aspects of Palaeoparasitological Technique. *Homo* 37:213-239.

Shachmatova, V.I. 1988. New Species of Genus *Skrjabinagia* Kassimov, 1947 (Nematoda, Trchostrongylidae) from Fossil Bison. Taxonomy of Siberian Animals. Novosibirsk, pp. 14-19. (in Russian)

Taylor, A.L. 1935. A Review of the Fossil Nematodes. *Proceedings of the Helminthological Society of Washington* 2:47-49.

Paleoenvironments: Plants

Preliminary Analysis of a Late Glacial Pollen Record from Cloquet Lake, Lake County, Minnesota, USA

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Palynological investigations of a core from Cloquet Lake, Lake County, Minnesota are currently being undertaken to aid in the understanding of Paleoindian occupation of the area. Preliminary pollen analysis indicates that the pollen sequence at Cloquet Lake records local and regional vegetational change during the late glacial/postglacial transition. The headwaters of the Cloquet River, Cloquet Lake are located approximately 90 km north of Duluth, MN (91°30'W, 47°30'N)

The 438-cm core extracted from near the center of the lake is composed of two distinct stratigraphic zones separated by a 3-cm thick gravel layer. The upper 397 cm consists of detrital gyttya; below the gravel layer (400-438 cm) is silty clay (Figure 1).

The pollen diagram from the site has been divided into three pollen-assemblage zones representing the late glacial and early postglacial history of the watershed. These zones are comparable to the pollen-assemblage zones defined by Cushing (1967) and Wright and Watts (1969) for northeastern Minnesota.

Zone I is characterized by more than 50% nonarboreal (NAP) pollen (Figure 1). The dominant NAP types are sedge (Cyperaceae), ragweed (*Ambrosia*-type), wormwood (*Artemisia*), and grass (Gramineae). Spruce (*Picea*) and willow (*Salix*) are most abundant arboreal (AP) pollen types. This zone suggests a shrub tundra-like environment with occasional stands of spruce or individual spruce trees.

Zone II is marked by the maxima and subsequent decline in spruce as pine (*Pinus*) increases; NAP also decreases (Figure 1). Birch (*Betula*) also increases

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in the upper part of this zone. Most of the pine grains are Diploxylon-type. The pollen spectra in Zone II indicate a conifer forest.

Diploxylon-type *Pinus*, *Picea*, and alder (*Alnus*) are the dominant AP taxa found in Zone III (Figure 1). NAP is low, 15% or less. Currently the upper limit of this zone is undefined pending further pollen analysis. Zone III indicates that a mixed conifer-hardwood forest is developing in the Cloquet Lake watershed.

Pollen analysis of the Cloquet Lake core is continuing, and radiocarbon dating of the core is planned. Analysis of algae recovered in conjunction with the pollen is also being undertaken. When this investigation is finished, the results will provide a more complete understanding of late glacial vegetational

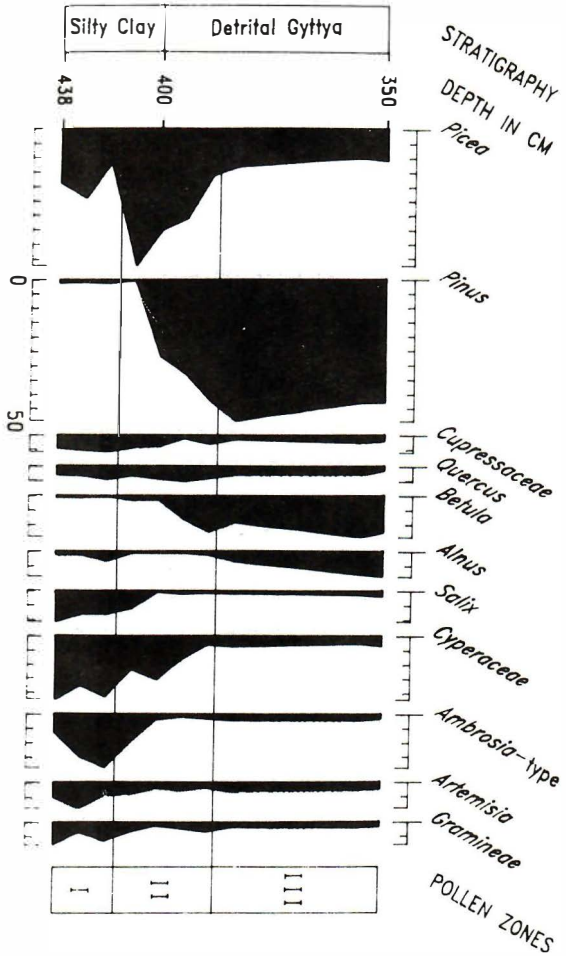

Figure 1. Pollen percentage diagram of selected taxa from Cloquet Lake Lake County, Minnesota.

change and lacustrine conditions in the Cloquet Lake watershed, as well as Paleoindian occupation of the area.

References Cited

Cushing, E.J. 1967. late-Wisconsin Pollen Stratigraphy and the Glacial Sequence in Minnesota. In *Quaternary Paleoecology*, edited by E.J. Cushing, and H.E. Wright, Jr., pp. 59-88. Yale University Press, New Haven.

Wright, H.E., Jr., and W.A. Watts 1969. Glacial and Vegetational History of Northeastern Minnesota. *Minnesota Geological Survey Special Publication, Series SP*-11.

A Paleolimnological Example of Modulated Succession from Southeast Venezuela, and its Significance in Pleistocene Paleoecology

Valentí Rull and Teresa Vegas-Vilarrúbia

Most frequently, Pleistocene records are interpreted in paleoenvironmental terms. However, they may provide more information, related with ecological successions.

To exemplify these type of ecological studies, we analyzed a recent pollen sequence from Lake Carinapay (4°37'N, 60°57'W). The lake is shallow and with well-developed macrophytic vegetation, characterized by *Sagittaria guayanensis*, *Sagittaria* sp., *Xyris*, *Utricularia*, and several Cyperaceae. *Zygnema* and *Mougeotia* (Zygnemataceae) also occur. The core studied (1.90 m long) was subdivided into 19 levels, from 1 (top) to 19 (base). A surface sample (0) represented the present-day conditions. Ages were deduced by correlation with ^{14}C dated sequences (Rull 1990). Common methods of pollen analysis (Faegri and Iversen 1989), with some modifications (Salgado-Labouriau and Rull 1986; Rull 1987) were used.

Based on the variations of algal remains, we established a ratio (P/L) between planktonic (*Botryococcus* and *Tetraedron*) and littoral (*Zygnema*, *Debarya* and other Zygnemataceae) ones, to estimate the relative water level (WL). The variations of P/L were slow and continuous, showing two phases of low WL (1,000-800 and 600-400 yr B.P.), and two of high WL (800-600 and 400-0 yr B.P.). The responses of macrophytic community were analyzed by defining assemblages, through clustering of samples according to the abundances of

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Cyperaceae (CYP), *Myriophyllum*-type (MYR), *Sagittaria guayanensis* (SGY), *Sagittaria* sp. (SSP), *Nuphar* (NUP), and *Xyris* (XYR) pollen. The euclidean distance and the weighted centroid agglomerative method were used and six assemblages were obtained: A (SGY dominant, CYP subdominant), B (CYP-SGY co-dominant), C (CYP dom., SGY subdom.), D (CHP only), E (CYP dom., NYR-SGY subdom.), and F (CHP dom., SSP subdom.). A transfer matrix was built, and the probabilities of between-stage moving were computed. The maximum probabilities corresponded to the stopping in assemblage B ($p = 0.16$), stopping in A and moving from A to C ($p = 0.11$). Other observed variations have equal probabilities ($p = 0.06$), except those not observed (69%). The total probability of stage A is $p = 0.33$, followed by C ($p = 0.28$), and B ($p = 0.22$). The more stable interval occurred between samples 15 and 9, where the probability of B is $p = 0.75$, but a general, largely oscillating trend could be easily seen. Furthermore, retrogressions and circular trends could be observed, thus indicating that the process in non-linear. Complexity, as measured by the Shannon-Weaver index of diversity was also oscillating. Minimum diversity ($H = 0$) corresponded to the pioneer stage D, whereas the more complex coincided with the more ephemeral, i.e., those with low total probability ($H = 1.80$-1.98 for E and 2.10 for F). On the contrary, the more frequent assemblages were the less complex, which attained the following mean values of H: 1.19 (A), 1.33 (B) and 1.28 (C). Therefore, the sequence studied did not show a directional autoorganizational tendency from simple to more complex seral stages—the classical concept of ecological succession (Odum 1971; Margalef 1977).

Rull (in press) differentiates among undisturbed and modulated successions, the former being those developed under a constant environment, whereas the latter are submitted to oscillating external factors which cause continuous reorganizations in the involved biocenose. A common feature is that succession (s. 1.) involves persistence of the community into its attraction domain (Holling 1973); if the biotic tolerance is overcome by an environmental shift, a substitution (change of attraction domain, i.e., change of community) occur. The case-study presented falls in the category of modulated succession, and supports the unsuitability of the "climax" concept (Flenley 1979), as well as the hypothesis of a maintained disequilibrium between environment and living communities (Davis 1984; Delcourt and Delcourt 1983).

Long Pleistocene sequences are probably full of undisturbed and modulated successions which are commonly ignored because of the sampling design and the research objectives. Paleoclimatic research is concerned with notable ecological changes, commonly substitutions, from which it is possible to derivate significant environmental shifts. However, Paleoecology is the Ecology of the past (Birks and Birks 1980), thus not only including the study of past environments, but also of past biotic relationships. Furthermore, sampling for paleoclimatology must take into account minor ecological reorganizations and trends, in order to avoid incorrect deductions from samples taken in different stages of successions, which are non-predictable, and most probably non-comparable. Similar errors are, for instance, to deduce significant sedimentary

changes from sampling designs based only on the within-samples distance and ignoring facies succession within single sedimentary units.

Detailed ecological analyses of selected short Pleistocene sequences and comparison with modern analogues like Carinapay are thus necessary, in order to avoid these problems.

References Cited

Birks, H.J.B., and H.H. Birks 1980. *Quaternary Palaeoecology*. E. Arnold, London.

Davis, M.B. 1984. Climatic Instability, Time Lags and Community Disequilibrium. In *Community Ecology*, edited by J. Diamond and T.J. Case, pp. 269-284. Harper & Row, New York.

Delcourt, P.A., and H.R. Delcourt 1983. Late-Quaternary Vegetational Dynamics and Community Stability Reconsidered. *Quaternary Research* 19:265-271.

Faegri, K., and J. Iversen 1989. *Textbook of Pollen Analysis*. (4th edition). Wiley, New York.

Flenley, J.R. 1979. *The Equatorial Rain Forest: A Geological History*. Butterworths, London

Holling, C.S. 1973. Resilience and Stability of Ecological Systems. *Annual Review of Ecological Systems* 4:1-23.

Margalef, R. 1977. *Ecologia*. Omega, Barcelona.

Odum, E.P. 1971. *Fundamentals of Ecology*. Saunders, Philadelphia.

Rull, V. 1987. A Note on Pollen Analysis in Paleoecology. *Pollen et Spores* 29:471-480.

Rull, V. 1990. Contribución a la Paleoecología de Pantepui y la Gran Sabana, Guayana Vezolana: Clima, Biogeografía y Ecología. PhD. thesis. CEA-IVIC, Caracas.

Rull, B. in press Quaternary Palaeoecology and Ecological Theory. *Orsis* 5.

Salgado-Labouriau, M.L., and V. Rull 1986. A Method of Introducing Exotic Pollen for Palaeoecological Analysis of Sediments. Review of Palaeobotany and Palynology.

Paleoenvironments: Vertebrates

Historic Bovid Teeth from Gardiner, Maine

Harold W. Borns, Jr. and Clayton E. Ray

On September 26, 1845, Sir Charles Lyell examined fossils in the cabinet of Mrs. Frederic Allen of Gardiner, Maine. Among these were four teeth subsequently identified by Richard Owen as those of American Bison (*Bison*) (Lyell 1849:44). Some of the teeth were figured by Packard (1867, plate VII, figs. 18, 18a, 18b) and by J.A. Allen (1876, pl. XII, figs. 13-15). J.A. Allen (1876:88-91, and note following caption to plate XII) provided a through history of the find to that date (including Owen's disavowal of his earlier identification), and concluded that the teeth represented modern domestic ox, *Bos taurus*, intrusive into the Pleistocene clays. The specimens have attracted very little later attention, excepting notably from G.A. Allen (1920:161) and Hay (1923:24, 292), both of whom were inclined to accept J.A. Allen's assignment to *Bos taurus*.

Three of the teeth from Mrs. Allen's estate were deposited in the collections of Bowdoin College, Brunswick, Maine, and one in the Museum of the Boston Society of Natural History. This last tooth, the one depicted in J.A. Allen's fig. 13, was located recently by one of us (Borns) in the collections of the Boston Museum of Science, the successor to the Boston Society of Natural History, under that society's number 15198. We have not as yet been able to confirm the current presence of the other teeth at Bowdoin College.

Reassessment of the published evidence indicated that the field data were uncommonly extensive and explicit for the time of collection (1837), including a written deposition by the collector (J.A. Allen, 1876:90), which made it difficult to dismiss the specimens summarily as the product of recent intrusion. The extreme rarity of evidence of Pleistocene terrestrial mammals in New England, and their potential importance as prey for humans populating the recently deglaciated terrain, stimulated our desire to resolve the identity and age of these remains.

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Accordingly, one of us (Ray) reexamined and compared the one available tooth with known *Bison* and *Bos* again, as with Allen, inconclusively, although inclined toward *Bos*. Particularly, with the potential ramifications attached to its identification, no decision seemed defensible on morphological grounds alone. A ^{14}C date using the AMS technique seemed the only realistic means of laying the problem to rest.

The Boston Museum of Science generously gave permission to sacrifice a small part of the tooth for dating; the Arizona AMS Facility, University of Arizona, agreed to analyze the sample; and funding was provided by the Department of Paleobiology, National Museum of Natural History, Smithsonian Institution

The specimen, University of Arizona sample AA-5275, yielded an age of less than 113 years, even younger than the 153 years since date of collection. Thus, there seems now to be no reason to doubt the the teeth represent modern domestic *Bos taurus*. The availability of the AMS technique affords the possibility of dating specimens of equivocal or unknown age, thereby resolving previously intractable problems with historic specimens, and increasing the scientific significance of specimens with inadequate data.

References Cited

Allen G.M. 1920. Bison Remains from New England. *Journal of Mammalogy* 1:161-164.

Allen J.A. 1876. The American Bisons, Living and Extinct. *Geological Survey of Kentucky Memoir* 1:ix+246.

Hay O.P. 1923. The Pleistocene of North America and its Vertebrated Animals from the States East of the Mississippi River and from the Canadian Provinces East of Longitude 95°. *Carnegie Institution of Washington Publication* 322:VIII+499.

Lyell, C. 1849. A Second Visit to the United States of North America. Volume 1. Harper and Brothers, New York, i-xii, 13-273 pp.

Packard, A.S., Jr. 1867. Observations on the Glacial Phenomena of Labrador and Maine, with a View of the Recent Invertebrate Fauna of Labrador. *Boston Society of Natural History Memoir* 1:210-303.

A record for Caracara from the Late Pleistocene of Nebraska

Robert M. Chandler and Larry D. Martin

The identification of a partial left tibiotarsus (UNSM 69609) as that of a caracara (Falconidae: Polyborini, *Polyborus* aff. *P. prelutosus* Howard 1938) is the northern most occurrence for a caracara in the fossil record (Brodkorb 1964; Lundelius et al. 1983). Today small populations of caracaras can be found in areas in Arizona, Florida, and Texas (Palmer 1988). Pleistocene records for caracara include those states listed above plus California and New Mexico.

The partial tibiotarsus (UNSM 69609) is with in the size range and relative proportions of the northern subspecies of the living caracara *Polyborus plancus cheriway* and the fossil species *P. prelutosus* Howard. The less angular tendinal bridge, the shape of the shaft, and the location where the fibula ankylosis to the shaft of the tibiotarsus are diagnostic for caracaras distinguishing them from falcons and hawks. The fossil (UNSM 69609) and the southern subspecies, *P. p. plancus*, differ from the northern subspecies, *P.p. cheriway*, by having a symplesiomorphic character: the intermuscular line on the anterior surface extends proximad to the fibular crest. Howard (1938) found the tibiotarsus of *P. prelutosus* to be more like *plancus* than *cheriway* qualitatively.

The fossil is from the Angus Local Fauna (LF) in Nuckolls County, Nebraska, which is late Irvingtonian, Sheridanian subage (Martin and Schultz 1971; Lundelius et al. 1987). A large avifauna is represented in the Angus LF which includes grebes, ducks, hawks, grouse, a crane, and avocet, a curlew, a dove, a woodpecker, and numerous perching birds.

The Angus LF was recovered from sediments deposited in a small pond that was closely associated with a fluvial system. Numerous fish remains were recovered along with aquatic molluscs. A diverse mammal fauna includes *Mammuthus* (mammoth), *Mammut* (mastodon), peccary, camel, and *Equus* (horse). Small mammals include boreal forms like the red-backed vole (*Clethrionomys*) and the southern bog-lemming (*Synaptomys*). Also represented are an ancestral *Cynomys* (black-tailed prairie dog), several ground squirrels, a pocket gopher, and a kangaroo rat. These rodents and the caracara would have required more open country. Therefore, the associated vertebrates in the fauna gives a parkland environmental picture.

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References Cited

Brodkorb, P. 1964. Catalogue of Fossil Birds, Part 2 (Anseriformes through Galliformes). *Bulletin Florida State Museum* 8:195-335.

Howard, H. 1938. The Rancho La Brea Caracara: a New Species. *Carnegie Institution of Washington Publication* 487:217-240.

Lundelius, E.L., Jr., R.W. Graham, E. Anderson, J.A. Holman, D.W. Steadman, and S.D. Webb. 1983. Terrestrial Vertebrate Faunas. In *Late-Quaternary Environments of the United States: vol. 1, The Late Pleistocene,* edited by S.C. Porter, pp. 311-353. University of Minnesota Press.

Lundelius, E.L., Jr., T. Downs, E.H. Lindsay, H.A. Semken, R.J. Zakrzewski, C.S. Churcher, C.R. Harington, G.E. Schultz, and S.D. Webb. 1987. The North American Quaternary Sequence. In *Cenozoic mammals of North America,* edited by M.O. Woodburne, pp. 211-235. University of California Press, Berkeley.

Martin, L.D., and C.B. Schultz 1971. Stratigraphic Position and Paleoecology of the Angus Local Fauna. *Geological Society of America, Abstr. Prog. North-central Sect.* 3:270-271.

Palmer, R.A. 1988. Handbook of North American Birds. (Ed.) Vol. 5, part 2:465 pp. Yale University Press, New Haven and London.

Taphonomic Analysis of the Burning Tree Mastodont

Daniel C. Fisher, Bradley T. Lepper, and Paul E. Hooge

Comparative taphonomic studies of late Pleistocene proboscideans may provide critical insight into the nature of the fossil record from this time period (Fisher 1984; Graham and Kay 1988). An opportunity to document taphonomic patterns for *Mammut americanum* (American mastodont) emerged in December, 1989, when a dragline excavating a pond in Licking Co., Ohio struck the cranium of the Burning Tree mastodont (Lepper 1990). Manual salvage excavation (recorded by photographs and video) revealed additional skeletal material

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undisturbed by mechanical excavation. Bones were preserved within peat that formed under anaerobic conditions in a small lake occupying a local depression on late Wisconsinan till. They occurred in three clusters (separated by 2-4 m), each consisting of tightly articulated units and multiple, disarticulated bones. The first included the cranium, mandible, articulated inominates and sacrum, both scapulae, thoracic vertebrae, and left hindlimb elements; the second included two articulated sets of thoracic vertebra, multiple ribs, and an approximately 60 by 12 cm cylindrical mass of plant material later confirmed as gut contents (Lepper et al. in press); and the third included articulated cervical vertebrae, articulated carpals, both humeri, additional forelimb elements, and the right patella. The skeleton lacks only the thyrohyoids; left patella; right femur, tibia and fibula; most phalanges and sesamoids; and all but two (ca. 10th and 14th) caudal vertebrae posterior to the 8th. Extensive probing, screenwashing, and manual spreading of sediment revealed little additional mastodont material. High recovery of even small elements suggests that missing mastodont bones were not present at the site. A stratigraphically consistent set of 12 radiocarbon dates and preservation of easily oxidized sedimentary pigments indicate little or no bioturbation. Dates on gut contents were 11,450±70 (Pitt-0832) and 11,660±120 yr B.P. (Beta-38241/ETH-6758).

This mastodont was an almost fully grown male (molar stage ca. XIX; Laws 1966). Incremental laminae in tusk dentin (Fisher 1988) and the suite of taxa represented by seeds in the gut contents indicate an autumn death. The bones show no evidence of subaerial weathering, and viable enteric bacteria have been isolated from the gut contents (Lepper et al. in press), indicating early introduction into anaerobic conditions. Despite the relative completeness of the skeleton, apparent drag marks on the last three right ribs imply that the carcass was partly disarticulated and then transported to the lacustrine setting from another location. Lateral surfaces of these ribs show gouges oriented normal to rib axes (Figure 1). Under SEM, the gouges (accompanied by some probable cutmarks) are clearly postdated by innumerable, finer, parallel striations that cover much of the surrounding bone surface. These finer marks could have been made by abrasion against a coarse clastic substrate, but their overwhelming parallel attitude, invariant from one rib to the to the next, argues against trampling (Behrensmeyer et al. 1986), especially in the fine, lake sediments. In situ mechanisms involving moving water or ice are incompatible with the low energy depositional setting and autumn season of death, respectively. Whatever caused the gouges, the fine striations probably record dragging of an articulated unit across a coarse substrate.

We have difficulty explaining these observations entirely in terms of nonhuman agents. Hyenas sometimes cache carcass parts in water (Kruuk 1972), and some North American Pleistocene carnivore could have shown analogous behavior, but mastodont size, patterns of bone distribution, and relative skeletal completeness challenge this explanation. There are tooth impressions at the distal ends of some ribs, but these suggest nothing larger than a medium-sized canid. We also note symmetrical treatment of some bones. Metacromion

processes, though present, are broken from scapulae, and dorsal and posterior scapular epiphyses show nearly identical patterns of gouges (Figure 1), some

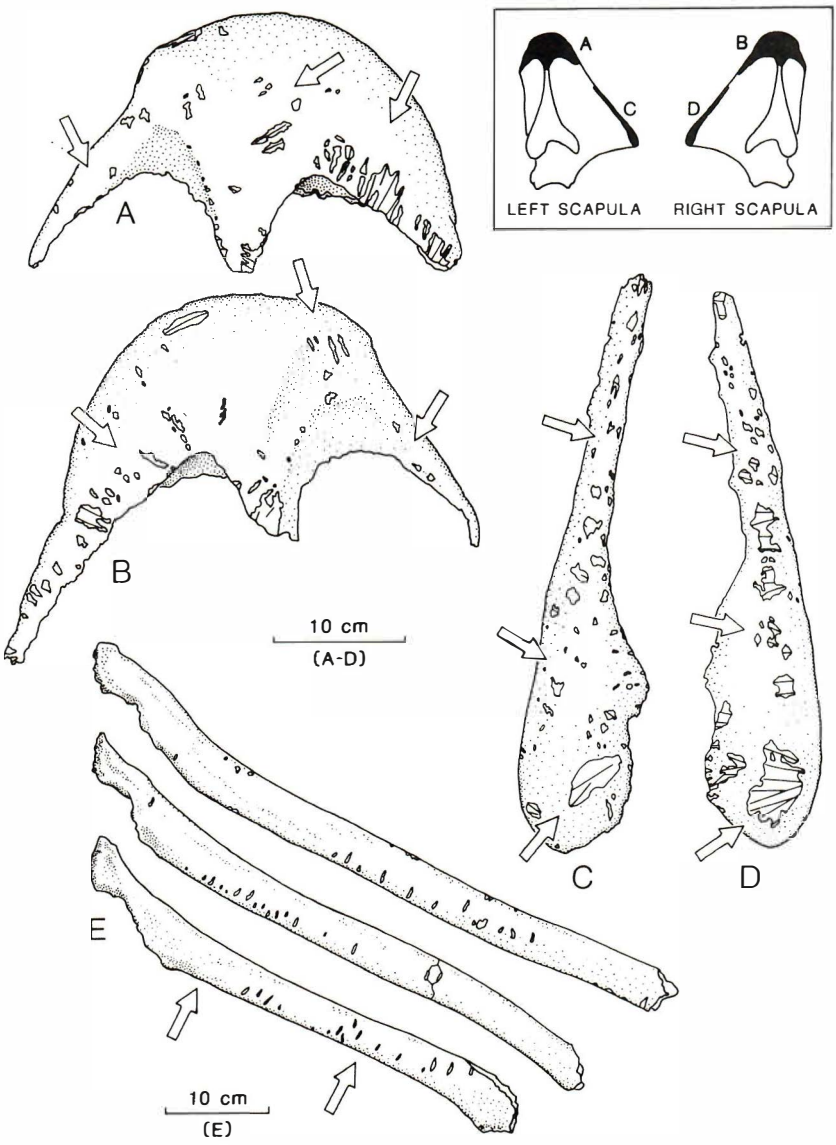

Figure 1. Distribution of gouges on several skeletal elements of the Burning Tree mastodont. Solid outlines show margins of gouges; interior lines show orientation of deep grooves within gouges; and open arrows indicate predominant, local direction of production of gouges. A, B, left and right dorsal scapular epiphyses, in lateral aspect; C, D, left and right posterior scapular epiphyses, in posteromedial aspect (asymmetry of gouge direction may relate to death orientation of carcass) ; E, right ribs 17-19, in dorsal aspect.

with internal striae. Such gouges were probably made during muscle detachment (nearby cavities in the bone retain sediment exotic to the lacustrine setting). The dorsal iliac border is modified similarly, and symmetrically. This symmetry has an anatomical component, but it also reflects highly structured behavior. Representation of hindlimb elements proximal to the tarsus (left longbones without patella; right patella without longbones) also suggests symmetry in dissociation of patellae from longbones, as may have occurred during removal of knee extensors. Many aspects of the condition and distribution of individual bones and the overall structure and context of the site replicate patterns at other mastodont sites such as Pleasant Lake and Heisler (Fisher 1984, 1987). Fisher (1989) has suggested that these occurrences represent butchery of mastodonts by Paleoindians and caching of carcass parts in ponds for later recovery and processing. We recognize the complexity of taphonomic inference with limited benefit of Recent analogues, and are committed to continued investigation of alternative explanations for the Burning Tree and other sites, but at present, the hypothesis of meat-caching by Paleoindians appears to be the simplest interpretation of our observations.

References Cited

Behrensmeyer, A.K., K.D. Gordon, and G.T. Yanagi 1986. Trampling as a Cause of Bone Surface Damage and Pseudo-cutmarks. *Nature* 319:768-771.

Graham, R.W., and M. Kay 1988. Taphonomic Comparisons of Cultural and Noncultural Faunal Deposits at the Kimmswick and Barnhart Sites, Jefferson County, Missouri. In *Late Pleistocene and Early Holocene Paleoecology and Archeology of the Eastern Great Lakes Region*, edited by R.S. Laub, N.G. Miller, and D.W. Steadman, pp. 227-240. Bulletin of the Buffalo Society of Natural Sciences 33.

Fisher, D.C. 1984. Taphonomic Analysis of Late Pleistocene Mastodon Occurrences: Evidence of Butchery by North American Paleo-Indians. *Paleobiology* 10:338-357.

Fisher, D.C. 1987. Mastodont Procurement by Paleoindians of the Great Lakes Region: Hunting or Scavenging? In *The Evolution of Human Hunting*, edited by M.H. Nitecke and D.V. Nitecki, pp. 309-421. Plenum Press, New York.

Fisher, D.C. 1988. Season of Death of the Hiscock Mastodonts. In *Late Pleistocene and Early Holocene Paleoecology and Archeology of the Eastern Great Lakes Region*, edited by R.S. Laub, N.G. Miller, and D.W. Steadman, pp. 115-125. Bulletin of the Buffalo Society of Natural Sciences 33.

Fisher, D.C. 1989. Meat Caches and Clastic Anchors: the Cryptic Record of Paleoindian Subsistence in the Great Lakes Region. *Geological Society of America, Abstracts with Program* 21:A234.

Kruuk, H. 1972. *The Spotted Hyena*. University of Chicago Press, Chicago.

Laws, R.M. 1966. Age Criteria for the African Elephant, *Loxodonta africana*. *East African Wildlife Journal* 4:1-37.

Lepper, B.T. 1990. The Burning Tree Mastodon: a Nearly Complete Skeleton from Licking County, Ohio. *Mammoth Trumpet* 6(1):7.

Lepper, B.T., T.A. Frolking, D.,C. Fisher, G. Goldstein, D.A. Wymer, J.E. Sanger, J.G. Ogden, III, and P.E. Hooge In press. Intestinal Contents of a Late Pleistocene Mastodont from Midcontinental North America. *Quaternary Research*.

Preliminary Report on the Fauna of Pendejo Cave, Otero County, New Mexico

Arthur H. Harris

Pendejo Cave, located in south-central New Mexico about 21 km east of Orogrande, contains both faunal and archaeological material. The material reported here was excavated during 1990. The upper stratigraphic levels contain Archaic archaeological material that continues downward to as deep as Zone F (MacNeish 1990; Turnbull 1990). Below the Archaic levels, extending down into Zone O, are plant and faunal remains associated with stone and bone items interpreted by the excavator, Richard S. MacNeish, as human artifacts; included here is material from layers ^{14}C dating from 25,420±560 yr B.P. to >34,000 yr B.P. (UCR-2495) (MacNeish 1990, per. comm. 1991; Turnbull 1990). Faunal remains under these circumstances are of obvious interest.

At this time, only coarse-screened material has been seen, preparation of specimens has been minimal, and the total number of elements somewhat scanty; thus identifications should be considered somewhat more tentative than average. Many of the bones of extinct mammals appear to be heavily burned, and ash layers occur to the bottom of the section in Zone O (MacNeish 1990).

Extralimital and extinct taxa identified are desert tortoise (*Gopherus* cf. *agassizi*), western vulture (*Coragyps occidentalis*) prairie chicken (*Tympanuchus pallidicinctus*), Conkling's roadrunner (*Geococcyx californianus* cf. *conklingi*), magpie (*Pica pica*), Aztlán rabbit (*Aztlanolagus agilis*), Nuttall's cottontail (*Sylvilagus nuttalli*), Gunnison's prairie dog (*Cynomys* cf. *gunnisoni*), northern pocket gopher (*Thomomys talpoides*), bushytailed woodrat (*Neotoma cinerea*), vole (*Microtus* sp,), lion or, possibly, short-faced bear (? *Panthera leo atrox* or, possibly, *Arctodus simus*), Mexican horse (*Equus conversidens*), larger horse (*Equus* sp., possibly *E. niobrarensis*), large-headed llama (*Hemiauchenia* cf. *macrocephala*), large camel (*Camelops* sp.), and small pronghorn (cf. *Capromeryx*). The remaining faunal members, consisting of some 32 taxa of amphibians, reptiles, birds, and mammals, either occur in the area today or likely did so historically.

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The occurrence of probable Archaic artifacts as low as Zone F suggests an age between 6,300 and 8,000 yr B.P. (Turnbull 1990). Presence of the small, western horse in Zone E and of moderate-sized horse and extinct llama in Zone F probably indicate some mixing of levels, as does presence of the northern pocket gopher in Zone D.

Two species of horse have been identified from Zone G, but no other extinct or extralimital taxa. A date of 16,440±650 yr B.P. (UCR-2504) may apply to Zone H or I (MacNeish 1990). Starting with Zone H, both extinct and extralimital taxa are moderately common, suggesting that Zones H through O are fairly certainly Pleistocene, agreeing with ^{14}C dates.

Remains of the Aztlán rabbit are rare in Zone M, but moderately common in the lowermost deposits, Zone O. This extinct rabbit probably is a marker for mid-Wisconsinan time in this part of New Mexico (Russell and Harris 1986). Desert tortoise in this region appears to have occurred in mid-Wisconsinan and again in post full-glacial times (Van Devender et al. 1976); its presence in Zone M, well below the uppermost Pleistocene material, indicates mid-Wisconsinan conditions.

The identified extralimital taxa occur elsewhere in the mid and late Wisconsinan of southern New Mexico and indicate cool summers and more effective moisture (Harris 1987, 1989). The desert tortoise probably requires relatively mild winter temperatures (Van Devender et al. 1976).

The relatively small number of recovered elements thus far examined is insufficient for detailed analysis of faunal changes within the Pleistocene segment. What is clear at this point in the investigations, however, is that bone and stone items believed by MacNeish to be tools are associated with a typical Pleistocene fauna and that some go back into the mid-Wisconsinan in conformity with the radiocarbon dates.

I thank Dr. Richard S. MacNeish for the opportunity to examine this material and for information concerning the site.

References Cited

Harris, A.H. 1987. Reconstruction of Mid-Wisconsin Environments in Southern New Mexico. *National Geographic Research* 3:142-151.

Harris, A.H. 1989. The New Mexican Late Wisconsin—East Versus West. *National Geographic Research* 5:205-217.

MacNeish, R.S. 1990. Excavations of Pintada and Pendejo Caves near Orogrande New Mexico. Annual Report and Briefing Booklet, Andover Foundation for Archaeological Research, Andover.

Russell, B.D., and A.H. Harris 1986. A New Leporine (Lagomorpha: Leporidae) from Wisconsinan Deposits of the Chihuahuan Desert. *Journal of Mammalogy* 67:632-639.

Turnbull, K. 1990. Pre-Clovis Barrier Broken in New Mexico? *Mammoth Trumpet* 6(2):1, 6, 8.

Van Devender, T.R., K.B. Moodie, and A.H. Harris 1976. The Desert Tortoise (*Gopherus agassizi*) in the Pleistocene of the Northern Chihuahuan Desert. *Herpetologica* 32:298-304.

The DeLong Mammoth Locality, Black Rock Desert, Nevada

Stephanie D. Livingston

At least a dozen concentration of fossil bones and lithic artifacts occur within a diffuse lithic scatter that covers extensive areas along the eastern edge of the Black Rock Desert (BRD) playa in northern Nevada (Clewlow 1968, 1983; Pedrick 1983; Dansie et al. 1988). Artifact styles identified in the lithic scatter include fluted points similar to the Clovis type dated elsewhere between 11,000 and 11,500 yr B.P. ; Great Basin Concave and Stemmed projectile point types and crescents, estimated to be at least 8-9,000 years old; and square-based projectile point types referable to the Cody Complex (Wallmann and Amick 1991), which is dated from 8,500-10,000 yr B.P. in the southern Plains (Thurmond 1990); as well as the more common post-Mazama great Basin types (Clewlow 1968; Gruhn and Bryan 1988; Roney 1979). Taxa represented in the various bone concentrations include mammoth (*Mammuthus*), bison (*Bison antiquus* and *B. bison*), camelids (*Camelops* cf. *hesternus*), carnivores (*Smilodon* and *Canis lupus*) and possibly ground sloth (*Glossotherium harlani*) (Clewlow 1983), as well as numerous extant species.

The occurrence of bones of extinct mammals with lithic artifacts referable to pre-Mazama complexes leads to speculation regarding the relationship between people and the extinct mammals. The chronology of artifact types and estimated time of extinction of the large mammals, both determined from other areas, indicate that people and extinct mammals coexisted on the BRD. Most observed BRD assemblages, however, could be the result of lithic concentrations deflating onto older deposits containing vertebrate remains. Attempts to obtain absolute dates for BRD bones have not been satisfactory and geomorphological evidence of contemporaneity is unclear at many localities. No local association of artifacts and vertebrate remains exposed on the surface of the BRD has been demonstrated to be other than fortuitous.

The DeLong Mammoth Locality (DML) on the east edge of the BRD provides an opportunity to examine site-formation processes responsible for the co-occurrence of artifacts and vertebrate remains along the edge of the BRD playa. The DML consists of an extensive (1,000 by 600 m) surface bone scatter bounded by dunes on the north and south, and a small, north-south-trending channel and

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more dunes on the west. Seven, and possibly eight, vertebrate families are represented in the surface bone: Anatidae, Leporidae, Cricetidae, Equidae, Cervidae, Antilocapridae, Elephantidae, and possibly Camelidae. The core bone concentration is approximately 75 by 50 m and consists of primarily mammoth bone. An additional taxon, a large carnivore, was recognized in the faunal material from one of two test units excavated in the main bone concentration. There are at least three mammoth in the main concentration, as determined from size and maturity estimates for exposed specimens. All three apparently died young.

East of the channel demarcating the eastern extent of the DML bone concentration is a large dune that is the nucleus of an extensive lithic artifact concentration. The numerous lithic flakes and biface fragments found among the surface bone of the DML are most likely related to human activities associated with the dune, events which probably post-date deposition of the DML bone. No lithic artifacts were found below the surface in the excavation units.

Paleotopography of the DML is being reconstructed using satellite imagery and aerial photography, soil conductivity measured with a non-contacting terrain conductivity meter and a bore-hole conductivity meter, sediment augering, and profiles of the two test excavation units. Data obtained from these sources indicate that the current, extremely flat playa edge, cut by occasional small channels and flanked by dunes, is similar to past conditions, but the locations of channels have varied through time. The mammoth bone is lying on a shallowly buried surface and in a buried channel.

Agenbroad (1984) observed that in a sample of 856 North American mammoth localities for which geologic environment is reported, 73 % are in environments associated with water, such as stream channels, flood plains, marsh or bog environments, springs, and lacustrine deposits. Two or more individuals have been found in at least 21 of those localities. He argued that multiple-mammoth localities probably represent environments of post-mortem events more closely than the habitat of the living animals, with the exception of the Hot Springs Site in South Dakota where more than 30 adult mammoth were apparently trapped alive. Current interpretation of known assemblages is that most multiple-mammoth localities represent post-mortem bone accumulation by carnivores or geological processes, or human predation events.

Human involvement in the deposition of extinct animals in localities similar to the DML on the BRD has been suggested based on degree of disarticulation and dispersion of skeletons and orientation of elements (e.g., Dansie et al. 1988). The effects of animal behavior and ecology, and fluvial processes, have not yet been assessed in the BRD playa sites because the behavior and ecology of Pleistocene animals is unknown, as is the prehistoric fluvial regime of the BRD.

Comparisons of paleofaunas containing extinct taxa with modern bone assemblages of similar and related taxa deposited in similar environments provide a basis for approximating the conditions under which assemblages exhibiting particular characteristics were accumulated. Conybeare and Haynes (1984; see also Haynes 1985,1988), suggested that elephant die-off at a natural water source in Zimbabwe following an unusually severe drought might provide

an analog for fossil proboscidian assemblages. The DML bone distribution is reminiscent of the bone scatters described by Conybeare and Haynes. Concentration of partially articulated and disarticulated mammoth bone in and adjacent to a small channel, the apparent youth of the mammoth, and the diversity of the rest of the faunal assemblage supports the possibility that the DML animals represent late Pleistocene faunal die-off along the receding edge of a pluvial lake.

Demonstration that fossil bone localities on the BRD, in areas that were inundated during pluvial maxima, represent drought-induced die-off similar to observed modern drought-induced die-off, could provide information important to understanding the extinction of Pleistocene animals. At a minimum, comparison of the DML with modern catastrophic death assemblages indicates the need for caution in interpreting terminal- or post-pluvial fossil animal localities in erosional environments that have witnessed extensive human use through time. Co-occurrence of artifacts with disarticulated bone in localities such as the DML is not necessarily indicative of human involvement in the death and deposition of the animals.

The investigations described here were conducted by the DRI-QSC, the BLM, and dedicated amateurs funded by Mrs. Betty Stout, EPSCoR, and the Lander Foundation. These studies were guided by the late Dr. J.O. Davis, whose vision will be sorely missed.

References Cited

Agenbroad, L.D. 1984. New World Mammoth Distribution. In *Quaternary Extinctions: A Prehistoric Revolution*, edited by P.S. Martin, and R.G. Klein, pp. 90-108. University of Arizona Press, Tucson.

Clewlow, C.W. Jr. 1968. Surface Archaeology of the Black Rock Desert, Nevada. *Reports of the University of California Archaeological Survey* 73:1-93.

Clewlow, C.W. Jr. 1983. Report on 1981 and 1982 Archaeological Investigations at Phu8 and 26Hu55, Black Rock Desert, Nevada. Report to the Bureau of Land Management, Winnemucca district.

Conybeare, A., and G. Haynes 1984. Observations on Elephant Mortality and Bones in Water Holes. *Quaternary Research* 22:189-200.

Dansie, A.J., J.O. Davis, and T.S. Stafford, Jr. 1988. The Wizards Beach Recession: Farmdalian (25,500 yr B.P.) Vertebrate Fossils Co-occur with Early Holocene Artifacts. In *Early Human Occupation in Far Western North America: The Clovis-Archaic interface*, edited by J.A. Willig, C.M. Aikens, and J.L. Fagan, pp. 153-200. *Nevada State Museum Anthropological Papers* 21.

Gruhn, R., and A. Bryan 1988. The 1987 Archaeological Fieldwork at Handprint Cave, Nevada. *Nevada Archaeologist* 6(2):1-13.

Haynes, G. 1985. On Watering Holes, Mineral Licks, Death, and Predation. In *Environments and Extinctions: Man in Late Glacial North America*, edited by J. Mead, and D. Meltzer, pp. 53-71. Center for the Study of Early Man, Orono, ME.

Haynes, G. 1988. Studies of Elephant Deaths and Die-offs: Potential Applications in Understanding Mammoth Bone Assemblages. In *Recent Developments in Environmental Analysis in Old and New World Archaeology*, edited by R.E. Webb, pp. 151-169. *BAR International Series* 416.

Pedrick, K.E. 1984. Black Rock Desert Cultural Resources Management Plan. Unpublished manuscript, Bureau of Land Management, Winnemucca District.

Roney, J. 1979. Cultural Resources Report for Geothermal leasing near McFarlan's Bath House. Report to the Bureau of Land Management, Winnemucca District.

Thurmond, J.P. 1990. late Paleoindian Utilization of the Dempsey Divide on the Southern Plains. *Plains Anthropologist, Memoir* 25.

Wallmann, S., and D. Amick 1991. Cody Complex Occupations in the Black Rock Desert, Nevada. Manuscript in Review.

Late Pleistocene *Hemiauchenia* from North Central Kansas

Brad Logan, Larry D. Martin and John F. Neas

Skeletal remains of a lamine camelid identified as *Hemiauchenia* sp. (KUVP-103561) were recovered form a late Pleistocene deposit on the northern shore of Lovewell Reservoir, Jewell County, Kansas. The reservoir is on White Creek, a tributary of the Republican River. Discovery of the remains occurred in October 1989 during an archaeological survey of the reservoir. Recovery of exposed and erosion-threatened bones at that time was followed in May 1990 by complete excavation of the specimen (Logan 1990).

The remains were found within a silt deposit at a depth of 1.2 m in a 2.5 m high wave-cut exposure. The stratigraphic unit containing the llama remains has been radiocarbon dated to 13,410±300 yr B.P. (Tx-3666). The dated material was a bulk sample of organic-rich sediment, with wood fragments, extracted with a truck-mounted coring device from an area on the adjacent beach less than 100 m from the find (Rolfe Mandel, University of Nebraska, Omaha, personal communication).

Elements recovered and their position are: 1) Left Forelimb: humerus (fragment of head to distal trochlea), ulna (proximal-olecranon and trochlear notch), radius, magnum, trapezoid, unciform and scaphoid, cuneiform, lunar (anterior fragment), metacarpus (proximal); 2) Right Forelimb: humerus

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(diaphysial fragment, deltoid tuberosity and spiral groove), radius (distal), scaphoid (anterior half), cuneiform, unciform metacarpus (proximal- 2 pieces); 3) Left Hindlimb: femur (complete), tibia (tuberosity only); 4) Hindlimb (position unknown): metatarsal (distal), proximal phalanx of pes, proximal phalange, metapodial; 5) Unknown limb: 2 fragments; 6) Axial Skeleton: 8 thoracic vertebrae, 3 lumbar vertebrae, ribs (numerous shaft fragments).

The remains include only postcranial elements from what appears to be one individual. conspicuously absent are the skull and axial parts such as scapulae, cervical vertebrae, sacrum and pelvis. Neither are there any articular ends of ribs in the assemblage, despite the presence of most of the thoracic vertebrae. Of elements represented, only the femur was found unbroken. Articular ends were intact but diaphyses were fragmented. Some elements of the specimen probably have been lost to wave action since inundation of the lake in the 1960s.

What force accounts for the breakage and positioning of the bones cannot be identified readily. The late Pleistocene date of the specimen and the presence of Clovis hunters in the area (e.g., at 14JW310 ca. one km east of the site), raised the possibility that Paleoindians might have dispatched and butchered the animal. No cultural material was found with the remains, nor are any cut-marks visible on the bones. It is unlikely that hunters broke the long bones for marrow since several articular ends retain more diaphsial bone than is typical of marrow-processed elements. Though broken and moved about, the bones remained within an area of 1.56 by 0.63 m. We can be reasonably certain that they have not been transported any great distance from the site of the animal's death. Some pieces were articulated (i.e., the distal metatarsal and proximal phalanx) or nearly so (i.e., the lumbar vertebrae). No clear evidence of carnivore gnawing or breakage is discernible so predatory behavior is not indicated.

That the bones were broken while in the green state is shown by the spiral fractures of several long bone fragments. This may indicate trampling by other animals. The presence of weathering cracks and weathered surfaces of the bones suggest that they remained on the surface for at least a year before burial. In at least one instance (the distal left metatarsal with articulated phalanges and sesimoids) the bones must have been held in place by ligaments and skin until burial. Strangely, the distal phalanges were missing from this specimen. Severe root damage to the bones suggests a relatively slow burial process. Natural death followed by trampling, a short period of exposure, and subsequent burial appears to be the only sequence of events that accounts for all observations, including lack of predation-related signatures, fragmentation of fresh bone, presence of weathering cracks, slight dispersal and unit articulation, good preservation, and lack of size-grading or sorting by water action.

Although most of the bones have sustained major damage, the characteristic shape of the proximal ligamental scar on the phalanges and its small size identify it as a member of the camel tribe Lamini (Breyer 1974). On biogeographic grounds, it is likely that the remains are those of *Hemiauchenia* as are probably those of the only other late Pleistocene lamine occurrences in

Kansas. The latter are two unpublished finds, both isolated proximal ends of first phalanges. The most diagnostic criteria are to be found in the proportions of the metapodials (Webb 1974). Unfortunately, the two metapodials from Lovewell are not complete. One reconstructed ulna gives a length of over 550 mm. It is within the range for *Hemiauchenia macrocephala* but would appear to be too long for *Paleolama mirifica*, the other possible lamine. *Hemiauchenia macrocephala*, the large-headed llama, was a relatively long-legged, highly cursorial plains-dweller that probably fed on grass (Kurten and Anderson 1980). The Lovewell specimen, the most complete late Pleistocene Lamine camel yet collected in the Central Plains, provides insight into the environment and faunal biogeography of that region.

We thank Steve Holen and Bob Blasing for their role in the discovery and recovery of the specimen and the Bureau of Reclamation, Grand Island, Nebraska for its support of our salvage of the Lovewell llama.

References Cited

Breyer, J. 1974. Examination of Selected Postcranial Elements in Pleistocene Camelids. *University of Wyoming Contributions to Geology* 13:25-85.

Kurten, B., and E. Anderson 1980. *Pleistocene Mammals of North America*. Columbia University Press, New York.

Logan, B. 1990. The Llama of Lovewell Lake: Recovery and Identification of Skeletal Remains of *Hemiauchenia*, Late Pleistocene, Jewell County, Kansas. Report submitted to Bureau of Reclamation, Grand Island, Nebraska. *University of Kansas, Museum of Anthropology, Project Report Series* No. 69.

Webb, S.D. 1974. Pleistocene Llamas of Florida, with a Brief Review of the Lamini. In *Pleistocene Mammals of Florida*, edited by S.D. Webb, pp. 170-213. University Press of Florida.

Preliminary Report of the Pleistocene Mammals of the Valley of the Axamilpa River, near Tepeji de Rodriguez, Puebla, Mexico

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The valley of the Axamilpa River, near Tepeji de Rodriguez, in the state of Puebla, is a newly discovered Quaternary fossil locality (Figure 1). Alluvial

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and lacustrine units have been dissected by the river, providing numerous exposures containing remains of Pleistocene flora and fauna.

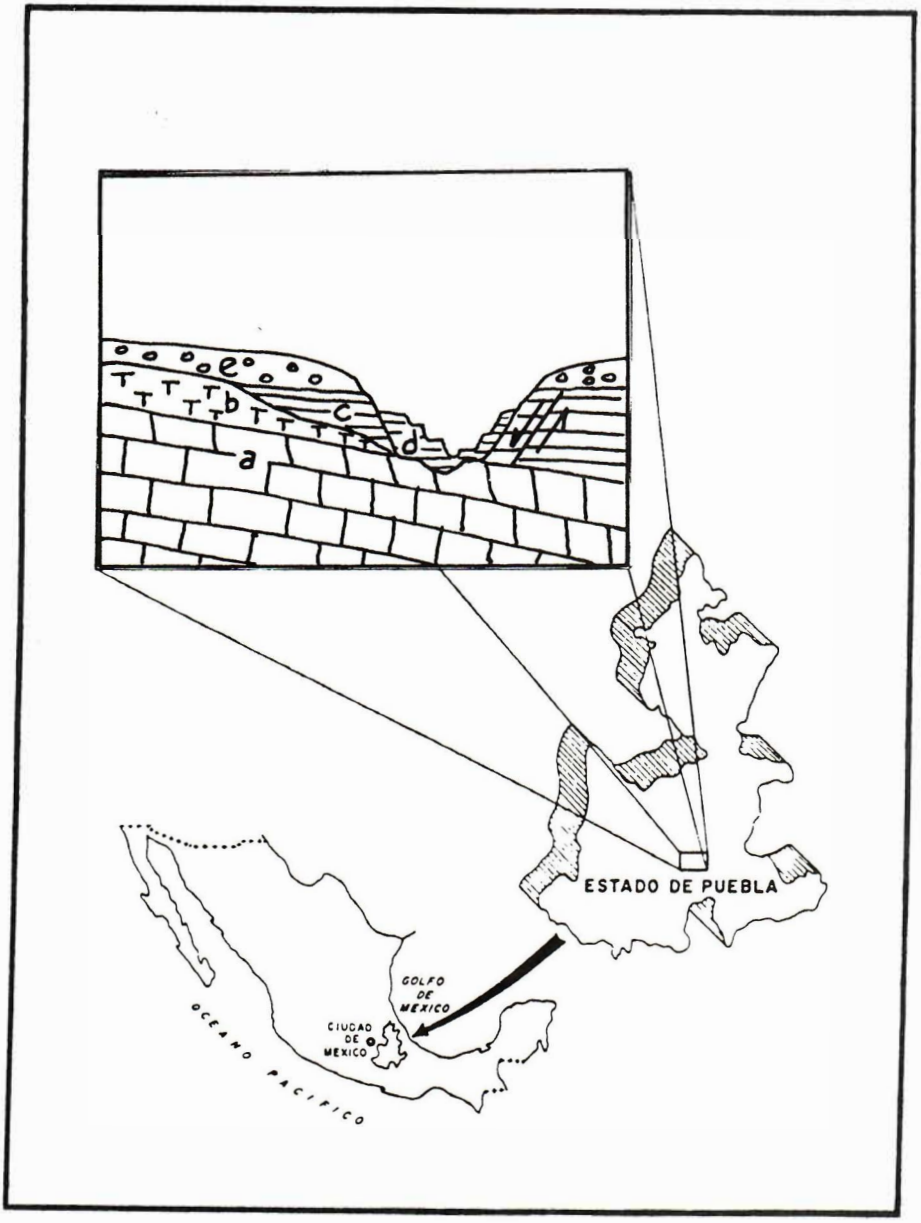

Figure 1. A location map of the Axamilpa River deposits, with a schematic cross-section, showing the relationship of the Quaternary deposits with older, Tertiary limestones (a) containing fossil fish, birds, reptiles, and mammal tracks; Tertiary/Quaternary travertines (b) with gastropods; and Quaternary lacustrine deposits (c, d) and alluvium (e) containing Pleistocene mammals.

At least five genera of large, extinct, Pleistocene mammals exist in these deposits, including the first occurrence of *Mammuthus columbi* (mammoth) reported for the state of Puebla along with a specimen of *Cuvieronius* (mastodon) discovered during the 1990-1991 field season. Faunal elements represent remains of reptiles, Testudinidae (turtle), and mammals: *Mammuthus columbi, Cuvieronius, Equus* (horse; possibly including: *E. caballus, Equus tau,* and *Equus asinus*), *Bison* sp. (bison), *Paleolama* (llama), and *Glyptodon* sp. (glyptodon) (Torres-Martinez 1986, 1988).

The region of investigation comprises an area of at least 6 km^2, located approximately 4 km northwest of the village of Tepeji de Rodriguez, near the geographic coordinates 18°30'N and 98°7'E. The deposits are at an altitude of 1750 m above sea level. The modern climate is semi-arid, with some semitropical variants. The deposits are contained in a topographic depression containing the Axamilpa River, which is tributary to the Atoyac River, draining a portion of the eastern Sierra Madre Mountains. The Quaternary deposits are superimposed on Cretaceous marine and Tertiary lacustrine sedimentary sequences (Padilla y Sanchez 1973).

The Quaternary deposits of the Axamilpa represent at least two, and possibly three, periods of deposition. Approximately 16 m of older Quaternary sediments (siltstone and marl) unconformably overly the older deposits, and contain plant impressions. These deposits have been tilted, and are overlain by up to ca. 30 m of alluvial sands, silt and gravels, tufa, lacustrine deposits composed of marls, siltstone, and carbonaceous evaporites including caliche and travertine.

The deposits containing the majority of the megafaunal remains are alluvial and lacustrine terraces formed, and abandoned by dissection of these deposits due to the river downcutting to its present level. Initially, five localities containing Pleistocene mammals were discovered. An additional six localities were investigated during the interval December 1990 - January 1991.

Preliminary pollen studies from locality 4 report the presence of *Pinus,* Graminea, and *Alnus,* interpreted to represent an open woodland that is currently more northerly or at higher elevations in Mexico (Rzedowski 1978). A bulk soil sample collected from below the *Cuvieronius* bone radiocarbon dated to 13,710±430 yr B.P. (Beta-45825).

References Cited

Padilla y Sanchez, R.J. 1973. Estudio Geologico de la Sierra del Tenzo, Estado de Puebla. Tesis, Facultad de Ingenieria, Universidad Nacional Autonoma de Mexico.

Rzedowski, J. 1978. Vegetacion de Mexico. *Ed. Limusa, S.A.* 1st Ed.

Torres-Martinez A. 1986. Reporte Preliminar de los Depositos Cuaternarios cerca de Rio Axamilpa al N.E. de la Localidad de Pie de Vaca, Tepeji de Rodriguez, Estado de Puebla, Mexico, Unpublished manuscript. Para el Simposio de Geologica y Paleontologia de la Cantera Tlayua, Tepeji de

Rodriguez, Puebla. Instituto de Geologica, Universidad Nacional Autonoma de Mexico.

Torres-Martinez, A. 1988. Mamiferos Pleistocenicos del Valle del Rio Axamilpa, Tepeji de Rodriguez, Puebla, Mexico. Unpublished manuscript. Laboratorio de Paleontologia Universidad Autonoma del Estado de Morelos. Cuernavaca, Mexico.

Paleoenvironments: Geosciences

Geomorphic Processes and the Archaeological Record in Small Basins of the Kansas River System

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A geoarchaeological model for the Kansas River basin has been proposed by Johnson and Logan (1990) which synthesizes the archaeological record and relates it to ongoing geomorphic processes in the basin. Results of the study indicate the cultural record ranges from Paleoindian through Historic and there is a high probability of locating these cultural components buried in situ beneath certain alluvial surfaces. Evidence suggests that erosion has removed much of the record, and that valley fills appear to decrease in age westward across the basin. According to Johnson and Logan (1990), however, spatial and temporal distributions are probably biased since much more is known stratigraphically about the Kansas River basin proper than smaller basins within the system.

Because of the present bias toward the trunk stream, recent research has focused on Wolf Creek, a small (163 km^2) basin located in the center of the Kansas River system (Figure 1). Detailed study of alluvial stratigraphy and terraces has revealed the relative an absolute ages, as well as the textural composition of these features in the basin. Stratigraphic evidence suggests that the entire cultural record may be preserved within alluvial deposits of this small watershed.

Results of the study indicate that a single terrace (T1) dominates the basin and is underlain by silt and silt loam alluvium, ranging in age from early through late Holocene. Early to mid-Holocene fill has been recognized only in the upper reaches of the basin's small tributaries, where it is buried by nearly three meters of late Holocene alluvium. Conversely, late Holocene fill is found throughout the basin, e.g., humates from an organic-rich deposit at the base of late Holocene alluvium yielded a radiocarbon age of 2,970±80 yr B.P. (Tx-6795).

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Stream entrenchment (up to 4 m) and lateral cutting has created up to four ill-defined terraces beneath T1 surface. In some portions of the basin, lateral cutting has been very active, removing up to 40 % of late Holocene fill, whereas in other areas the effects of this process have been minimal.

Three distinct episodes of soil formation, reflecting episodes of relative floodplain stability, have been recognized thus far. Radiocarbon age determinations from the upper 5 cm of buried A horizons in these paleosols reveals that soil formation terminated shortly after about 6,770±110 yr B.P. (Tx-6914) in early to mid-Holocene fill and about 1,750±70 yr B.P, (Tx-6959) and 1,250±60 yr B.P. (Tx-6960) in late Holocene alluvium. Each of the paleosols exhibit simple A/C profiles, indicating that pedogenic process were of short duration, i.e., less than 1,000 years.

The results obtained from the Wolf Creek basin have significant implications regarding preservation of the archaeological record in similar sized basins in the Kansas River system. Certainly, the focus of any survey should be paleosols, which represent the best potential for cultural artifact concentrations in these basins (Ferring 1986). While Paleoindian and early to mid-Holocene Archaic sites were likely eroded sometime between ca. 6,500 and 3,000 yr B.P., they may exist, deeply buried in upper reaches of small tributaries. The likelihood of preservation of late Archaic and other late Holocene Plains Woodland and Plains Village sites is much greater, as most valley fill is late Holocene in age. Subsequent removal of late Holocene sites, and further erosion of older cultural components, has most certainly occurred in portions of these small basins due to dramatic lateral migration and channel entrenchment in the last 1,000 years.

A research grant from the Sigma Xi Foundation was provided for this study and is gratefully acknowledged.

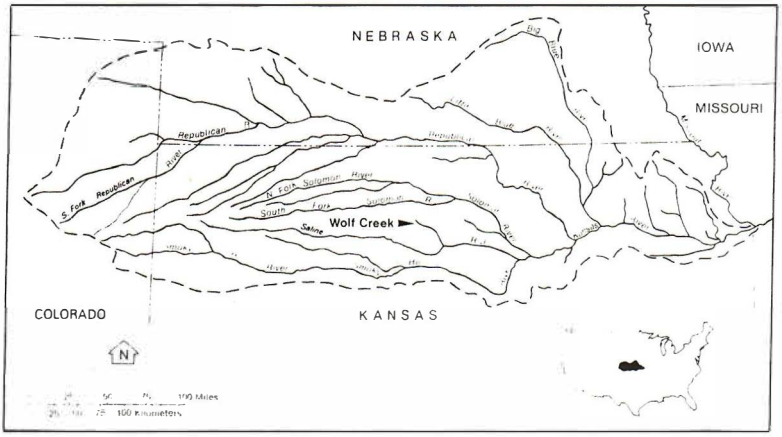

Figure 1. Location of Wolf Creek in the Kansas River basin (modified from Johnson and Logan 1990).

References Cited

Ferring, C.R. 1986. Rates of Fluvial Sedimentation; Implications for Archaeological Variability. *Geoarchaeology* 1:259-274.

Johnson, W.C., and B. Logan 1990. Geoarchaeology of the Kansas River Basin in the Central Great Plains. In *Archaeological Geology of North America*, Geological Society of America Centennial Special Volume 4, edited by N.P. Lasca, and J. Donahue, pp.267-299. Geological Society of America Boulder.

Geoarchaeological Reconnaissance for Late Glacial Sites in the Upper Kuskokwim and Holitna Lowlands, Alaska

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During August 1990, we undertook a "geoarchaeological reconnaissance" for late glacial sites in the Upper Kuskokwim and Holitna lowlands of southwest-central Alaska. This type of reconnaissance represents part of a general research strategy based on the systematic application of historical geomorphology to archaeological survey (e.g., Butzer 1960; Hoffecker 1988). The principal objective of the study was to assess the potential of the region for archaeological remains of the late glacial (14,000-10,000 yr B.P.). Preliminary results suggest that some highly promising sedimentary contexts for sites in this time range are present.

Our reconnaissance was focused on two intermontane lowlands in the drainage basin of the upper Kuskokwim River (Figure 1). These lowland basins adjoin the Alaska Range on the south/southeast, and are rimmed by low mountains and rolling hills to the north, west, and east. Today the lowlands are characterized by meandering river channels and extensive tracts of muskeg and bog with localized stands of cottonwood and spruce. Quaternary geologic studies were conducted in these areas by Fernald (1960), Lea (1990), and Waythomas (1990; Lea and Waythomas 1990). These studies indicated that eolian deposits of late Pleistocene age are widespread and well exposed along the many drainages in the region, thus providing a potentially suitable sedimentary context for archaeological remains in this time range. However, the geologic investigations were not undertaken with the needs of an archaeological survey in mind, and it was necessary to assess the archaeological potential of these

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deposits. It was also necessary to acquire more detailed knowledge of the late Quaternary stratigraphy and environments of the region.

During the field reconnaissance (August 1-27, 1990), selected localities along the Kuskokwim and Holitna rivers were described and sampled; access to localities was achieved by boat and foot. Two types of localities were examined: (a) those likely to yield useful information on regional stratigraphy and environments, and (b) those likely to represent geomorphic settings with high potential for archaeological remains. At each locality, sediment samples were collected for analysis of granulometry, mineralogy, and fossil biotic contents (pollen/spores, insect remains). All buried organic horizons and tephras were sampled. Samples of aeolian sand, loess, and tephra also were collected for TL dating, while organic horizons were sampled for radiocarbon dating.

The preliminary results of our study indicate that both lowland areas probably possess high potential for late glacial archaeological remains. The most promising geomorphic setting is represented by deep loess deposits that mantle bedrock hills located primarily, but not exclusively, on the north side of the Kuskokwim River. In some places, these deposits occur on south-facing promontories adjacent to tributary streams representing attractive site locations. The massive unbedded appearance, almost complete absence of buried soils, and evidence of thaw-induced reworking and extensive colluviation on lower slopes suggests that the loess accumulated under periglacial conditions, which have not existed in the lowlands since the end of the Pleistocene. It is difficult to account for the thickness of this loess (typically > 2 m) if it is assumed to be primarily of post-glacial age, because local Holocene conditions have not been favorable to loess deposition (i.e., anastamosing suspended-load river, well vegetated surfaces, limited eolian transport). Nevertheless, the late glacial (or earlier) age of these deposits remains to be confirmed by TL dating (see Figure 1b and 1c).

Thick sequences of eolian sediment (sand and silt) lie on the south side of the Kuskokwim River, but represent a less promising geomorphic context for late glacial archaeological remains. Although these deposits, which apparently span much of the late Pleistocene, yield useful information on regional stratigraphy and paleoenvironments (see Figure 1a), they are notably deficient in adequate topographic setting for late glacial sites. The meandering river has eroded the margins of this massive eolian sequence during the Holocene, destroying the low promontories that probably overlooked the Pleistocene floodplain.

Two other geomorphic settings were examined in terms of their potential for late glacial sites. Colluvial deposits described as "creek valley fill" by Fernald (1960:218-219) are exposed at several locations on the north side of the Kuskokwim River. This sediment apparently represents loess reworked from bedrock slopes into tributary stream valleys. However, while the creek valley fill is almost certainly of late glacial (and older) age, it provides little in the way of a topographic focus for archaeological sampling. Alluvial deposits, which occur along the north side of the Kuskokwim in the form of several low

terraces, also were examined. Radiocarbon samples from buried woody peat layers in the highest terrace levels (10-15 m) yielded estimates of 6,020±70 yr B.P. (Beta-60406) and 2,990±60 yr B.P. (Beta-60405), indicating that they are too young to contain in situ late glacial remains.

Funding for this research was provided by the National Geographic Society. We also thank the Alaska Geological Survey for the loan of a sixteen-foot Zodiac, and Robert E. Ackerman (Washington State University) for information about the study area, based on his past research.

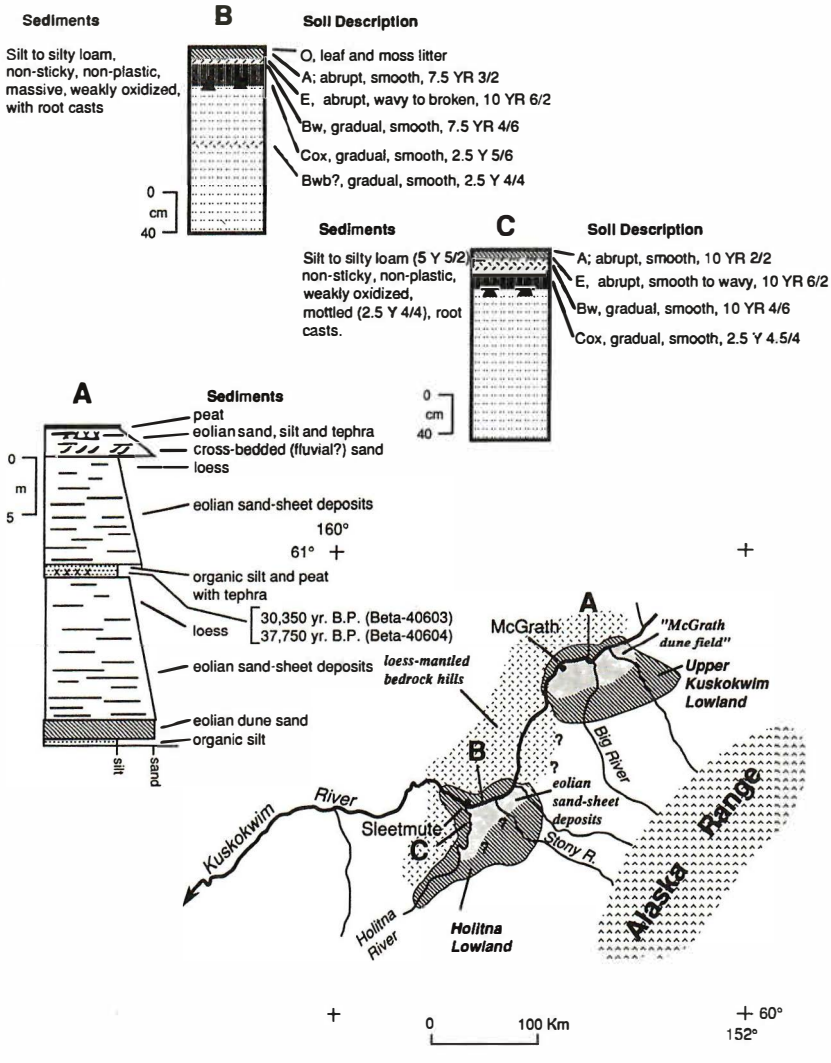

Figure 1. Map of the Upper Kuskokwim River area, showing the location of three stratigraphic profiles: A) Big River Bluff; B) Inowak Bluff Site (artifacts recovered from depth of up to 30 cm); and C) Beaver Ridge Site [discovered by Ackerman (1982), who recovered artifacts, including a side-notched point, from depth of up to 15 cm].

References Cited

Ackerman, R.E. 1982. The Archeology of the Central Kuskokwim Region. *Report to the National Geographic Society.*

Butzer, K.W. 1960. Archaeology and Geology in Ancient Egypt. *Science* 132:1617-1624.

Fernald, A.T. 1960. Geomorphology of the Upper Kuskokwim Region, Alaska. *U.S. Geological Survey* 1071-G:191-279

Hoffecker, J.F. 1988. Applied Geomorphology and Archaeological Survey Strategy for Sites of Pleistocene Age: An Example from Central Alaska. *Journal of Archaeological Science* 15:683-713.

Lea, P.D. 1990. Pleistocene Periglacial Eolian Deposits in Southwestern Alaska: Sedimentary Facies and Depositional Processes. *Journal of Sedimentary Petrology* 60:582-591.

Lea, P.D., and C.F. Waythomas 1990. Late Pleistocene Eolian Sand Sheets in Alaska. *Quaternary Research* 34:269-281.

Waythomas, C.F. 1990. *Quaternary Geology and Late-Quaternary Environments of the Holitna Lowland and Chuilnuk-Kioluk Mountains Region, Interior Southwestern Alaska.* Ph.D. dissertation, University of Colorado.

Buried Soil Surfaces Beneath the Great Bend Prairie of Central Kansas and Archaeological Implications

William C. Johnson

The Great Bend Prairie of central Kansas, bound on the north by the Arkansas River, is mantled by a sand sheet, from less than 1 to 10 m thick. The sand sheet is immediately underlain by an eolian silt layer containing one or more soils, one of which is always formed within the surface of the silt layer. Backhoe trenches were excavated and drill cores extracted from within the study area in order to describe the stratigraphy and to sample for physical and chemical analysis. At selected locations, soil A horizons were sampled for radiocarbon dating of soil humates (Figure 1). Soils developed within the surface of the silt layer were found to vary from about 13,700 to 800 yr B.P. With the exception of one sample at site 9, all humate ages were determined from the upper 5 cm of the A horizon and therefore represent a minimum age on the soil, i.e., the time

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immediately prior to burial of the soil. The silt parent material is presently believed to be of Wisconsin (Peorian) age. The ranges in ages of the soil surfaces is, however, likely attributable to prolonged exposure of the silt surface between periodic mobilizations of the sand sheet. Soils buried within the silt layer suggest the silt itself was also mobile.

Although no artifacts have yet been reported from the silt layer, archaeological implications for the Great Bend Prairie are substantial. Most of the soils developed in a well drained environment, but yet the position of carbonates and relative elevation of contemporaneous paleochannels of the Arkansas River and tributaries indicate groundwater was within 2 m of the silt surface. Consequently, water was likely available for wildlife and prehistoric peoples, resulting in a favorable cultural resource base.

The buried soils associated with the silt layer differ in age and duration of development. Based upon soil morphology and radiocarbon data, it appears soil development, and attendant surface stability, persisted from approximately 500 to over 1,000 years. Site 1 dated to 13,670±290 yr B.P. (Tx-6742), designating it a pre-Clovis surface. An age of 5,870±150 yr B.P. (Tx-6478) from the lower 5 cm of the A horizon at site 9 indicates a minimum of 1,000 years for pedogenesis,

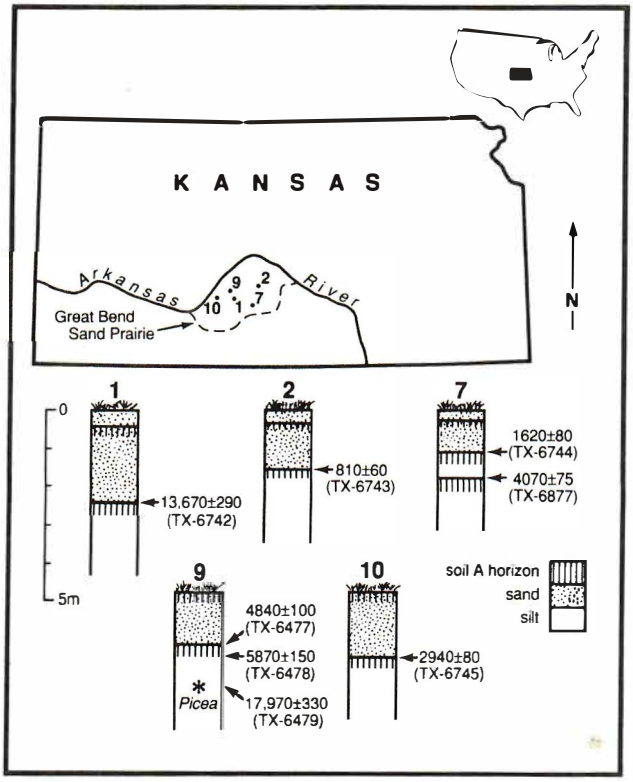

Figure 1. Locations and and ages of radiocarbon dated soils buried beneath the sand sheet of the Great Bend Prairie.

all of which falls within the middle and late Archaic period. The age of 17,970±330 yr B.P. (Tx-6479) from spruce (*Picea* cf. *glauca*) charcoal below the solum dates the silt parent material. An age of 2,940±80 yr B.P. (Tx-6745) from the soil at site 10 indicates its development took place during the late Archaic period. Trenching at site 7 exposed two well developed soils within the silt. The surface of the silt was last exposed approximately 1,700 years ago, during the Plains Woodland, or early Ceramic period. An underlying soil dated to late Archaic time. A moderately developed soil at site 2 dated to 810±60 yr B.P. (Tx-6743), i.e., pedogenesis during the Plains Village, or Middle Ceramic period.

The limited radiocarbon data indicate at least one surface of pre-Clovis age, three of Archaic age, and one each of Plains Woodland and Plains Village age. A comparison of soil morphology at undated sites with those dated suggests late Pleistocene to middle Holocene surfaces have the greatest areal extent. Therefore, this nearly 2,000 km^2 area of sand in central Kansas may very well conceal an extensive archaeological record of considerable antiquity.

Preliminary Geoarchaeological Studies of the Sheguiandah Site, Manitoulin Island, Canada

Patrick J. Julig, William C. Mahaney, and Peter Storck

Sheguiandah is a stratified quarry-workshop and habitation site on Manitoulin Island in northeastern Lake Huron. Thomas Lee and John Sanford, the original investigators (see, for example, Lee 1954, 1955, 1956, 1957; Sanford 1957, 1971) describe a sequence of cultural levels (Figure 1). The uppermost deposits contain Woodland and Archaic material. Underlying these deposits is a stratum of fine-grained sediments, possibly of eolian origin (Lee 1957), containing Paleoindian (Easter Plano) projectile points. A single radiocarbon date of 9,160± yr B.P. (W-345) from the basal part of peat deposits in swamp 3, overlying mineral deposits containing artifacts (Lee 1956), was interpreted to be consistent with the late Paleoindian occupation of the site and indicative of yet older occupations, presumably by other cultural groups. Lee and Sanford described two mixed deposits (diamictons) beneath the late Paleoindian stratum, interpreted to be glacial tills. The occurrence of roughly shaped bifaces

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in the lower "till" and more finely shaped bifaces in the upper "till" was regarded as evidence for human occupation prior to the onset of l ate Wisconsin glaciation. Since the initial work, the interpretation of artifacts in "till" has often been mentioned as evidence for pre-Clovis occupation in the New World (Lorenzo 1978; Lee 1986).

Since the work of Lee and Sanford at Sheguiandah in the early 1950s knowledge of the late Pleistocene history of the Great Lakes region has increased considerably. This prompted the senior author to undertake a restudy of some of the artifacts and sediment samples obtained by Lee as a preliminary step to planning renewed excavations at the site. William Mahaney is assisting in the re-analysis and interpretation of the sediment sequence. Recently, Julig, Storck, and Thane Anderson, re-cored swamp 3 in an attempt to obtain material for dating from the basal part of the peat layer and the underlying mineral sediments, which contain organics. It is anticipated that these data will assist in determining the age of some of the sedimentary episodes on the site and the scope of future archaeological/geological fieldwork.

The purpose of this brief report is to present preliminary results of recent particle size and SEM analysis of sediment samples obtained by Lee and Sanford from the so-called habitation area of the site. In addition, several observations are made on possible water-rounded artifacts from the "till" deposits. These data, as well as the sedimentological evidence, provide insights into the geologic origin of the "tills" and the age and cultural affiliation of the artifacts they contain.

Particle Size. Using sediment samples obtained by Lee from four areas of the site particle size ratios of the <2.0 mm fraction were analyzed to determine if any of the deposits have linear curves (non-sorted) suggesting a glacial and/or colluvial origin. Of the 27 samples analyzed from the so-called "till" deposits and underlying sediments, 20 exhibit curves which are characteristic of non-sorted sediment such as colluvium or till. From the "Habitation" area of the site the samples of the sandy gravel over boulder pavement (Figure 1) are sorted and are probably of lacustrine origin. However, detailed fabric analysis in the field and microfabric analysis (Mahaney et al. 1989) in the laboratory should be undertaken in conjunction with scanning electron microscopy of sand subsamples (Mahaney 1990) to assist in determining the origin of the sediments. From these initial analysis the so-called "till" deposits are clearly non-sorted and may be till, or colluvium, or possibly the result of storm beach processes during a high water phase (Early Mattawa flood) during early post-Lake Algonquin times (Lewis and Anderson 1989).

Scanning Electron Microscopy. Quartz grains from the fine and very fine sand fractions (63-250 μm) from deposits in the habitation area that Lee interpreted to be glacial were analyzed for surface features. The results indicate a mix of old fractured and well-weathered grains that were likely preweathered and/or reworked from older deposits. No evidence of fresh glacial-crushing effects or abrasion were observed on any of the grains studied. some quartz grains in the upper "till" (diamicton) had sawtooth fracture patterns that have been observed on sub-aqueous marine debris flow deposits (Mahaney

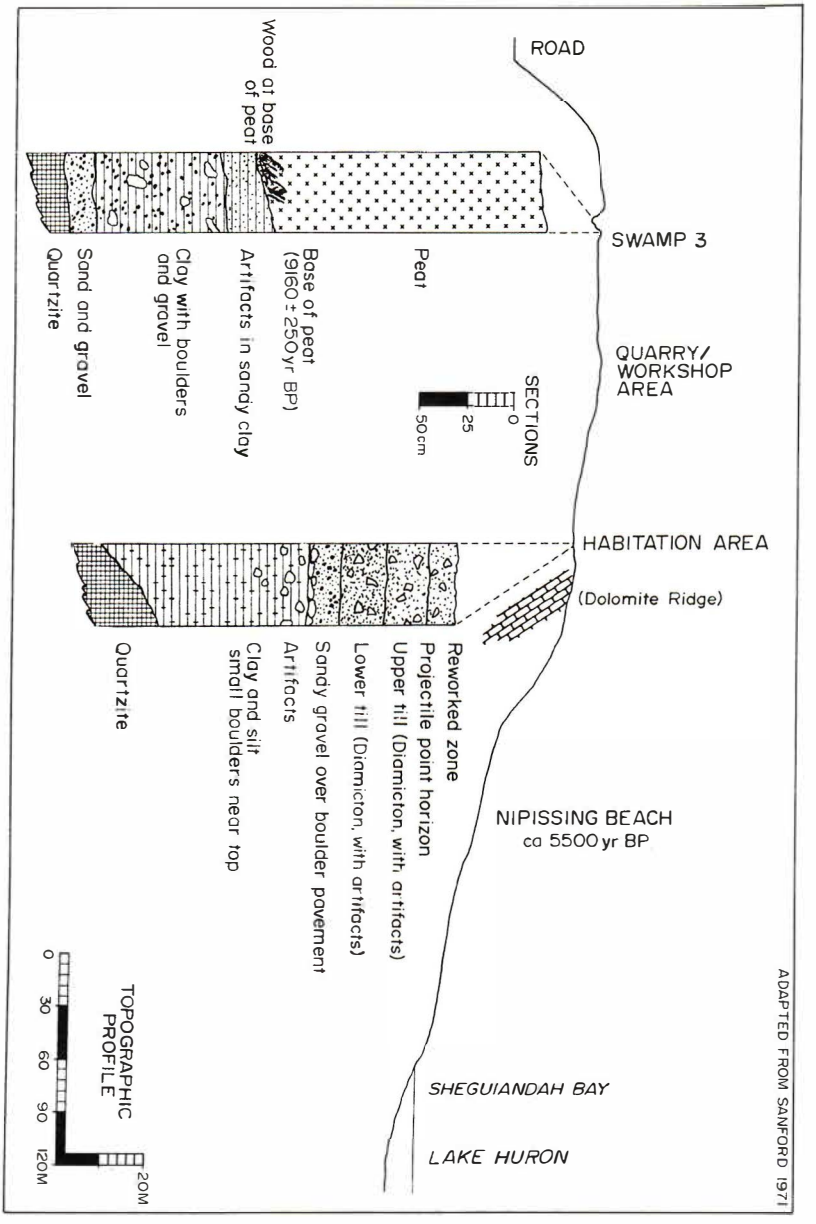

Figure 1. Topographic profile and representative stratigraphic sections from Sheguiandah site, Manitoulin Island, Canada.

unpublished). Crescentic gouges (Krinsley and Doornkamp 1973) which are widely considered to be the effect of transport by continental ice, were also observed on grains of several samples. Some rounded grains of quartz were found in all samples. Some rounded grains of quartz were found in all samples studied but all were weathered to some degree. Even fragments with deep-furrow features, presumably originating from transport in continental ice, showed weathering effects, mainly as dissolution etching (Mahaney et al. 1988). The lack of fresh crushing in these samples suggests they may not have been transported to the Sheguiandah site as a result of transport by continental ice.

Waterworn Artifacts. During the analysis of artifacts a number of possible water-rounded specimens were examined, including both tool fragments and flakes. Certain of these had significant rounding and smoothing of lateral margins and flake scar ridges, which may indicate that the site was affected by a post-occupation flooding episode, however this clearly requires further investigation.

Future Research. Further excavations and a range of sedimentary analyses are clearly required to resolve the complex geological problems at this complex site. Organic samples from the base of the peat and wood and plant fragments from the underlying mineral sediments in swamp 3, obtained in the recent coring, have been submitted for AMS ^{14}C dating. Further excavations are planned in 1991.

The authors would like to thank Dr. Thane Anderson of the Canadian Geological Survey for his participation in this project. Field expenses connected with the recoring of swamp 3 were partly funded by the Royal Ontario Museum. The support of the Social Science and Humanities Research Council of Canada for ongoing Sheguiandah site research is gratefully acknowledged by the senior author.

References Cited

Krinsley, D.H., and J.C. Doornkamp 1973. *Atlas of Quartz Sand Surface Textures*. Cambridge University Press, Cambridge.

Lee, T.E. 1954. The First Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 20:101-111.

Lee, T.E. 1955. The Second Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 21:63-71.

Lee, T.E. 1956. The Position and Meaning of a Radiocarbon Sample from the Sheguiandah Site, Ontario. *American Antiquity* 22:79.

Lee, T.E. 1957. The Antiquity of the Sheguiandah Site. *Canadian Field Naturalist* 71:117-137.

Lee, R.E. 1986. Geology of the Sheguiandah Early Man Site. *Geographie Physique et Quaternaire* 40:325-330.

Lorenzo, J.L. 1978. Early Man Research in the American Hemisphere: Appraisal and Perspectives. In *Early Man in America from a Circum-Pacific Perspective*. Occasional Paper 1, edited by A.L. Bryan, pp. 109. Department of Anthropology, University of Alberta, Edmonton.

Lewis, C.F.M., and T.W. Anderson 1989. Oscillations of Levels and Cool Phases of the Laurentian Great Lakes Caused by Inflows from Glacial Lakes Agassiz and Barlow-Ojibway. *Journal of Paleolimnology* 2:99-146.

Mahaney, W.C. 1990. Macrofabric and Quartz Microstructures Confirm Glacial Origin of Sunnybrook Drift in the Lake Ontario Basin. *Geology* 18:145-148.

Mahaney, W.C., W.B. Vortisch, and P.J. Julig 1988. Relative Differences Between Glacially Crushed Quartz Transported by Mountain and Continental Ice—Some Examples from North America and East Africa. *American Journal of Science* 288: 810-826.

Mahaney, W.C., W.B. Vortisch, R.W. Barendregt, and K. Fecher 1989. Differentiation of Lahars and Tills by Scanning Electron Microscopy Using Microfabric Samples from Southwestern Alberta and Mount Kenya, East Africa. In *Palaeoecology of Africa*, edited by K. Heine, 20:69-77.

Sanford, J.T. 1957. Geological Observations at Sheguiandah site. *Canadian Field Naturalist* 71:138-148.

Sanford, J.T. 1971. Sheguiandah Reviewed. *Anthropological Journal of Canada* 9:2-15.

Applications of Quaternary Surficial Mapping to Archaeological Investigations in British Columbia, Canada

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Surficial mapping projects of Pleistocene deposits are routinely conducted by Quaternary geologists. Paleoenvironmental reconstructions and inferred suitability for habitation by man can be compiled for each mapped terrain unit. These data can by utilized to focus archaeological surveys on terrain units with the greatest potential for Pleistocene archaeological sites. Therefore, this survey procedure would be preferable to random grid survey techniques. A recent Quaternary mapping program was initiated in British Columbia (BC) in 1990 and the results of this program and implications for archaeological studies of Pleistocene sites are discussed here to exemplify the potential utility of this procedure. Published data on Pleistocene and early Holocene archaeological sites are lacking in this region of British Columbia (Bobrowsky et al. 1990). However, environmental impact assessments and archaeological surveys are planned in many areas due to mining developments. Archaeological investigations would be expedited by focussing on terrain units of high

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potential, as exemplified here for one of BC's most active areas of mineral exploration.

The mapped area (Kerr 1991) is in central BC, 150 km north of Prince George. The area lies in the Omineca Mountains and is characterized by a boreal forest vegetative cover and abundant wildlife. Figure 1 illustrates a representative portion of the mapped area. The area was glaciated during the last glacial episode (late Wisconsin). Ice-flow indicators such as drumlinoids and striae suggest a southwest to northeast direction of ice advance across the area, with only minor changes in flow direction on a local scale. Regional mapping indicates a complex deglaciation pattern with glaciolacustrine ponding and sedimentation along some valleys. Paleocurrent directions from glaciofluvial sediments laid down during deglaciation (Figure 1) show a general trend to the northeast. Ice had completely disappeared sometime before 10,000 yr B.P. (Clague 1989). Evidence for human occupation between 10,700 and 10,100 yr B.P. has been documented at the Charlie Lake Cave site, about 225 km to the northeast of the map area (Fladmark et al. 1988; Driver 1988).

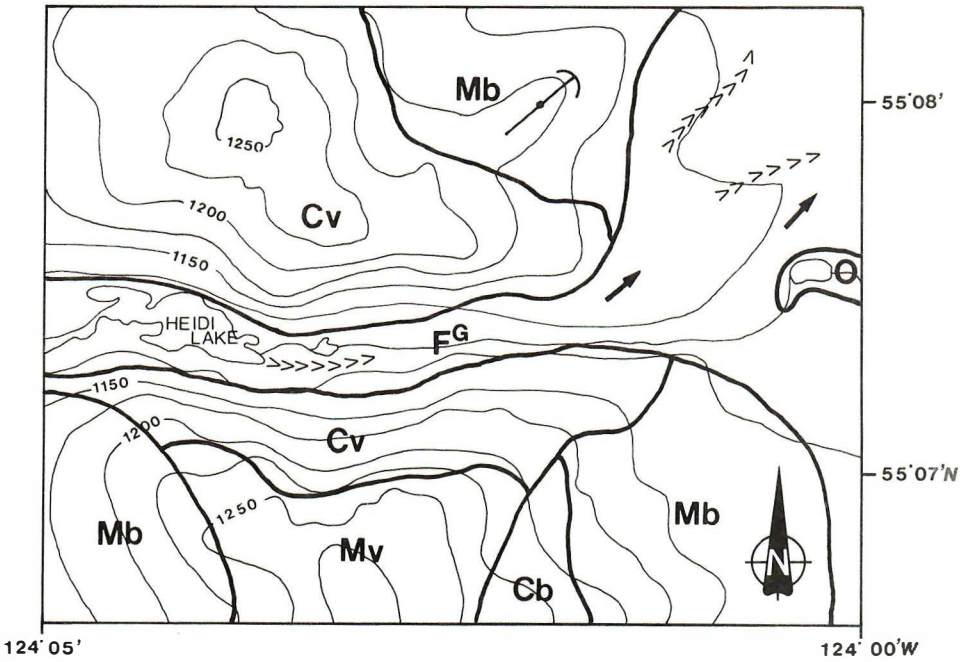

Figure 1. Surficial geology of the Heidi Lake area, central British Columbia, Canada. Large arrow indicates ice flow direction. Small arrows show paleoflow directions in glaciofluvial deposits. Hachure symbols identify eskers. Mapped terrain units are described in the text.

The surficial deposits, which may attain tens of meters in thickness, consist mainly of matrix-supported diamictons in the form of a till blanket (Mb on Figure 1), as well as glaciofluvial deposits of sand and gravel (F^G). The latter generally exhibit a southwest-northwest trend as defined by sinuous esker ridges and broad outwash plains; the dominant meltwater paleocurrent direction obtained from outwash sediments is to the northeast. Till veneer (Mv) and colluvium (Cv, Cb) frequently mantle the steeper slopes of hills and valleys. Organic deposits (O) locally overlie fluvial or lacustrine sediments. To the east of the area shown in Figure 1, isolated deposits of glaciolacustrine fine sand, silt and clay are found within several topographic depressions.

Terrain units with the greatest potential for discovery of Pleistocene archaeological sites include littoral zones of some fluvial and lacustrine units. During the late Pleistocene lake basins and river channels were generally more extensive than at present. Low lying portions of these units are locally overlain by organic deposits and paleo-shorelines typically lie at higher elevations. Although mainly occurring in the Holocene, some fluvial and lacustrine deposition may date to the late Pleistocene. High fluvial terraces, raised beach ridges and perched deltas are the best targets for detailed field surveys. Esker ridges would have been ideal vantage points for spotting game. The ridges were well drained and may have been preferred sites for both humans and large mammals migrating through the area. Eskers are still preferred migration routes for caribou in the Canadian Arctic, and deer and other large mammals commonly utilize these terrain features in the map area. Paleoenvironmental interpretations of glaciofluvial and glaciolacustrine units indicate generally unfavorable conditions for aquatic flora and fauna due to high sedimentation rates, high turbidity and low water temperature. However, due to good drainage and proximity to water, these areas may have been preferred over poorly drained morainal units, by early peoples inhabiting or migrating through these recently deglaciated areas. Within these broad map units, sites with the greatest potential include glaciofluvial terraces, deltas, and sandy glaciolacustrine littoral units.

References Cited

Bobrowsky, P.T., N.R. Catto, J.W. Brink, B.E. Spirling, T.H. Gibson, and N.W. Rutter 1990. Archaeological Geology of Western and Northwestern Canada. In *Archaeological Geology of North America,* Geological Society of America, Centennial Special Volume 4., edited by N.P. Lasca and J.E. Donahue, pp. 87-122. Geological Society of America, Boulder.

Clague, J.J. 1989. Quaternary Geology of the Canadian Cordillera. in *Quaternary Geology of Canada and Greenland,* edited by R.J. Fulton, pp. 17-95. Geological Survey of Canada, Geology of Canada.

Driver, J.C. 1988. Late Pleistocene and Holocene Vertebrates and Paleoenvironments from Charlie Lake Cave, Northeast British Columbia. *Canadian Journal of Earth Sciences* 25:1545-1553.

Fladmark, K., J. Driver, D. Alexander 1988. The fluted Point Component at Charlie Lake Cave (HbRf-39), British Columbia. *American Antiquity* 53:371-384.

Kerr, D.E. 1991. Surficial Geology of the Mt. Milligan Area, NTS 93N/1E, 93O/4W. *British Columbia Geological Survey, Open File* 1991-7.

Late Pleistocene-Early Holocene Soil-Sediment Relationships on the Kersey Terrace, Northeastern Colorado

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The Kersey terrace of the South Platte River at Kersey, Colorado, is one of the most well-known Paleoindian locales on the Great Plains. Sites and isolated finds on the terrace and vicinity exhibit materials from Llano, Folsom, and Plano complexes. Proposed highway construction resulted in an examination of terrace soils/sediments along 8 km of US 34 as well as those at Klein II, Fox, 5WL48, 5WL1555, and Frazier sites. A 50-m-interval soil-coring program paralleling the highway right-of-way and an examination of natural exposures defined the extent and characteristics of the soils/sediments. Additional soil/sediment analysis and dating is on-going.

The Kersey terrace, which is correlated with the late Pleistocene Broadway terrace upstream in the Denver vicinity (Scott 1963; Smith et al. 1964; Colton 1978), is considered the oldest of three alluvial terraces in the area (Holliday 1987). At Kersey, the terrace is a broad (3 km wide), low-relief surface about 12 m above the South Platte River.

Basal terrace sediments are moderately-sorted, quartz and granite-rich channel sands and gravels derived from the Rocky Mountains. These sediments were deposited in the late Pleistocene across a braided network. Forms indicative of braided conditions include numerous low-relief gravel bars and abandoned channels.

Clovis artifacts were found in the upper Kersey gravels at the Klein II site and at other scattered localities. The absence of post-Clovis artifacts within the gravels indicates that braided deposition ceased after 11,000 yr B.P. The association of these artifacts with gravel ridges suggests these Clovis groups used the ridges to traverse the braided network (Louis Klein, pers. comm. 1990).

Fine-grained and thin-bedded overbank alluviation replaced braided deposition after 11,000 yr B.P. Radiocarbon dating of the organics in the upper

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12 cm of these sediments at 5WL1555 suggests that overbank alluviation continued through 8,637±130 yr B.P. cal (Beta-40751; Stuiver and Reimer 1986). Indicators of a high water table within the fine-grained sediments imply that prior to 8,637 yr B.P. the South Platte River had not yet abandoned the terrace. This evidence includes an Aquoll with: 1) an organic-rich soil A horizon, 2) a gleyed soil B horizon, and 3) iron and manganese staining.

Continued overbank deposition, possibly augmented by eolian sedimentation from the adjacent river channel, resulted in burial of the Aquoll (≤8,637 yr B.P.). A well-developed Argiustoll with strong prismatic structure developed in these sediments. Subsequent erosion and/or agricultural practices (e.g., leveling, plowing) has removed the epipedon of this soil.

A re-examination of soils/sediments at the Frazier site, described by Malde (1988), suggests that the buried A horizon (Aquoll) and the overlying Bt horizon (Argiustoll) correlate respectively with his "gley layer" and "prismatic clay". Bison (*Bison*) bone and artifacts that include Agate Basin projectile points (ca. 10,500-9,500 yr B.P.) were recovered from the lower "prismatic clay". However, we disagree with: 1) the use of the term "gley layer", 2) the proposed eolian origin of the sediments in the "prismatic clay", and 3) the statement that the "gleyed layer" has no recognized counterparts upstream.

On the contrary, we find evidence that the soil/sediment relationships at the Frazier site occur elsewhere on the Kersey terrace. Furthermore, the existence of the Aquoll at numerous localities across the Kersey terrace and a similar-aged soil in dune sediments at Hudson, Colorado (Forman and Maat 1990) suggests that the Aquoll is a floodplain member of a regional, late Pleistocene-early Holocene pedoderm rather than a site specific phenomenon.

References Cited

Colton, R.B. 1978. Geologic Map of the Boulder-Fort Collins-Greeley Area, Colorado. *U.S. Geological Survey Map I-855-G.*

Forman, S.L., and P. Maat 1990. Stratigraphic Evidence for Late Quaternary Dune Activity Near Hudson on the Piedmont of Northern Colorado. *Geology* 18:745-748.

Holliday, V.T. 1987. Geoarchaeology and Late Quaternary Geomorphology of the Middle South Platte River, Northern Colorado. *Geoarchaeology* 2:317-329.

Malde, H.E. 1988. Geology of the Frazier Site, Kersey, Colorado. In *Guidebook to the Archaeological Geology of the Colorado Piedmont and High Plains of Southeastern Wyoming*, edited by V.T. Holliday, pp 85-90. Department of Geography, University of Wisconsin, Madison.

Scott, G.R. 1963. Quaternary Geology and Geomorphic History of the Kassler Quadrangle, Colorado. *U.S. Geological Survey Professional Paper 421-A.*

Smith, R.O., P.A. Schneider, and L.R. Petri 1964. Ground-Water Resources of the South Platte River Basin in Western Adams and Southwestern Weld Counties, Colorado. *U.S. Geological Survey Water-Supply Paper 1658.*

Stuiver, M., and P.J. Reimer 1986. A Computer Program for Radiocarbon Age Calibration. *Radiocarbon* 28:1022-1030.

Late Pleistocene-Early Holocene Paleoclimates and Environments of Southwestern Montana.

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Geoarchaeology of a Pleistocene/Holocene archaeological site in southwestern Montana, the Everson Creek/Black Canyon Quarry Complex (Bonnichsen et al. 1990a,1990b; Turner et al. 1988) shows that major and abrupt shifts in climate occurred at the Pleistocene/Holocene boundary, about 11,000 yr B.P. (Birkeland et al. 1971; Locke 1990; Turner et al. 1988). Dating of this episode is constrained by archaeological data, ^{14}C dates, and rates of deposition. There is evidence of massive flood(s) occurring over a relatively short period of time, from a year to several tens of years, during this climatic episode. South Fork Everson Creek is presently about 1 m wide and 10 cm deep. Our data show that flood-plain flow occurring before and after the climatic episode at 11,000 yr B.P. had a grain-size-carrying-capacity of less than 3 mm in diameter. Thus, the stream flow could move only very small particles of rock. However, flood(s) occurring at the time of the climatic episode, approximately 11,000 yr B.P., were much larger, causing deep erosion in parts of the Pleistocene flood plains and concurrently depositing sediments over 1 m thick that contain transported boulders of up to 50 cm in diameter. This indicates that stream flow during these large floods increased several thousand times in volume over stream flows prior, and subsequent to, the end of the Pleistocene.

Evidence for a major environmental change and several lesser environmental alterations comes from the presence of a strongly developed paleosol within the strata of the Cody workshop floor, and from the presence of three paleosols above it. These paleosols are weakly developed morphologically but show noticeable enrichment with organic matter when compared to horizons which overlie and underlie them (Soil Survey Staff 1975, 1981). Most significant is an

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abrupt change in clay-mineral species above and below the Cody workshop paleosol. Clay in and below this paleosol is dominantly vermiculite; above this soil, the smectite clays dominate. The paleosol has strong prismatic peds coated with clay argillons and organic stains which are on the tops and upper sides of the peds. It has many of the morphological characteristics of a natrargid (Soil Survey Staff 1975, 1981) but has been leached of exchangeable sodium, soluble salts, and calcium carbonate. The morphology of this soil suggests a much drier climate at the time of intense human use that led to development of a rich assemblage of Cody workshop-floor artifacts about 9,400 yr B.P. (AMS date on charcoal, 9,390±90 yr B.P. (TO-1976)).

Two charcoal samples from hearths in upper levels of the Mammoth Meadow sequence were dated by ^{14}C at 1,830±90 yr B.P. (Beta-40580) (Level IE, 50-60 cm) and 490±50 yr B.P. (Beta-37608) (Level IC, 49.8 cm). For Level relationships see diagram of composite vertical section of site (Bonnichsen et al. 1990a).

The soil chemistry of this paleosol suggests a much drier climate. The clay minerals in the section relate strongly to bedrock sources for the soils in which the minerals occur (Klages and Montagne 1985; Montagne et al. 1982), because weathering of clay-size layer-silicate minerals in soils in Montana is minimal. Thus, the distinct change from vermiculite clays below the Cody workshop paleosol to smectitic clays in the loess and paleosols above it indicates a distinct and important change in source materials for the deposits entering the valley of South Everson Creek

Vermiculite in clay-size soil fractions from this area is typically derived from rock types of the Belt series, a pre-Cambrian metamorphic complex that forms the core of the mountains to the northwest of the site (Staatz 1979; Turner et al. 1988). Thus, while late Pleistocene glaciers were actively eroding Belt Series rocks in the mountains, finely-ground rock dust (silt) produced by this erosion was being laid down on flood plains below the foot of the glaciers. Pedogenic processes converted some of these sediments to vermiculite. Subsequently, but still during the Pleistocene, these silts and clays were picked up by winds blowing southeastward and deposited as loess across the area that includes the archaeological site.

Smectite in the site area is typical of clay minerals derived from soils and sediments younger than the Belt Series and associated with the Laramide Revolution (Cretaceous) to Present. Such sediments are primarily Tertiary-age lake beds that lie largely to the north and northeast of the site (Nichols 1988). The occurrence of smectite shortly after the close of the Pleistocene and throughout the Holocene, indicates a rapid increase in temperature and lower precipitation. This caused a loss of vegetation cover in the basins and dried up the Tertiary lake beds northeast of the site, and exposed them to wind erosion. The climatic changes also included a shift of wind patterns, so that dust and smectite clay from the basins in the north and east were transported to the site area, depositing them as loess.

Lying between the Pleistocene loess and the Holocene loess is the natrargid paleosol/Cody workshop-floor soil. This paleosol is indicative of drier

conditions and alkaline water near the pedogenic surface. Additional scientific project data are being developed to determine if major changes in flora, fauna, and human culture also occurred in site area at this time.

We conclude from our evidence, presented above, that a major environmental/ecological shift occurred in southwestern Montana at the end of the Pleistocene, and that lesser shifts occurred both prior and subsequent to the major shift described herein. An intense climatic event with very high precipitation took place at or near the time of this major Pleistocene/Holocene climatic shift.

References Cited

Birkeland, P.W., D.R. Crandell, and G.M. Richmond 1971. Status of Correlation of Quaternary Stratigraphic Units in the Western Conterminous United States. *Quaternary Research* 1:208-227.

Bonnichsen, R., D. Douglas, M. Beatty, M.D. Turner, J.C. Turner, and B. Stanyard 1990a. New Paleoindian Discoveries at Mammoth Meadows, Southwestern Montana. *Current Research in the Pleistocene* 7:3-5.

Bonnichsen, R., D. Douglas, BN. Stanyard, A.C. MacWilliams, M. Beatty, M.D. Turner, and J.C. Turner 1990b. Change in Lithic Procurement Systems from Southwestern Montana: Culture History or Environmental Forcing? In *Scientific Reports of the International Symposium: Chronostratigraphy of the Paleolithic of North, Central, East Asia and America* Academy of Sciences, Union of Soviet Socialist Republics, Siberian Branch, Institute of History, Philology, and Philosophy, Novosibirsk, Union of Soviet Socialist Republics 146-157.

Klages, M., and C. Montagne 1985. Montana soil Clay Minerals as Related to Parent Materials. *Montana Agricultural Experiment Station Special Report 16* Montana State University, Bozeman.

Locke, W.W. 1990. Late Pleistocene Glaciers and the Climate of Western Montana, U.S.A. *Arctic and Alpine Research* 1:1-13.

Montagne, C., L.C. Munn, G.A. Nielsen, J.W. Rogers, and H.E. Hunter 1982. *Soils of Montana*. Montana agricultural Experiment Station, Montana State University, Bulletin 744.

Nichols, R. 1988. Miocene Biostratigraphy of the Bannock Pass Area of Montana-Idaho and Adjacent Valleys. *Geological Society of America Abstracts with Program, Rocky Mountain Section* 459.

Soil Survey Staff 1975. Soil Taxonomy; A Basic System of Soil Classification for Making and Interpreting Soil Surveys. *Agriculture Handbook* 436. United States Department of Agriculture, Soil Conservation Service.

Soil Survey Staff 1981. Examination and Description of Soils in the Field. *Soil Survey Manual Issue 1*. United States Department of Agriculture, Soil Conservation Service.

Staatz, M.H. 1979. Geology and Mineral Resources of the Lemhi Pass Thorium District, Idaho and Montana. *United States Geological Survey Professional Paper* 1049-a.

Turner, M.D., J.C. Turner, and R. Bonnichsen 1988. A Long Pleistocene Glacial Sequence in Southwestern Montana. *Current Research in the Pleistocene* 5:96-97.

Late Quaternary Fluvial Activity and Climate Variability in the Colorado Front Range Foothills and Piedmont

C.E. Waythomas, R.D. Jarrett, and W.R. Osterkamp

Research has been initiated in the Colorado Front Range foothills and piedmont region to explore the relations between latest Pleistocene and Holocene river behavior and climatic variability. Recent large floods in the Western United States (e.g., Big Thompson River, Colorado, 1976; Rapid City, South Dakota, 1972; Swift River, Montana,1964) have focused attention on the temporal aspects of floods and their potential relation to aberrations in the climate system. To understand the significance of such large-magnitude flood events, one must place them in an appropriate geomorphic context that can explain their temporal and spatial occurrence. The goal of our research in Colorado and other western states is to establish a linkage between climate and river response using data derived from study and dating of alluvial stratigraphic records. Such information can be used to develop better predictive models involving anticipated climatic variation and associated changes in the hydrologic system. The research is expected to provide new data about late Quaternary flood frequency and magnitude, the chronology of geomorphically significant fluvial events, and paleohydraulic conditions. Locally, the results will serve as an extension of the historic record.

Fluvial deposits and their associated landforms in several geomorphic settings are being studied. In the mountainous foothill belt of the Colorado Front Range, the principal record of Holocene fluvial activity consists of coarse-grained flash-flood deposits and minor debris-flow deposits (Bradley and Mears 1980; Costa 1983). Typically, these deposits are well preserved along steep bedrock channels, where they form longitudinal boulder bars of berms (Carling 1987). Field studies have documented the deposit geometry and sedimentology by using measurements of clast orientation, particle size, and weathering characteristics. These data also are useful for differentiating water-flood deposits from debris-flow and other deposits formed by mass-wasting. Wood samples for radiocarbon dating have been collected from many

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flash-flood deposits. These results are expected to provide chronological control on flood events in the region.

Selected localities where bouldery flash-flood deposits are well preserved have been chosen for paleohydraulic reconstructions of flow competence (bed shear stress, unit stream power) and discharge using the step-back water approach (Baker and Costa 1989; Carling 1983; Chow 1959; Costa 1983; Henderson 1966; Komar 1989). At these locations, channel cross-section dimensions and altitudes of paleostage indicators are surveyed. Paleodischarge and flow competence estimates are made from representative cross-section data, estimates of bed-roughness, and particle-size measurements. Preliminary results from Arthurs Rock Gulch, an ephemeral stream tributary to a large municipal reservoir west of Fort Collins, Colorado, indicate that peak flood flows have decreased in magnitude throughout the Holocene. However, in other basins in the Front Range foothills, some of the largest known floods have occurred in the last century (e.g., 1976 Big Thompson flood; McCain et al. 1979).

In addition to studies of bouldery flash-flood deposits in steep bedrock canyons, fine-grained alluvial deposits preserved along rivers and tributaries of the Colorado Front Range piedmont are being examined. In this region, Holocene alluvial deposits (e.g., Piney Creek alluvium) appear on most geological maps; however, information about the age, sedimentology, and environmental significance of these sediments is lacking. Typically, Holocene alluvial deposits in the study area consist of 5- to 10-m thick sequences of massive- to horizontally-bedded overbank sediments that contain numerous buried soil horizons and organic matter suitable for radiocarbon dating. Bounding surfaces between sedimentation units commonly represent minor unconformities and are usually denoted by sharp contacts or buried soil horizons that are readily identifiable in the field. These relations permit identification of episodes of overbank flood deposition. At some locations (e.g., Plum Creek near Sedalia, Colorado), as many as 15 episodes of Holocene flooding have been recognized.

The objectives of our studies of Holocene alluvial deposits are to (1) establish a detailed, high-resolution chronology of flood events from areas in eastern Colorado, as well as other localities in the Western United States, (2) document the fluvial sedimentologic and geomorphologic relations of latest Pleistocene and Holocene deposits in these areas, and (3) provide paleohydrologic information that may be useful in extending existing systematic and historic records. This information can be compared to proxy records of Holocene climatic variation (pollen, fossil insects, tree rings, glacier fluctuations) to develop an understanding of the possible linkages between climate and river behavior (e.g., Knox 1983; Schumm and Brackenridge, 1987).

References Cited

Baker, V.R., and J.E. Costa 1989. Flood Power. In *Catastrophic Flooding*, edited by L. Mayer and D. Nash, pp. 1-21. Allen and Unwin, Boston.

Bradley, W.C., and A.I. Mears 1980. Calculations of Flows Needed to Transport Coarse Fraction of Boulder Creek Alluvium at Boulder, Colorado: Summary. *Geological Society of America Bulletin*, Part I 91:135-138.

Costa, J.E. 1983. Paleohydraulic Reconstruction of Flash-flood Peaks from Boulder Deposits in the Colorado Front Range. *Geological Society of America Bulletin* 94:986-1004.

Carling, P.A. 1983. Threshold of Coarse Sediment Transport in Broad and Narrow Natural Streams. *Earth Surface Processes* 8:1-18.

Carling, P.A. 1986. The Noon Hill Flash Floods; July 17th, 1983. Hydrological and Geomorphological Aspects of a Major Formative Event in an Upland Landscape. *Transactions of the Institute of British Geographers* 11:105-118.

Carling, P.A. 1987. Hydrodynamic Interpretation of a Boulder-berm and Associated Debris-torrent Deposits. *Geomorphology* 1:53-67.

Chow, V.T. 1959. *Open-Channel Hydraulics*. McGraw Hill, New York.

Henderson, F.M. 1966. *Open Channel Flow*. McMillan, New York.

Komar, P.D. 1989. Flow-competence Evaluations of Hydraulic Parameters of Floods: an Assessment of the Technique. In *Floods: Hydrological, Sedimentological and Geomorphological Implications*, edited by K. Beven, and P.A. Carling, pp. 107-134. John Wiley and Sons, New York.

Knox, J.C. 1983. Responses of River Systems to Holocene Climates. In *Late Quaternary Environments of the United States, The Holocene*, edited by H.E. Wright, Jr., pp. 26-41. University of Minnesota Press, Minneapolis.

McCain, J.F., L.R. Hoxit, R.A. Maddox, C.F. Chappel, F. Caracena, R.R. Shroba, P.W. Schmidt, E.J. Crosby, W.R. Hansen, and J.M. Soule 1979. Storm and Flood of July 31-August 1, 1976 in the Big Thompson River and Cache la Poudre River Basins, Larimer and Weld Counties, Colorado; A, Meteorology and Hydrology in Big Thompson River and Cache la Poudre River Basins. B, Geologic and Geomorphic Effects in the Big Thompson Canyon Area, Larimer County, *with a section on* Damage Caused by Geologic Processes During Flood Producing Storms. *U.S. Geological Survey Professional Paper* 1115.

Schumm, S.A., and G.R. Brackenridge 1987. River Responses. In *North America and Adjacent Oceans During the Last Deglaciation*, edited by W.F. Ruddiman, and H.E. Wright, Jr., pp. 221-240. K-3. Geological Society of America, Boulder, CO.

Bathymetry and Stratigraphy of Wonder Lake, Alaska

Al Werner

The Muldrow Glacier invaded Wonder Lake (63°30'N, 150°50'W) three times during the late Wisconsin; the north end of the lake is dammed by the glacial limit, the south end of the lake is dammed by a younger stadial moraine, and a moraine of intermediate age occurs midway in the basin (Werner 1982).

Twenty six transverse and longitudinal bathymetric profiles were measured with an acoustic "fish-finding" device, and digitized to produce computer maps. These data refine the bathymetry presented by LaPerriere and Casper (1976). Wonder lake is relatively shallow (<10 m) at both north and south ends, but reaches a maximum depth of 78 m in the deep main basin (Figure 1). The lake basin has a classic "glacial trough" morphology with steep sides and a broad flat bottom. An east-west trending bathymetric ridge separates a northern basin from the deep main basin.

An acoustic sub-bottom profiling device was used to document the stratigraphy along 20 transects. The resulting profiles were digitized and computer isopach maps were produced (Figure 1). Three main sedimentary units are recognized in the lake basin; a northward thickening (7 m) sediment wedge at the north end of the lake, a thick (25-30 m) layered unit at the south end of the lake, and a 4-6 m layered sediment unit in the deep main basin. The sediment wedge at the north end of the lake indicates a northerly sediment source (i.e., the modern inflow stream). Although the modern stream is small, during deglaciation it served as a meltwater stream along the glacial limit. during glacial retreat, meltwater would have emptied into Wonder Lake before draining to Moose Creek. According to this model, the unit immediately post-dates the glacial maximum.

The thick sediment wedge at the south end of the lake (thickening southward) is associated with the moraine damming the south end of the basin. The well-layered stratigraphy is consistent with a meltwater origin, and is correlated with an outwash fanhead on the east side of the lake. The notable thickness of this unit suggests the glacier maintained this position for a relatively long time.

Of greatest interest is a layered unit in the distal deep main basin. The banded stratigraphy indicates changing sedimentological conditions interpreted as glacial advance and retreat. Wonder Lake is currently "sediment-limited", but sedimentation would have changed abruptly when the

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Muldrow Glacier entered (and retreated from) the basin. The number of acoustic layers in the basin fill is consistent with the number of stadial moraines (and interstadial periods) recognized in the valley.

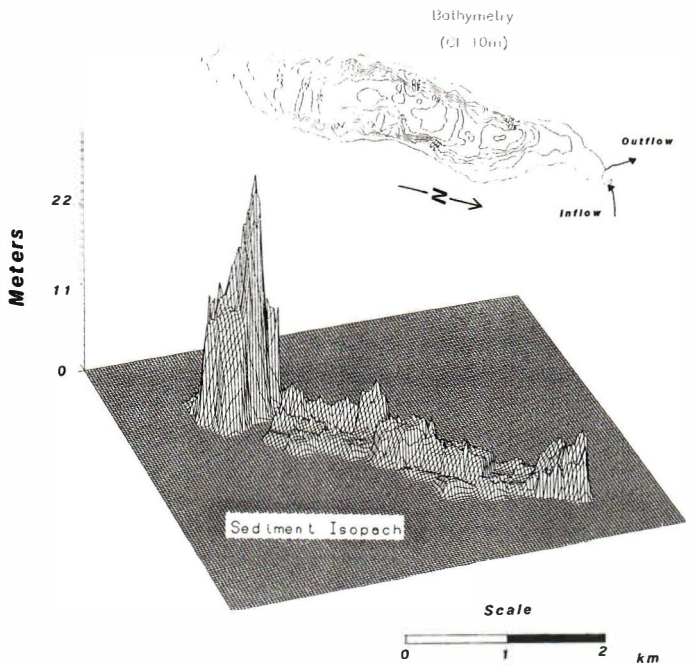

Figure 1. Bathymetry (1a) and sediment isopach (1b) maps of Wonder Lake. Lake basin is 1.0 by 4.5 km.

References Cited

LaPerriere, J., and L. Casper 1976. Biogeochemistry of Deep Lakes in the Central Alaskan Range. Institute of Water Resources, University of Alaska IWR-68: 35p.

Werner, A. 1982. Glacial Geology of The McKinley river Area, Alaska With An Evaluation of Various Relative Age Dating Techniques. MS Thesis, Southern Illinois University at Carbondale.

Information for Contributors

GENERAL INFORMATION

Categories of notes will be: 1) Archaeology, 2) Physical Anthropology, 3) Lithic Studies, 4) Taphonomy-Bone Modification, 5) Methods, 6) Paleoenvironments (which includes the subsections: Plants, Invertebrates, Vertebrates, and Geosciences), and 7) Special focus. The last category is reserved for a pre-selected topic; articles are submitted by authors at the request of the Center. Usually no more than 65 unsolicited papers for the regular sections and 5 solicited papers for the Special Focus section will be accepted. No more than 2 papers will be accepted from any one senior author. Time being of the essence, the earlier a paper is received, the better its chance of being published. Manuscripts concerned with any of the above categories should include research dating ≥10,000 yr B.P. or have direct implications for research of that time period.

Manuscripts should be of note length, ≤1000 word, or 400 words with one figure and caption, plus references. They should be current, original, not be or have been submitted to another journal, and may cover any aspect of the above-mentioned categories. All notes will be published in English. Authors submitting manuscripts in a language other than English may either submit their manuscript also in English or request the editorial staff to provide a translation (final decision will be left to the editorial board). In either case, both accepted manuscripts will be published. Manuscripts submitted in a language other than English should be typed double-spaced throughout and be legible. If a manuscript requires extensive editing or if a meaning is unclear, the author will be contacted—this could delay the printing of the manuscript.

Manuscripts are first read by the editorial staff to ensure the minimum requirements are met, as outlined above. All manuscripts are edited for style and general grammar. Because one of the practical goals of the journal is to provide quick turnaround time for the printing of manuscripts, authors do not review galley or page proofs. The editor staff compares the submitted manuscripts with the style-edited page proofs. Thus it is imperative that authors carefully proof their manuscripts for content, journal style, and grammar. It is suggested that all manuscripts be reviewed by a colleague of the author prior to submission. All manuscripts receive peer reviews.

FORM AND STYLE

Manuscripts should be concise but detailed enough to permit critical appraisal. They must be typed and DOUBLE-SPACED THROUGHOUT (i.e., entire

manuscript, references, and figure caption) on one side of 22 by 28 cm (8-1/2 by 11 inch) paper with no less than 4 cm (1-1/2 inch) margins.

If a word processor is used, use the following specifications in preparing and printing your manuscript. Use letter quality or near letter quality printing. Align text to the left margin only—do not justify. Underline any words that should be italicized in the final typeset galleys. DO NOT hyphenate words at the right margin. Manuscripts should be submitted in both printed form and on computer disk (Macintosh, MS DOS/IBM, or Apple II format). In addition to the original word processing document, the disk should also contain an ASCII version . The computer will probably be able to translate the text and formatting from the original document, but if it can't translate the original, it will at least be able to read the ASCII file. Manuscripts that conform to these specifications will allow us to fully utilize the technology we have available in preparing manuscripts for publication, to keep both the turnaround time, and the cost of the journal down.

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Standardized words or spellings that do not need to be underlined or described: in situ; et al.; pers. comm.; Paleoindian; archaeology; CRM (for cultural resource management); MNI (for minimum number of individuals); TL (for thermoluminescence dating); yr B.P. (for years before present); and AMS or TAMS (for accelerator mass spectrometer technique of radiocarbon dating). Do not italicize words in the manuscript, only underline (Ficus not *Ficus*). The use of either Latin or common names is fine, but include the other (common or Latin) name in parentheses following the first time use (e.g., "..recovered the dung of the Shasta ground sloth (*Nothrotheriops shastensis*)"). If technical jargon or abbreviations are to be used, and possibly are not well known to all readers, provide a more common term or explanation in parentheses.

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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 (e.g., 11,000±140 yr B.P. (A-1026)). International notation should be employed in all cases of chemical notations.

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