MAMMOTH TRUMPET

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Center for the Study of the First Americans
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The Hole in the Ground Gang

That's the name given to the excited team of volunteers who work at the Topper site. They gladly camp in tents and pay for the privilege to work alongside nationally known scientists. They're the stars of *They Were Here: Ice Age Humans in South Carolina*, a flawless film, professional in every respect, produced by South Carolina Educational TV to inform the public about the pre-Clovis discovery at the Topper site. Here host Jim Welch (left) interviews scientists Al Goodyear (center) and Dennis Stanford 29 October 2002, when *They Were Here* was first broadcast on SCETV. The première included a live question-and-answer session with the studio audience and telephone callers.

DARYL P. MILLER SCIAA-USC

We first reported news of Dr. Goodyear's discovery in September 2001. We revisit the Topper site in this issue because of the pivotal role of geochronologist Steve Forman in dating sediments at Topper, using powerful luminescence dating techniques. Starting on page 10, Dr. Forman of the University of Illinois–Chicago explains the principles of OSL dating and how he applied them at Topper.

Steve Forman is only one scientist who supports Al Goodyear's discovery. *They Were Here* parades him and experts in other fields—soil morphologist John Foss, radiocarbon-dating authority Tom Stafford, and TAMU geoarchaeologist Mike Waters. Primitive-technology specialists Steve Watts and Scott Jones show how early Americans made and used the kinds of stone tools they're finding at Topper. Splendid photography shows off the gorgeous Savannah River country, the backdrop for work at Topper. *They Were Here* is a fascinating story of history being made—and a crackerjack training film about how to excite a team of volunteers with the thrill of discovery. To order the VHS videocassette (catalog no. 266-000), phone 1-800-553-7752, or send $24.94 (includes s&h) to SCETV Marketing, P.O. Box 11000, Columbia, SC 29211.

The Center for the Study of the First Americans fosters research and public interest in the Peopling of the Americas. The **Center,** an integral part of the Department of Anthropology at **Texas A&M University,** promotes interdisciplinary scholarly dialogue among physical, geological, biological and social scientists. The **Mammoth Trumpet**, news magazine of the **Center,** seeks to involve you in the peopling of the Americas by reporting on developments in all pertinent areas of knowledge.

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World Wide Web site **http://www.centerfirstamericans.com and http://www.peak.org/csfa/csfa.html**

CONGRESSIONAL INTENT:
What Is the Purpose of NAGPRA?

by Ryan M. Seidemann

The Native American Graves Protection and Repatriation Act (NAGPRA), passed by Congress and signed by President Bush in 1990, creates a mechanism for Native Americans to seek the return of certain skeletal remains and sacred objects from museums and other institutions around the U.S. The law also provides for the protection of certain in situ Native American burials. Unfortunately, not all the details of NAGPRA were worked out prior to its passage. The recent court case *Bonnichsen v. United States* places the poorly understood shortcomings of NAGPRA center stage. These shortcomings concern questions of whether or not NAGPRA applies to ancient, unaffiliated human remains.

Although Congress periodically considered these problems during the hearings on NAGPRA, there is an absence of any resolution to the problems in the final draft of the law. In the *Bonnichsen* case, the question of what to do with the 9,200-year-old remains of Kennewick Man highlights the problems caused by this absence of age- and affiliation-related standards.

The problem is that it is unclear whether NAGPRA applies to remains of the antiquity of Kennewick Man that have no known relationship to any modern Native Americans. Judge John Jelderks, a federal magistrate judge in the District of Oregon, held that, with respect to Kennewick Man, NAGPRA does not apply because of the antiquity of the remains and the lack of affiliation of the remains to the claimant groups. This holding is grounded in Jelderks's review of the legislative history of NAGPRA.

Aside from Jelderks's examination of some of the legislative history, very little has been written on the intent of Congress

TAMU STAFF

During the CSFA Grand Opening, director Rob Bonnichsen (*left*) presents the first D. Gentry Steele Award for Academic Excellence in First American Studies—to D. Gentry Steele, TAMU Professor Emeritus of Anthropology. See page 3 for details on the award.

INSIDE

when its members drafted NAGPRA. I have reexamined the question of when NAGPRA may apply to ancient and unaffiliated remains. In light of the legislative history, I have found strong support for Judge Jelderks's holding that certain ancient, unaffiliated remains fall outside the scope of NAGPRA. The results of this analysis should be useful in cases that may arise in the future.

Before going any further, the NAGPRA legislation must be placed in its historical context. Any consideration of the history of NAGPRA must necessarily incorporate a review of the history of the National Museum of the American Indian Act (NMAIA), which started the repatriation ball rolling in the mid-1980s. NAGPRA grew out of concerns of Native Americans and lawmakers over the disposition of the Smithsonian Institution skeletal collections during the early NMAIA hearings. Since that time, both NMAIA and NAGPRA have been considered together in the Congressional hearings and legal literature. The histories of both NAGPRA and NMAIA are considered in concert here, and both are referred to as NAGPRA for convenience.

One commentator on NAGPRA has stated that "there are many indications in the legislative history that Congress intended NAGPRA to apply to some prehistoric remains" (Lannan 1998:407). Lannan bases his statement on a comment by Senator Inouye of Hawaii in the 1988 Senate hearings on an early draft of NAGPRA. Senator Inouye stated that "we are also fully in concurrence with the importance of knowing how we lived a thousand years ago or a million years ago, whatever it may be." However, it is contextually evident that this comment was not intended to imply that NAGPRA would apply to *all* skeletal remains. Simply stating that NAGPRA was intended to apply to *some* prehistoric remains is not detailed enough. To *which* prehistoric remains does Lannan refer? Does he refer to remains older than European contact, but with a clear affiliation to modern groups? Or does he refer to all prehistoric remains, regardless of affiliation? The legislative history can clear up this confusion.

In order to truly understand the purpose of NAGPRA, we must understand the concerns of the legislators and Native Americans who were involved in the creation of NAGPRA. The general tenor of the Congressional record on NAGPRA suggests that both these groups were concerned with the disposition of the skeletal remains of individuals who had died since European contact (ca. A.D. 1492). As the Inouye comment illustrates, NAGPRA was not intended as anti-science legislation to stop all study of the past.

Questioning at the Congressional hearings was dominated by an interest in U.S. Army acquisitions of skeletal remains in the 19th century. Common questions echoed the tenor of this inquiry by Senator Inouye: "How many were acquired during the Indian Wars?" Members of the anthropological community repeatedly attempted to raise questions of ancient remains in their testimony before the various Congressional committees. Thomas King commented, "I don't think that it necessarily follows that the bill pertains only to extremely recent remains." Such statements were not addressed by the Congressional committees, and after Dr. King's comment Senator Inouye immediately returned to questions of recent remains. Even more telling of this attitude is Senate Report No. 100-601, which indicates that the Senate was not concerned at all with skeletal remains recovered through legitimate archaeological excavations.

The Congressional hearings on early drafts of NAGPRA are replete with references to remains 200 years old or younger. Senator Inouye went as far as to state that remains as old as 2,000 years are not the primary interest of the bill. Additionally, Senator Melcher, the author of the original Senate repatriation bill, explicitly addressed the issue of ancient, archaeologically derived remains: "In

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CSFA Grand Opening

THE **Center for the Study of the First Americans** held its Grand Opening March 4, celebrating our move to the Department of Anthropology at TAMU. The Grand Opening featured an open house and reception during the afternoon, announcement of the D. Gentry Steele Award for Academic Excellence in First Americans Studies, and an evening lecture by Dennis Stanford from the Smithsonian Institution.

After months of unpacking with the assistance of 20 TAMU Anthropology graduate students, who painted, cleaned, moved books, and set up exhibits, we were ready and right on schedule for the Grand Opening.

The Grand Opening gave guests an overview of operations and programs using a self-guided tour through the **Center**, which is located on the 2nd floor of the Anthropology Building. Using posters, exhibits, and personnel located at stations to explain our programs, visitors could have toured the entire operation in about 20 minutes. But most of the nearly 200 visitors from the TAMU academic community, professional archaeologists, avocational archaeologists, and **CSFA** Advisory Board members took much longer to tour our new facilities and research laboratories. Visitors were first met by our welcoming committee of one, Laurie Lind, the new **CSFA** office manager. Although the next stop was at a poster that outlined the **Center**'s mission and goals, most visitors quickly moved on to the archaeological exhibits. Most spent the afternoon crowded around graduate student exhibits featuring thesis and dissertation research on archaeological materials recovered from the Gault Clovis site, a workshop and quarry complex located north of Austin, Texas. (This is a joint project between TAMU, led by Michael Waters and Harry Schaffer, and University of Texas archaeologist Michael Collins.) Student exhibitors on hand to explain their research included geoarchaeologist Heidi Luchsinger, who exhibited samples prepared for her M.A. thesis on the analysis of the microstructure of the soils and sediments from the Gault site; Bill Dickens, a Ph.D. candidate who specializes in prehistoric archaeology, exhibited and explained Gault biface and blade core and blade tools; Charlotte Pevny, a Ph.D. candidate specializing in prehistoric archaeology, exhibited her research on debitage and stone expediency tools; Dawn Alexander, an M.A. candidate, showed how she uses orientation of flakes and artifacts as well as refitting data to determine site formation processes. Exhibits on faculty research in palynology (Vaughn Bryant, Jr.),

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TAMU STAFF

◀ **Kathy Hodge, CSFA Advisory Board member (*right*), discusses the geoarchaeology of the Gault site with Heidi Luchsinger.**

TAMU STAFF

George Carter, Jr. (*left*) ▶ and Gerry Fritts (*right*) listen as George Carter (*center left*), author of *Earlier than You Think*, and Rob Bonnichsen discuss First American issues.

The D. Gentry Steele Award for Academic Excellence

In commemoration of the **Center**'s move to one of the nation's finest universities, the **CSFA** Advisory Board directors decided to use the Grand Opening to establish a new award for academic excellence in first American studies. It will be awarded every two years to an individual that has made outstanding contributions to furthering knowledge about the initial peopling of the Americas. In developing criteria for the award, we came to a consensus that not only must recipients have a demonstrated record of contributions to the field, they must also have a record as a role model of helping others develop their careers. The first and most prominent name that came to mind in our initial discussions with colleagues is an old friend of the **Center**—Professor D. Gentry Steele. Gentry embodies two qualities that we believe set the standard for excellence in First American Studies, outstanding scholarly contributions that have moved the overall field forward and a record of helping others to advance their careers in the field. It is for this reason that the **CSFA** leadership has decided to name this award the D. Gentry Steele Award for Academic Excellence in First Americans Studies.

Nomination letters for this award may

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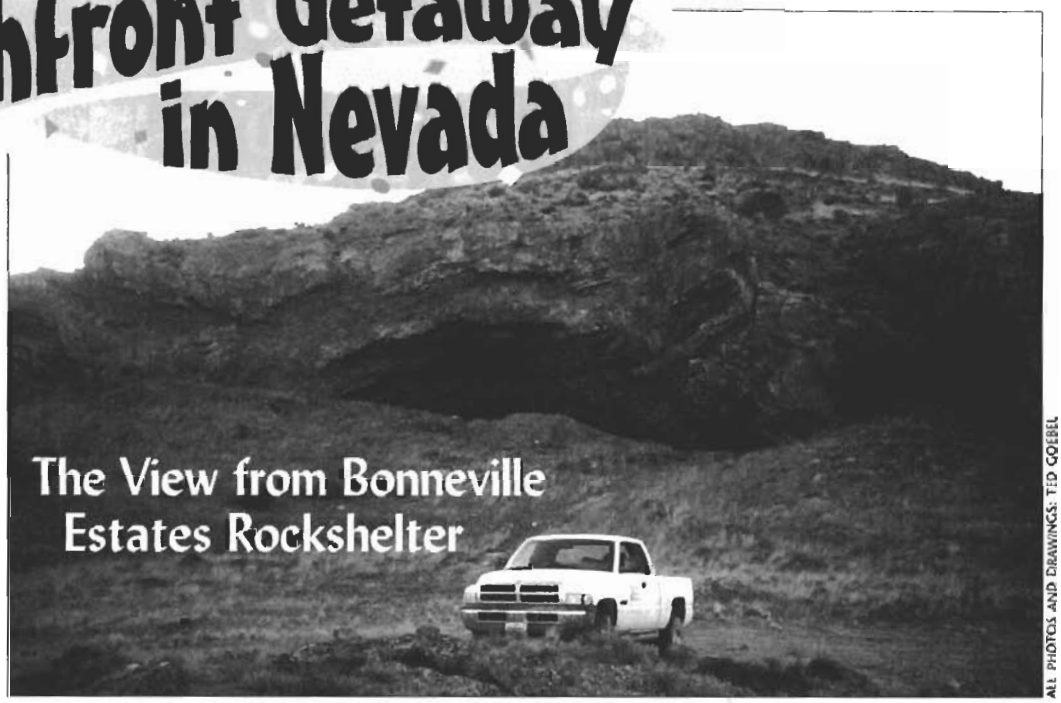
A Beachfront Getaway in Nevada



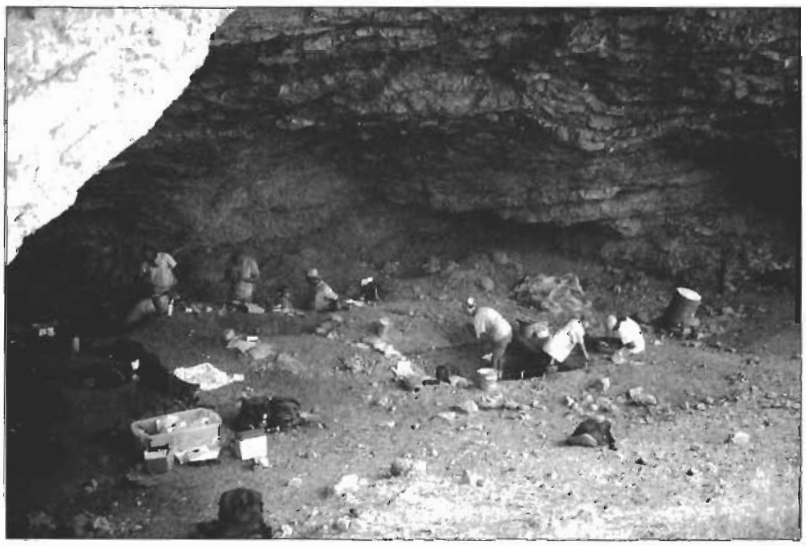
ALL PHOTOS AND DRAWINGS: TED GOEBEL

Seen from a distance, Bonneville Estates Rockshelter indeed resembles an eye set in a giant's wrinkled brow. The south-facing shelter overlooking a lake that teemed with wildlife would have been a prize for nomadic early Americans.

LONG AGO, a deep fold in a hillside brooded above the shores of a vast lake, like some great littoral eye slitted in annoyance. There were times when the lake's waters lapped at its base; there were even times when the great eye was partially submerged. Since then, the eye has seen the lake level rise and fall repeatedly, then fall, fall, fall until the lake was finally reduced to mere briny remnants far away. Now cactus and sage dominate the parched landscape around Elko, Nevada, near the border with Utah, where once there was a great expanse of water, unbroken save for an occasional island.

That cleft in a rocky hillside, which we now call Bonneville Estates Rockshelter (BER), isn't a true cave, but at 25 m wide and 15 m deep (about 82 by 49 ft), it has offered shelter to goats and to opportunistic hunter-gatherers. The waves of human beings who occupied it have since receded like the lake, but they left behind their history in sediments 3 m (about 10 ft) thick. Now those sediments are providing researchers with clues about the life-styles of the people who left 10,000 years of history literally lying around on the floor.

Although the sediments within the shelter are deep, the ceiling still rises in places to a height of more than 10 m (about 33 ft). The walls and roof are wrinkled and irregular, etched by time, water, and the relentless wind. Parts of the roof are blackened with soot—possibly from millennia of prehistoric campfires, and just as likely from natural fires and fires set by modern shepherds who penned animals here.

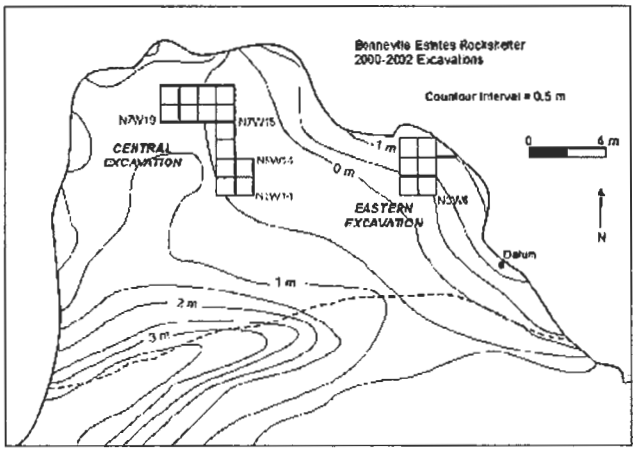


Excavations in summer 2000.

Beachfront property

Bonneville Estates Rockshelter owes its name to a bit of whimsy: because it's the largest and highest of 13 grottos in the surrounding hills, Tim Murphy, an archaeologist with the Elko Field Office of the Bureau of Land Management, considered it the local "high-rent district" and jokingly named it Bonneville Estates when he and colleague Steve Dondero discovered it in 1986. BER and its "low-rent" cousins are located in the Permian sandstones and dolomites of the Lead Mine Hills, a series of low rises set into the eastern slope of the Goshute Mountains. All that remains of Lake Bonneville in this location is a few wave-cut terraces and ancient beaches, one of which rims the shelter. The bone-white Bonneville Salt Flats—another abiding remnant of the monster lake that once inundated the basin—brightens the horizon to the east.

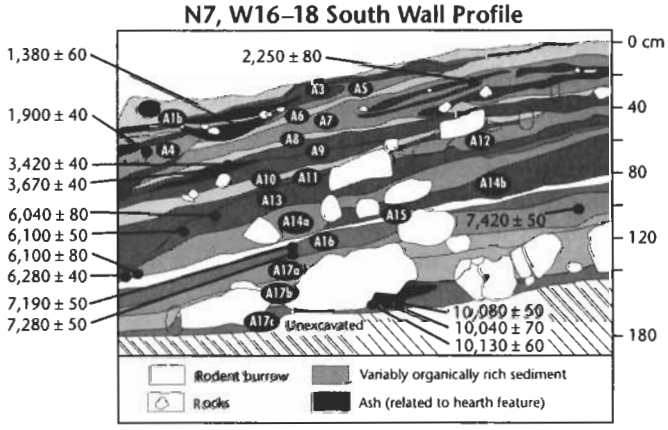
The sediments inside BER consist mainly of wind-borne materials mixed with roof fall and enriched with human-derived organic materials (especially ash and charcoal). Given the arid conditions of the region for the past dozen millennia, these sediments are a wonderfully well preserved record of human activity over the entire depth of occupation at BER. For Ted Goebel, project director of the Sundance Archeological Research Fund (SARF) at University of Nevada–Reno, the sediments provide the means to test modern theories of human adaptation across time. Dr. Goebel is a veteran researcher, with plenty of field experience in the Great Basin and places as far-flung as Kamchatka and the Siberian Transbaikal (**MT 18-1,** "Hunting Pre-Clovis in Siberia" and "A Campaign to Find the First Americans"). BER is an excellent opportunity for Goebel to study the evolution of human adaptations during the early- to mid-Holocene period, 5,000–10,000 years ago, as the eastern Great Basin became increasingly dry and inimical to human life.



◀ Relief map showing the location of excavations. The dotted line indicates the overhang above the shelter entrance.

▼ Generalized stratigraphic profile, showing dated cultural-related finds (all dates are uncalibrated radiocarbon yr B.P.).

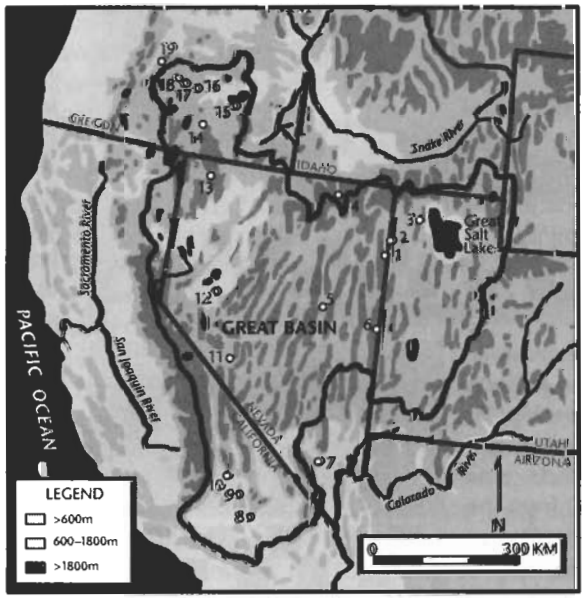
Bonneville Estates Rockshelter
N7, W16–18 South Wall Profile



"Native Americans continued to use the shelter throughout the Holocene, intermittently up until latest prehistoric times," Goebel points out. "But precisely when the last such occupation was, we can't presently say." To plumb the mysteries of BER, Goebel has assembled a multidisciplinary crew that includes geomorphologist Ken Adams, stratigrapher Kelly Graf, zooarchaeologist Bryan Hockett, and paleoecologist David Rhode. They are searching for answers to such questions as, How long was BER occupied? How did human groups use the shelter across this span of time? How did human populations living in BER handle the dramatic climatic changes in the region?

Over the years BER has been systematically looted by relic collectors, despite—or perhaps because of—its location on BLM land, so some information has been irretrievably lost. In 1988 P-III Associates, a firm specializing in cultural resource management, tested the site and estimated the age of the cultural deposits at 6,000 years or older. The SARF team's work began in summer 2000, with members of the University of Nevada–Las Vegas Field School in Great Basin Archaeology and Paleoecology providing most of the basic labor. "We used P-III's representative stratigraphic profiles as a guide in our initial excavations," says Goebel, "and were able to identify most of their preserved profile. From there, we began to excavate by natural stratigraphic layers, but the stratigraphy of the shelter is quite complex, and many of the recognizable units aren't laterally continuous over a large area."

Piece by piece, Goebel's team began to accumulate the pieces of a puzzle that, when properly assembled, will give a clear picture of the lifeways of the people who occupied the great eye across a hundred centuries.



String grids and plummets

Excavations over the last three summers have yielded a mountain of evidence, most of it not yet completely analyzed, about the people who once occupied Bonneville Estates Rockshelter. Sediments have been carefully removed deeper than 2 m (about 6½ ft) in several areas, and in one unit the excavators dug down more than 3 m (about 10 ft) until they reached the rounded river cobbles that mark the highest stand of the prehis-

Significant Great Basin sites: 1 Bonneville Estates Rockshelter; 2 Danger Cave; 3 Hogup Cave; 4 Deer Creek Cave; 5 Sunshine; 6 Smith Creek Cave; 7 Tule Springs; 8 Calico; 9 Henwood, Roger's Ridge, and Awl; 10 China Lake; 11 Tonopah; 12 Spirit Cave; 13 Last Supper Cave; 14 Dietz and Tucker; 15 Nials; 16 Buffalo Flat; 17 Connley Caves; 18 Fort Rock Cave; and 19 Newberry Crater.

Exposed stratigraphic profile in the main excavation unit.

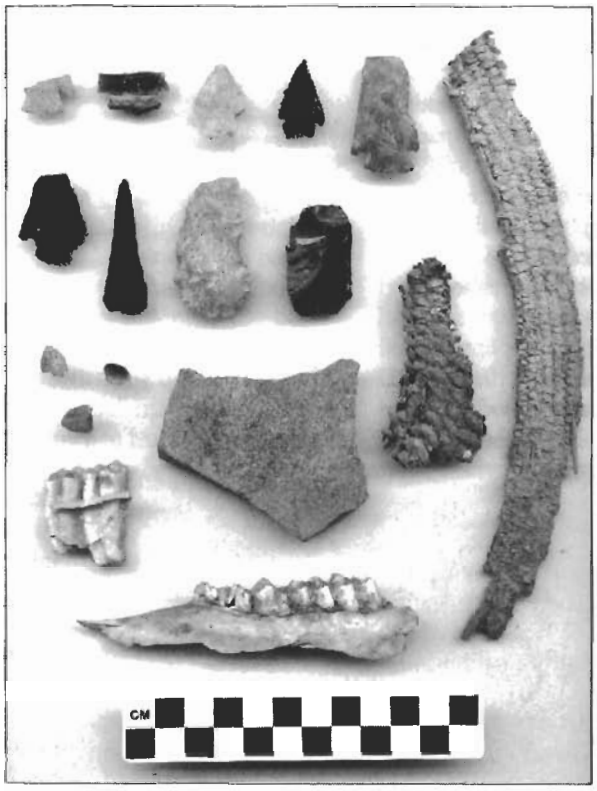
toric lake. Sediments up to 2 m deep are still unexcavated in most areas of the shelter.

The sediments consist largely of organic-rich silts—with enough large roof fragments to remind the excavators that roof-fall is a constant danger inside any cave or rockshelter. The rockshelter opening faces south. The primary excavation area, near the center rear portion of the shelter, consists primarily of an initial 2-by-2-m block that was later expanded north to the back wall and then farther west. Another block excavated east of the original block, initially quite small, now includes most of the east end of the rockshelter. Stratigraphic control is maintained during excavation by a system of string grids and plummets—lead weights dangling from the roof—which makes it possible to record the exact location of finds. (The crisscrossing cordage is also an obstacle course for excavators, noted by one volunteer in his personal Web log: "Both methods have advantages and disadvantages. Do you want to strangle yourself, or keep hitting yourself in the head?")

An embarrassment of riches

Bonneville Estates Rockshelter has yielded a bounty of cultural remains, and much of it directly addresses the researchers' central interest in adaptation to the arid environment during the early- to mid-Holocene. Occupations were found to span at least a 9,000-year period, from approximately 10,100 to less than 1,000 years ago. The extent of the preservation the excavators encountered is simply amazing. Even perishable organic materials, which rarely survive very long at any archaeological site, have been recovered from the shelter deposits in amounts that continue to astonish the researchers. Among the more interesting finds are Elko and Eastgate points, some with bindings still attached; intact woven matting from the Archaic period; intact bone awls; basketry and twine fragments galore; and plenty of ecofacts of all kinds. Perhaps the most exciting find thus far is a coiled basket base, indirectly dated to approximately 7,200 years ago. In 2002, Goebel and his crew discovered two stemmed Parman-style projectile points, a biface, nearly 100 flakes, numerous animal bones, a few plant remains, and a distinct oval-shaped hearth feature in a context dated to about 10,080 ± 80 RCYBP (about 11,900 CALYBP), meaning the shelter may have been occupied in the Paleoindian period—or even earlier. Such an early date is exceedingly rare for the Great Basin. In addition, stratified occupation floors were found that date clearly to about 5,000–7,000 years ago, one of the hottest and driest periods of the middle Holocene. This is also unusual, since evidence from most other Great Basin sites suggests the region was abandoned during that period. BER and nearby Danger Cave, however, buck this trend by showing clear signs of repeated occupation throughout this particularly arid phase. However, 7,300–8,300 years ago, conditions were so miserably hot and dry that even Bonneville Estates was abandoned.

Hearths, very common throughout the shelter sediments, and subsistence-related ecofacts provide plenty of material for dating occupations. Pronghorn antelope bones and hair, pinyon pine cones and seeds, Indian ricegrass seeds, and beavertail cactus pads are especially plentiful. Among the subsistence-related features uncovered are a 1,300-year-old Fremont-age pit filled with ricegrass seeds, and several early-Holocene firepits full of charcoal and bone. The abundance of subsistence materials makes the shelter a paleoecological paradise, a rich vein that researchers like David Rhode are sure to mine for years. "So far the only faunal remains that have been analyzed are those from the 10,100 B.P. layer," states Goebel. "That small assemblage consists of cottontail rabbit, waterfowl, and small-sized ungulates. Later deposits have more preserved plant remains, as well as a broad array of faunal remains—but primarily pronghorn antelope and jackrabbit."



Materials recovered from the Bonneville Estates Rockshelter: (*above*) artifacts (Elko bifacial points, bifaces, bipolar core, groundstone metate fragment, and basket fragments) and ecofacts (pine nut hulls, artiodactyl teeth) from the middle-Archaic layers; (*right*) a human coprolite from the middle Archaic.

What the future holds

Although it may take years to interpret the data from Bonneville Estates Rockshelter, excavations are far from complete. Excavations in future seasons will be expanded and deepened to collect more data that will help refine the researchers' understanding of prehistoric use of the shelter. Of particular interest are deeper sediments as yet unexplored. The excavators have about 2 m to excavate before they encounter the high-stand beach gravels left by Lake Bonneville 14,500 years ago. There's plenty of room for more surprises.

Goebel is cautiously optimistic about what his team might find this year. "Given that there are nearly another two meters of sediments below this, there's always the chance that even older cultural deposits occur in the shelter," he points out. "Clovis-aged deposits, perhaps? Pre-Clovis? Who knows?"

–Floyd B. Largent, Jr.

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CSFA Grand Opening

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ethnobotany (Phil Dehring), and physical anthropology (D. Gentry Steele) illustrated the interdisciplinary scope of the Department's research program.

New equipment attracted visitors' attention: Leitz microscopes, a binocular scope and a compound scope that are well suited for the study of small-scale objects. Jim Weiderhold, an M.A. candidate, is conducting a comparative micromorphological study of use-wear patterns between end scrapers from the Gault site and experimental specimens; his study demonstrates the research potential of these powerful microscopes that use software to construct composite in-focus images of microfeatures on specimens ranging from 10x to 500x. Visitors were also introduced to other resources including the **Center**'s library, our collection of over 8,000 reprints and 10,000 First American 35 mm slides.

The Grand Opening concluded with a two-pronged evening event, the announcement of the D. Gentry Steele Award for Academic Excellence in First Americans Studies, and Dennis Stanford's lecture, "The First Americans: Evidence for a North Atlantic Paleo-Maritime Tradition?" A substantial crowd learned about the latest evidence that Dennis and Bruce Bradley have developed in support of their speculative, yet intriguing and compelling, hypothesis that the descendants of a Solutrean population from the Iberian Peninsula colonized eastern North America during the last Ice Age.

The Open House was a success. Support by the Department of Anthropology and the Dean's Office and assistance from graduate students contributed to that success. We look forward to a bright and promising future at our new home at TAMU, investigating the many intriguing mysteries posed by the initial peopling of the Americas.

–Rob Bonnichsen, Director

D. Gentry Steele Award

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be submitted to the Director of the **CSFA** at any time. Nomination letters should stipulate why the proposed nominee is a meritorious candidate and list important works published by the candidate. Recipients will receive a lifetime membership in the **Center** and a plaque acknowledging their achievements, and their names will be inscribed on a plaque in the **Center**'s office with previous award winners.

The first nominee and winner of the award is none other than D. Gentry Steele, who recently retired as the Department's senior physical anthropologist at TAMU. Gentry's academic background includes course work at Del Mar Corpus Christi Liberal Arts College, a B.A. from the University of Texas–Austin, a Ph.D. from the University of Kansas, and a post-doc from the Smithsonian Institution. Gentry, who has held offices and positions in many professional organizations, served as a member of the **CSFA** Scientific Council, Associate Head of the Department of Anthropology at Texas A&M University, and as President and Board Member at the Brazos Museum.

Important topics that bear his personal stamp include North American paleobiology and human osteology, techniques for analyzing human skeletal remains and human populations, taphonomy, and First Americans archaeology, casting, and photography. Gentry performed the first forensic reconstruction of a Paleoamerican skull, the 10,000-year-old woman's cranium from the Wilson Leonard site, Texas.

Gentry has influenced many graduate students who now hold prominent positions at institutions of higher learning. His book *Anatomy and Biology of the Human Skeleton*, now in its ninth printing, is used by thousands of students.

Gentry's craniometric research (study of human skull forms) in collaboration with his former Ph.D. student Joseph Powell, has been very influential in changing our perceptions about the significance of variation among New World human skeletal remains. Steele's pioneering work has led to the recognition that ancient First American long and narrow skull forms differ markedly from modern Native Americans forms, which tend to be more spherical. Some specialists have used these observations to suggest that the Americas may have been peopled more than once by populations who originated in different parts of Asia. Today, experts are seeking to fully understand of the implications of Gentry's significant insight through additional research.

Glen Greco, a gifted artist in the TAMU Nautical Archaeology Program, carved a scale replica of the Leonard Wilson skull. This was attached to the D. Gentry Steele Award in Academic Excellence in First Americans Studies plaque presented to Gentry Steele.

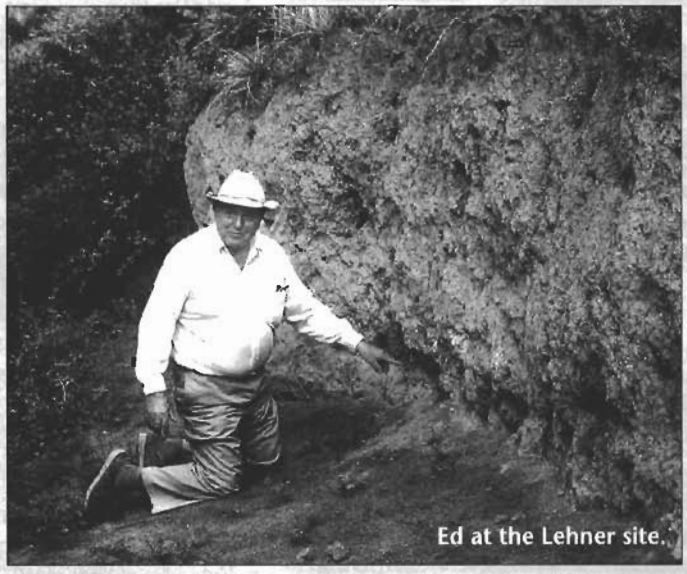
Remembering Ed Lehner (1914–2003)

Avocational archaeologist Edward F. Lehner died in Tucson, Arizona, on 3 January 2003 after a brief illness. Ed, born in New York City in 1914, spent his first five years with his family living in a sod hut in North Dakota. He must have been captivated by the West because after formal education in New York state he moved to Arizona, where he spent most of the rest of his life except for government-sponsored duty in the European theater during World War II. Ed's contributions to American archaeology were recognized by the National Park Service at the Pecos Archaeological Conference held at the Salinas Pueblo ruins in New Mexico in 1985.

Edward F. Lehner has to be the most remarkable and unforgettable person I have ever had the pleasure of meeting. I don't remember when we first met. It was either 1961 or 1962. In any case, on our first visit, Peter J. Mehringer and I became enamored with the discoverer of the famous Lehner Clovis site. This is where we first learned of the Hereford Hiking and Horticultural Society.

We had studied the site by thoroughly reading everything that had been written about it by our mentors, Emil W. Haury, John F. Lance, William Wasley, Ted Sayles, and Ernst Antevs. Furthermore, as Paul Martin's students at that time in palynology, we learned that Paul and Alexander Lindsey had acquired useful fossil pollen sequences from some of the strata at the site. We both wanted to reinvestigate the site to obtain more complete stratigraphic coverage and additional radiocarbon ages on strata above and below the Clovis level by cleaning up arroyo walls and excavating some stratigraphic trenches. Ed welcomed these suggestions with great enthusiasm. He offered the services of his neighbor across the San Pedro, Alfred Weik, who had a small bulldozer. So with Emil Haury's enthusiastic approval we conducted geochronological investigations at the Lehner site in 1963. In the process we discovered more mammoth bones, much to Ed's delight.

Many of us who knew Ed fairly well always felt that his decision to purchase the quarter section containing the site was, in no small part, decided by bones he had discovered in what we now call Lehner Ranch Arroyo. Ed had witnessed the Arizona State Museum excavations at the Clovis mammoth kill site near Naco in 1952.



Ed at the Lehner site.

So seeing similar bones in the arroyo on his place probably clinched the deal. Then in 1954, as Ed put it, "after 6 inches of rain in 5 hours or, I forget, 5 inches in 6 hours," there were mammoth bones exposed for over 20 feet along the arroyo wall. Ed immediately called Emil Haury and the rest is history. Thirteen Clovis points and eight stone tools were found among the bones of nine mammoths, a bison, and a tapir. The first radiocarbon ages for Clovis came from the Lehner site indicating their presence about 13,000 years ago. Essentially every year thereafter Ed took great delight in escorting visiting groups of schoolchildren through the site. He always welcomed visitors. They included some of the world's most noted archaeologists, geologists, paleontologists, and palynologists. His guest books are filled with such signatures and addresses which, with tongue in cheek, he said he would sell to junk mail dealers as a little side business.

The discovery of the Murray Springs Clovis site, 10 miles to the north, by Pete Mehringer and myself in 1966 was due to what we had learned at the Lehner site, that the Clovis occupation surface and associated extinct fauna of the upper San Pedro Valley was covered by a very distinctive black layer of organic clayey silt, the "black mat." Before our discovery we had been reworking one of Paul Martin's pollen sections below the old Murray place in Curry Draw. On one of our field visits the battery in my International Scout pooped out. We started to carry the dead battery to Sierra Vista 7 miles away, but abandoned it after less than a mile. At the most easterly development of Sierra Vista a nice Korean service wife allowed us to call Ed on her house phone (there were no cell phones in those days). So Ed and Lyn came to the rescue with their pickup. It was the trip after this that we went farther upstream and discovered mammoth bones directly under the black mat at the Murray Springs site. Ed could not have been happier when we told him.

Ed was a pretty good hunter and, early on, harvested waterfowl coming to his irrigation ponds, but eventually he reduced his bird hunting and became more interested in bird watching. In fact his place became a favorite of bird watchers, some of whom Ed and Lyn allowed to use the guest house. However, Ed told Pete and me that anytime we wanted to hunt doves feel free to do so. One day while we were looking for doves between the two ponds Ed came out to see how we were doing. As he came up to us he reached for Pete's shotgun, saying, "Pete, let me see that." He promptly put the shotgun to his shoulder, fired, and dropped a dove practically in our midst. Handing the gun back he said, "Don't ask me to do that again."

In the late 1960s Dr. Noye M. Johnson of Dartmouth and I were scouting the San Pedro Valley for paleomagnetic samples to age-date the "Benson beds" or St.

David Formation. Just the other day I noticed a note in my 1969 field book. It says, "Noye and I went to Lehner's in PM to watch Apollo 11 moon landing." Ed had an interest in just about all things scientific including botany. In fact, somewhere around the house I have a bumper sticker that Ed gave us that says "I brake for verbascom." I don't know that Ed had a particular attraction for this plant. I think he just liked the name.

With degrees in economics and chemistry from Colgate University in 1936 and animal husbandry from Cornell in 1938, Ed went west to work with cattle above the Mogollon Rim. This was before World War II. With war on the horizon Ed joined the U.S. Cavalry and was stationed at Fort Robinson, Nebraska, an important cavalry outpost during the Indian Wars. Here, at the last horse cavalry post of the U.S. Army, Ed said he did more shoveling of meadow muffins than riding horses. He told me about his being transferred during the war to military intelligence, which he considered an oxymoron. This was when the Army learned he was fluent in German. He also told of his experience in looking after some notorious Nazis held prisoner at Wiesbaden for trial at Nuremberg, but he never told me of his being wounded. This I learned from John Jennings's article about Ed in the Tucson *Citizen* of 12 June 1995. In the interview Ed says it was a beautiful August night in the French countryside when a German machine gunner cut loose on his Jeep. As Ed told it, "One bullet came in the side of the Jeep and would have put a hole in the other side, too, but luckily my legs got in the way." That is quintessential Ed Lehner humor.

In 1994 Sam Lowe of the Phoenix *Gazette* interviewed Ed and reported, in the July 16 issue, on the science conducted at his Clovis site over the past 40 years. In the article Lowe included some of the Lehner humor we had all come to appreciate. He quoted Ed as saying, "Not much to do around here, so we organized the Hereford Pre-Mortem Funeral Association. We figure a person ought to have the chance to go to his funeral before he dies so he can hear all the nice words people are going to say about him." And here I quote Lowe: "The meetings start, Lehner says, with the designated guest knocking at the front door. Then he has to clear his throat loud enough so somebody inside the house will ask, "Is that you coffin?"

The guest replies, "Of corpse it is."

And the guy inside will answer, "Well, you cadaver tell."

After Lyn's death Ed moved to Santa Catalina Villas in Rancho Sin Vacas and always had humorous things to say about all the sin that took place on the streets there,

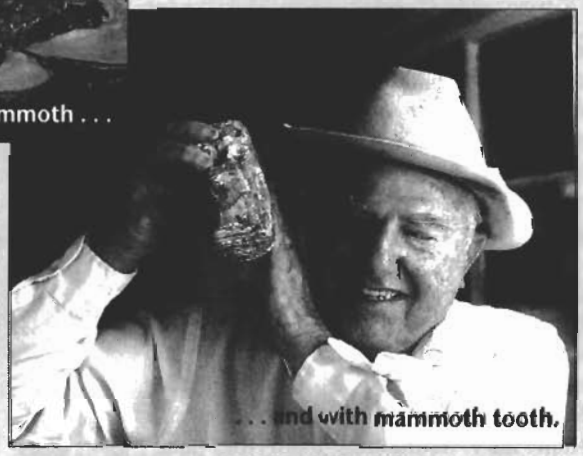
Ed with bronze mammoth . . .

Calle Sin Envidia, Calle Sin Rudio, etc. When I took Ed out to lunch or to barbecue at my place he would confirm that he "had the warden's permission" to leave. When I first had Ed at my place to barbecue he asked, "Where on earth did you get that raggedy mutt?" I said, "Why, Ed, you gave it to us in 1987 and Taffy named her Sparkie." His response was, "Oh no, really!? Okay, she is one of that litter of mutts we had then." Ed always preferred mutts to pure breeds."

When Larry Agenbroad, Jim Mead, Bruce Huckell, and I reopened excavations at the Lehner site in 1974 and 1975, Lyn would make sun tea for us each day. Lunch was taken in their carport, and Ed and Lyn would join us in the conversation to learn about our findings. Ed informed us that the original excavators had reburied many of the mammoth bones and showed us where, but excavating with a backhoe failed to find any. We now believe they are under the mound of back dirt between the original site and the arroyo.

Aside from his quick wit and great sense of humor, Ed was a serious scholar with interesting thoughts about Paleoindian lifeways, peopling of the Americas, and the extinction question. Many years ago there was a deep freeze in the San Pedro Valley that lasted nearly a week. During one of my class visits soon thereafter Ed asked, "What if a freeze like this were to last for two weeks and megafauna were not able to drink?" I thought that was very interesting, considering that the black mat was deposited precisely during the Younger Dryas return to glacial climate.

Each year when I took my classes on weekend field trips to the Clovis sites of the San Pedro Valley we would camp out Saturday night in Ed and Lyn's yard and barbecue hamburgers on their grill on the patio, where we could watch the quail come to the feed that Ed tossed out each evening. We would bribe Ed with bourbon-on-the-rocks to recount tales of the Hereford Hiking and Horti-



. . . and with mammoth tooth.

cultural Society, but of course the bribe was really not necessary. We were going to hear, like it or not, about how difficult it was to shoot fish in a barrel, or fall off a log, or how hot cakes don't always sell all that well. But we loved it. Seeing his Clovis site was only part of the reason for visiting Ed and Lyn. Social pleasure was the rest of the reason. My students always considered the Lehner visit the highlight of their academic year. It was mine too.

–Vance Haynes
8 March 2003

Luminescence Dating of Quaternary Sediments

New Methods for Dating Archaeological Components

by Steve Forman

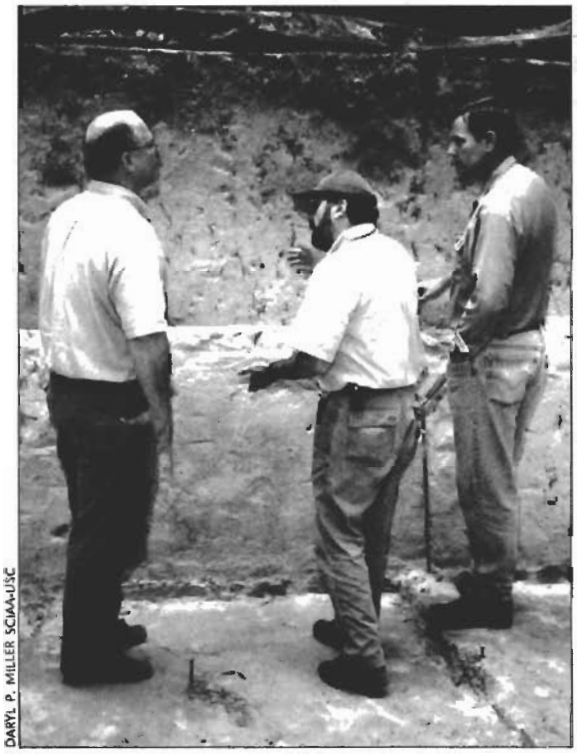
SIGNIFICANT INNOVATIONS during the past decade in dosimetry-based dating techniques, such as optically stimulated luminescence (OSL), have improved our capability of directly dating Quaternary sediments. Luminescence dating is an important tool for deciphering the archaeological record because it can be applied to sediments from a wide range of environments. With it we can potentially date cultural components from the past 200,000 years with precision better than 10 percent. Recent research has shown that OSL dating, used solely or in tandem with other dating methods, is particularly useful in dating cultural horizons of Clovis and pre-Clovis age.

Luminescence dating techniques, specifically thermoluminescence (TL), were originally developed in the 1960s to date pottery and other fired archaeological materials. In the late 1970s and early 1980s TL dating was applied to different Quaternary sediments from the past 500,000 years or so with varying success; eventually TL was found most effective in dating sediments 100,000–200,000 years old. In the early 1990s TL dating was largely replaced by optically stimulated luminescence (OSL), which is more precise and accurate. Thanks to advances in technology and data-analysis software in the past five years, we can now place the age of a few hundred grains of quartz—even a single grain!—from many sedimentologic contexts up to 20,000 years old *within a century, sometimes within a decade.* Continuous improvements in luminescence dating are making it possible to date ever-smaller aliquots of sediments—that single quartz grain again!—with precision approaching 3 percent.

Tapping the radiation memory of sediment grains

The principle of OSL dating of Quaternary sediments is similar to that of earlier TL dating of pottery. When pottery is fired, the heat completely depletes the luminescence of grains of quartz and feldspar. Similarly, when mineral grains are exposed to sunlight for a brief period ranging from a few tens of seconds to tens of minutes, their inherited luminescence is reduced to a low definable level, often to a background value. Because solar energy rapidly resets the luminescence signals measured by OSL, the method can be used to date eolian deposits as well as various deposits of colluvial and fluvial origins, where sediment is either rapidly deposited or, owing to the screening effect of turbid water, exposed to restricted wavelengths and low intensities of light.

Sediment grains behave like long-term radiation dosimeters, similar to the dosimetry badges worn by x-ray technicians. Luminescence is a measure of cumulative exposure to ionizing radiation after particles are buried and shielded from sunlight. Ionizing radiation (alpha, beta and gamma particles) comes mostly from the decay of U-238, Th-232, and daughter isotopes; from K-40, a radioactive isotope of potassium; and usually a minor contribution from cosmic sources. Electrons freed by ionizing radiation from the mineral lattice are subsequently trapped in crystallographic charge defects in quartz or feldspar minerals. When minerals are excited by a specific wavelength of light (blue, green, and infrared are most commonly used), stored-electron charges migrate to luminescence centers in the crystal lattice and emit a time-dependent light signal. The intensity of the light signal is calibrated in the labo-



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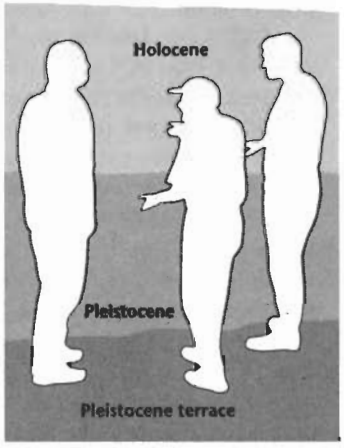
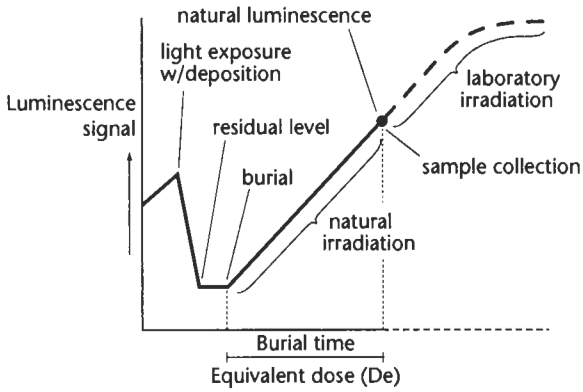


The Topper site in South Carolina in 1999. Steve Forman (*center*) examines the stratigraphic profile with excavation leader Al Goodyear (*left*) and TAMU geoarchaeologist Mike Waters. OSL dating by Forman helped establish the depositional history (*below*).



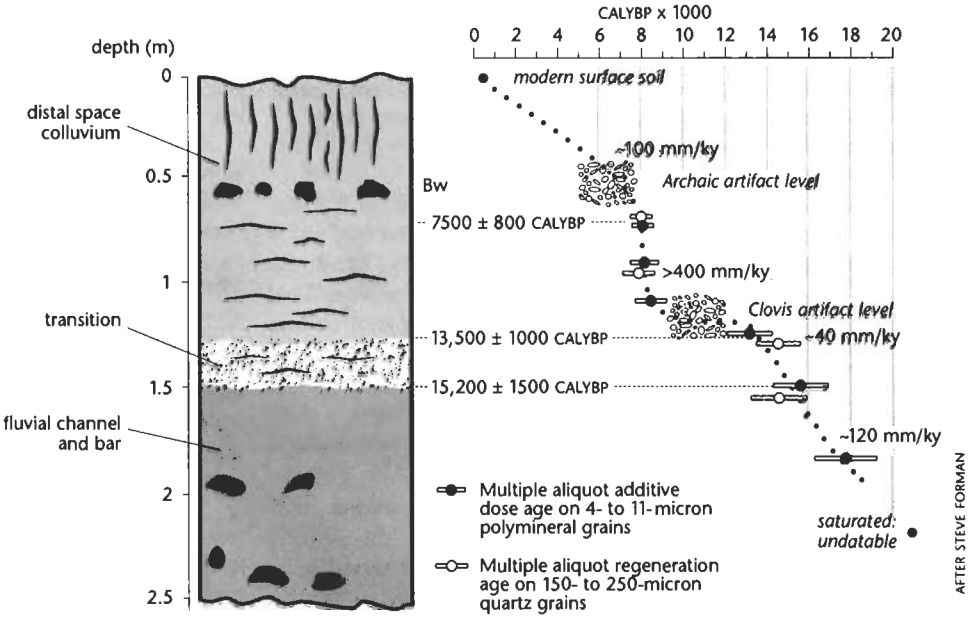
The luminescence geological cycle. Exposure to light reduces luminescence of mineral grains to a low definable level. After sediment is buried and shielded from light, environmental radiation imparts cumulative luminescence. The luminescence at the time the sample is collected is termed the natural luminescence. Laboratory irradiation added to the natural mineral grains defines a function, which is the basis for determining the radiation dose over the burial period.

ratory to an equivalent radioactive (often a beta or gamma) dose exposure measured in grays (100 rads = 1 gray). Determining this value solves half the OSL age equation. The other half is solved by estimating the dose rate (grays/ka), the environmental radioactivity the sediment sample was exposed to over the time it was buried. A critical component in accurately calculating OSL age is estimating the moisture content during the burial period, since moisture "dilutes" background environmental radiation. Often it is also necessary to determine if uranium or thorium has been mobile in the sediments; their presence, by altering the environmental dose rate, can degrade the precision of the calculated age.

Taking samples: some pointers, some caveats

Taking samples for luminescence dating is relatively straightforward, although particular attention must be paid to sedimentologic and archaeological contexts. Weathered horizons exhibiting pedogenic accumulations of clay, silt, and carbonate of silica must be scrupulously avoided, since post-depositional weathering can corrupt the luminescence time-dependent signal by altering the radionuclide concentration, by altering the crystal structure, and by translocating particles between younger and older sediments. Ideally, the sample stratum should be surrounded by at least 30 cm (about 12 in) of homogeneous sediments to insure a uniform dose rate environment. Avoid sampling within 30 cm of boulders or the surface; both are potential sources of inhomogeneous radioactivity.

The optimum sediment sample size is 30 g, although more or less may be adequate depending on the concentration of the particle size chosen for dating. It is well established that the geologic OSL signal of sediments is reset within seconds to minutes of exposure to sunlight; therefore *it is absolutely essential that sediments for OSL dating be totally shielded from light.* It is also essential to take all samples for OSL dating in the light of day so that the sedimentological and archaeological contexts are well understood. It isn't hard to take a sample from most stratigraphic settings without exposing it to light: just take an intact core, 3–10 cm (1.2–4 in) in diameter and 10–30 cm (4–12 in) long, from the target stratigraphic level. Although the end grains of the core may be exposed to light, there will be ample unexposed material in the interior for OSL dating.



This marvelous graph by Steve Forman tells the history of depositions and human occupations at the Topper site. The transition area, from about 1.25 to 1.5 m depth (about 4 to 5 ft), marks where deposits change from colluvium (slopewash) to alluvium (riverborne sediments). This graph is a pictorial history of the same events described as a narrative history in the sidebar "The Stratigraphy story at the Topper site."

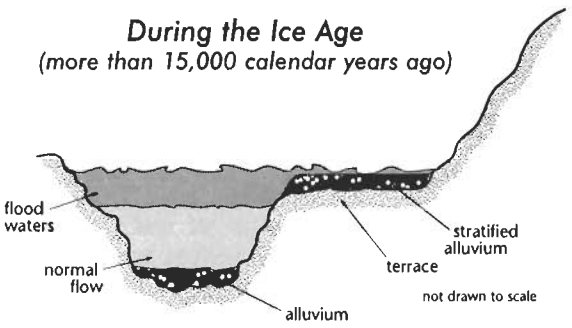
Take at least three samples for measuring age spread. Confidence in the calculated OSL age is greatest if the sample is accompanied by an additional 30–200 g of material, taken from a 30-cm radius around the target, for estimating the dose rate and for mineralogic and granulometric analyses if needed; this material doesn't have to be sealed from light or moisture loss.

In practice, OSL dating techniques vary according to particle sizes (generally ranging from fine silt to medium sand), mineralogies (quartz and feldspar), excitation wavelengths, and analyti-

The stratigraphy story at the Topper site

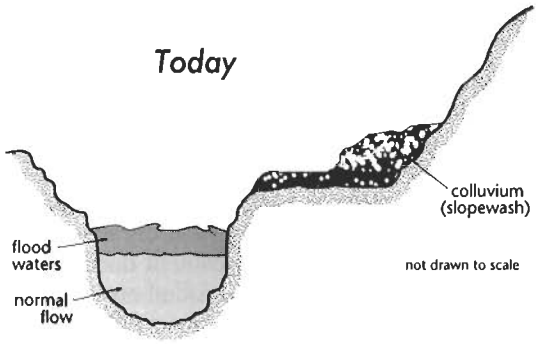
We first published this description in September 2001 with our story of the discovery of pre-Clovis materials at the Topper site (MT 16-4, "The Topper Site: Beyond Clovis at Allendale"). Since OSL dating by Steve Forman played a vital role in determining the geochronology, it seems worthwhile to repeat Dr. Goodyear's report here. –Ed.

IN 1998 when we first found evidence of possible human activity in the deeper levels at the Topper site, soil morphologist John Foss and I thought the entire 2-meter-deep deposit of sand had probably washed off the hillside and slowly covered the artifacts on the terrace below. Today when it rains you can see sands washing down the hill. The upper 2 m of sediment is virtually all quartz sand (like that found on the hilltop today), with little change in color or texture to allow detection of discrete depositional layers. Furthermore, there was no evidence of pedogenesis, or soil formation, within the sands even though thousands of years were indicated by the archaeology. To complicate things further, in the lowest meter there was no macroscopically visible charcoal or other organic matter to radiocarbon-date. In an effort to find charcoal, I window-screened the sands and recovered tiny pieces of charcoal suitable for AMS C-14 dating. Four samples yielded dates of less than 2900 RCYBP. Given the complete Holocene archaeological sequence lying above them, the dates represented small specks of charcoal that had blown in or fallen in from nearby surface layers. Although disappointing, the dates showed there was essentially no old charcoal in situ available for dating.



In order to document and date the stratigraphy, we turned to outside experts. Rob Bonnichsen urged me to contact Dr. Tom Stafford of Stafford Research Laboratories to come and collect radiocarbon samples. Dr. Mike Waters, geoarchaeologist at Texas A&M, offered his services, as did his colleague Dr. Steve Forman, a geochronologist and OSL-dating specialist at the University of Illinois–Chicago. In June 2000 these scientists, along with Dr. John Foss, project soil morphologist from the University of Tennessee, joined our team for an intensive geological study of the Topper site and nearby floodplains.

With the benefit of several deep backhoe trenches, they found clear evidence of fluvial activity in the lower portion of the sands. Small chute channels with gravels were found paralleling the



Savannah River, indicating river activity. These earth scientists learned that the approximate upper meter of sand was formed by slopewash, while the lower meter was formed or modified by river floods. Since the upper sands were colluvial in origin, they realized that OSL dating might work. An OSL date from the base of the colluvium came back 13,000–14,000 calendar years ago, which was in perfect agreement with the presence of Clovis-related bifaces also situated in that zone. (The Clovis culture dates from about 13,000 to 13,500 calendar years ago.) A few centimeters below that date another OSL date on the transition from colluvium to alluvium came back 15,000–16,000 calendar years ago. The majority of the pre-Clovis artifacts lie below that date and thus are older.

This geochronological finding is in agreement with the paleoclimate and Pleistocene river behavior in the Southeast. Prior to 16,000 calendar years ago, the climate was drier and cooler and rivers flowed at higher elevations owing to sediment-choked floodplains. As the earth warmed at the end of the Last Glacial Maximum around 15,000–16,000 calendar years ago, greatly increased precipitation in the South caused the major rivers to scour and incise their floodplains, lowering them to their present elevations. The Savannah River was thus no longer capable of flooding at the Topper site elevation; only slopewash gradually contributed sands to the terrace below. By the time Clovis people arrived to quarry chert at Topper, only the colluvial system was operative.

Clovis people and all subsequent prehistoric groups at Topper always utilized chert from river-smoothed cobbles available today in the modern Savannah River floodplain. But river-cobble chert and the large quartz-cobble hammerstones present in the river bottom today are absent from the pre-Clovis zone at Topper. These sources of fine-quality chert apparently were not available for human use prior to the great scouring of the Pleistocene.

Thus the plain sands at Topper finally told their story. The upper sands housed the Clovis through Mississippian cultures who lived in the Savannah River valley as we see it today. Underneath them were the stone tools of much earlier peoples who camped in and adjacent to the Ice Age Savannah River floodplain. Their secret remained hidden for over 16,000 years until in 1998, because of finds in Chile and Virginia, archaeologists dug a little deeper.

–Albert C. Goodyear


DARYL P. MILLER SCIAA-USC

Volunteer Ann Judd shows off the Taylor point she found at the Topper site in 2002. Ms. Judd, Executive Director of the American Red Cross National Testing Lab, is proof that Al Goodyear's volunteers aren't intellectual lightweights.

cal approaches. The coarse-grain quartz fraction (100–250 microns) and fine-grain feldspar-dominated fractions (4–11 microns) have proven to be the most consistent geochronometers, particularly for the past 100,000 years.

Putting theory into practice

A matrix of analytical approaches has been developed that can be tailored for dating samples from specific sedimentologic settings found at most archaeological sites. For example, we applied OSL dating to fine and coarse sediment fractions from slope colluvium and fluvial deposits at the Topper site in South Carolina (**MT 16-4,** "The Topper Site: Beyond Clovis at Allendale"), where there is a lack of radiocarbon-datable organic matter but a well-dated artifact-bearing horizon. In this instance, since both size fractions yielded similar ages that agreed with the known age of artifacts, we had high confidence in the geochronology. Detailed OSL dating of sediment sequences can provide insight into the ways natural and human processes influence the rate of sedimentation. At the Topper site, OSL dating detected an apparent period of rapid colluviation about 8000–7000 CALYBP; our finding coincides with a period of significantly increased precipitation inferred from previous geomorphic and paleobotanical studies.

OSL dating at an archaeological site can fix the age of artifact-bearing levels with remarkable precision and confidence. Moreover, it can increase our understanding of the processes that shaped the site. An invaluable tool in archaeological research because it can fill in many parts of the total geoarchaeological picture, OSL dating is poised to address many questions about the chronology of human activity in the late Quaternary.

–Steve Forman

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About the author Steven L. Forman, director of the Luminescence Dating Research Laboratory at the University of Illinois at Chicago, pursues a diverse research agenda that includes geoarchaeology, paleoclimatology, glacial geology, eolian depositional systems, hydrology, experimental geochronology, and luminescence dating. Dr. Forman regular teaches undergraduate courses in surficial processes and global climate change, and conducts graduate seminars in Quaternary environmental Systems, Quaternary geochronology, and paleoclimatology. He received a B.S. in Geology at the University of Illinois at Champaign-Urbana and in 1986 earned his Ph.D. in Geological Sciences at the University of Colorado–Boulder.

As a graduate student with NSF support, he studied a year in the Luminescence Dating Laboratory of Ann Wintle at the University of Cambridge, England. Forman later established one of the first luminescence dating laboratories in North America, applying luminescence dating methods to sediments from a variety of environments. This laboratory has developed luminescence techniques to date prehistoric earthquakes, flood events, glaciations, dune reactivation, and potentially the earliest humans in Eurasia and North America. Having pursued paleoenvironmental field work in the Russian Arctic since the early 1990s, Forman is one of the first Western scientists to conduct synergistic research with Russian counterparts. His most recent research focuses on applying luminescence geochronology to decipher the environmental history of the many stabilized and active dune systems in North America.

Forman has served on the editorial board of *Geology* for six years, was book review editor for *Quaternary Geochronology,* and is the appointed reviewer by the American Geological Institute for glacial geology entries in *Glossary of Geology.* He has written over 100 papers and book chapters. He has served on advisory panels for the Nuclear Regulatory Commission, NASA, and the NSF, and he chaired the NSF–Arctic System Science Initiative Russian-American Initiative on Shelf-Land Environments in the Arctic (RAISE). He received the Gladys W. Cole Research Award from the Geology Society of American, Quaternary Geology & Geomorphology Division, and he was granted the Committee for Institutional Cooperation Academic Leadership Fellowship and the inaugural Institute of Environmental Science and Policy Faculty Fellowship from the University of Illinois.


STEVE FORMAN

The Elusive Pollen Grain

by Vaughn M. Bryant

IT WAS A SULTRY June evening in 1971, with temperatures still hovering in the mid 80s, when I left the check-in counter at the Houston airport and started the long walk to the gate where a Braniff 707 would carry me to Miami, then south to Panama City and finally on to Lima, Peru. Walking through the airport, I kept getting stares from other passengers dressed in T-shirts, shorts, and sneakers. After all, I was dressed in long pants and a long-sleeve shirt and had a down jacket slung over my shoulder. I guess they suspected I wasn't headed for someplace else in Texas!

Plane flights from Boredom to Terror

After a brief stopover in Miami, the packed jet headed south for Panama. It was nearly midnight when we climbed above the clouds and the cabin lights dimmed. Some passengers tried to sleep while others tried to read.

It was raining when we landed in Panama. Most passengers deplaned for the two-hour wait before we left for Lima. The enclosure where we were confined was spacious, but hot and humid. Lacking air conditioning, the windows were open, but there was no cooling breeze as we listened to raindrops pelting the banana and palm leaves outside. Everyone smoked in those days, so soon the room was filled with a haze of cigarette and cigar smoke, which added to the discomfort of some.

At 39,000 feet, sunrise comes much sooner than on the ground. As we began our descent into Lima the plane's wings reflected brilliant sunlight into the cabin where passengers were beginning to stir and took turns heading for the small closet-size bathrooms in the rear. After being awake all night I was groggy, but tried to freshen up with cold water and a cup of hot coffee. I had grown up in various cities in South America, including Lima, but I had left there when I was only four. It would be fun to return, I thought, but I also knew that I wouldn't have time to see the sights before my next flight left for Ayacucho, high in the Andes.

ALL PHOTOS: VAUGHN BRYANT

"As all good archaeologists know," Bryant declares, "one gets up at or before dawn to go to work at sites!" He took this photo of a spectacular dawn from his bedroom window in Ayacucho.

I didn't get to see much of Lima as the plane descended because of "La Garuùa," the name they give to the fog that drifts in from the cold ocean and rolls up the western side of the Andes in an engulfing blanket. It was cold, dark, and foggy when we landed at the Lima airport, known for its Spartan facilities. That early Sunday morning there were no booths selling curios, food, or even magazines and newspapers, just rows of metal seats where weary travelers could stop and rest between flights. I made my way to the Lansa Airline booth, where a lone clerk in Spanish said my flight would leave on time in two hours. I hunkered down on one of the metal seats and zipped up my down jacket. The airport windows were open, and the fog crept in and settled on everything like a heavy dew. People passing by left footprints on the slippery black-tiled floor.

Two hours later I walked across the tarmac and up a metal ramp to board an old four-engine plane with faded markings. I hesitated for a few moments, wondering if I should board what looked like a WW II–surplus relic. Inside there were no carpeted floors. Instead of insulation on the walls, wires of all kinds ran in rows through holes in the fuselage ribs above the windows; the seats were anchored to rails on the aluminum floor with large wing nuts. In the back, rows of seats had been replaced with wooden crates of fresh produce for the trip to Ayacucho. As the plane lumbered down the runway, the noise inside the cabin was deafening. I had a window seat, but all I could see was the outline of a wing in the dense fog. Minutes later we suddenly climbed above La Garuùa and into a cloudless, brilliant sky. Below me lay the jagged slopes of the Andes with their thin ribbons of green in the narrow valleys formed by streams and rivers flowing toward the sea.

As the plane climbed higher and higher I zipped up my down

jacket, put on my hat, and stared out the window looking for any signs of life on the barren slopes below. I was still looking out the window when the stewardess tapped me on the shoulder and handed me the end of surgical tubing about 3/8 of an inch in diameter. I looked puzzled, so the stewardess pointed to the front of the plane where two large oxygen bottles were strapped to the wall next to the captain's cabin door. From there, a labyrinth of tubes like the one I was holding flowed down the center aisle to each seat. I knew the plane wasn't pressurized, so I suspected my labored breathing and the chill in the cabin meant we were climbing high over the Andes to reach Ayacucho. I put the tube in my mouth and inhaled the oxygen, and soon my head began to clear. I must have dozed off because when I awoke the plane was bucking from turbulence and the stewardess was yelling at some old Peruvian man across the aisle to put his seat belt on. Sucking on my tube, I looked out the window and watched the right wing bounce up and down as we hit air pockets. I closed my eyes and prayed, "God, please don't let the wing fall off this old crate!"

When I opened my eyes again, my window was streaked with oil flowing in a steady stream from both engines. I leaned forward and saw little rivulets of oil flowing from the sides of the engine cowlings and down the top of the wing. Looking down, all I could see was the jagged, snow-covered peaks of the Andes.

I couldn't leave my seat because of my oxygen supply, so I waved frantically to get the stewardess's attention. A few seconds later she was next to my seat wearing a portable breathing mask. I pointed at the oil on the window and yelled over the incessant roar of the engines, "*Mira, aceite!*" The stewardess took off her breathing mask and, smiling, leaned over and said loudly in Spanish, "The engines have enough oil to make it to Ayacucho." She then turned and calmly walked back to her seat in the rear of the plane.

She was right. A little over an hour later we landed on the gravel runway in Ayacucho. I have no fear of flying, but for once I was glad to get off an airplane!

Coca market at Ayacucho: burlap sacks of coca leaves sold by the gram (or handful). The black rock-looking object is a mixture of ash, lime, and salt. A piece of it was given with all coca-leaf purchases because you get none of the active alkaloids from chewing coca leaves unless you also chew a bit of the "rock."

To learn about the vegetation of the region so that he could make sense of pollen records he might find, Bryant investigated the High Puna near the Pikimachay site. Here he rests on the tundra near an ice-cold lake carved out by a glacier many years ago. The elevation was around 12,000–13,000 feet. At these altitudes, he notes, "I had to sit down and rest often."

A land lost in time

Ayacucho is located on a plateau about 9,000 feet high near the famous Pampa de la Quinua, where Simon Bolivar's troops sealed the independence of an entire continent on December 9, 1824, by defeating the Spanish army in the famous battle of Ayacucho. This town of nearly 60,000 had once served as the staging area for that battle, but today it was one of Peru's largest cities even though it had only 10 km of paved and cobblestone streets. The rest were gravel and dust.

Richard ("Scotty") MacNeish met me at the plane with his chain-smoking Peruvian driver, who picked up my bags and headed for a nearby Land Rover. Ten minutes later we were in front of a two-story concrete-block house with a red tile roof and small interior courtyard, the headquarters for the MacNeish archaeological team. I was dead tired, but too excited to sleep, so Scotty took me on a walking tour of downtown Ayacucho, located only a kilometer away.

The city center was an interesting place. There were rows of small shops along both sides of the narrow cobblestone street leading to the central plaza with its benches, greenery, and large Catholic church at one end. Old cars, diesel-belching buses, wooden pushcarts, and a steady stream of llamas loaded with all sorts of goods inched along the street and around the plaza. Along the sidewalks and in the plaza were barefooted women wrapped in hand-woven blankets with black bowler hats on their heads and colorful slings around their necks cradling small babies that looked no larger than toy dolls. Scotty and I aren't tall men, but we towered over the local Indians, most of whom were barely five feet tall. Along one side of the plaza were women vendors sitting on flattened cardboard boxes selling potatoes, quinoa seeds, alpaca blankets and an array of other food items, cigarettes, live guinea pigs, and open burlap sacks of beans, dried corn, and wheat. As we walked along I noticed one woman doing a brisk business selling leaves that she would carefully wrap in pieces of old newspaper. With each

sale she would hand the customer a small chunk of black material that she would break off from what looked like a large black salt lick. I asked her in Spanish what she was selling. She looked up with a stare that suggested she didn't hear me, so I repeated my question, but still got no reply.

"She probably only knows Quecha," Scotty said between puffs on his cigarette. In the weeks to come I discovered that neither Spanish nor English was of any use once I ventured into the countryside. Most of the time I had to take a translator with me who could speak Quecha and Spanish.

Scotty MacNeish standing on boulders from a massive roof collapse at the Pikimachay site. Found in strata near the bottom of a nearby excavation pit were broken bones associated with objects he identified as human tools made from tufa-type stone. Radiocarbon dating put the age of the bone fragments at about 17,500 calendar years old; MacNeish estimated the age of the bottom layers at about 20,000 years old. Tufa, a coarse granite-like rock of volcanic origin, is prevalent in the region. "The flaking on the tools was hard for a non-expert to recognize," Bryant admits. "They just looked like broken rocks to me."

I examined several of the leaves carefully. "My God!" I said to Scotty, "these are coca leaves and she has several twenty-pound bags of them!"

Scotty just laughed, "All the locals up here chew this stuff; it deadens hunger pains. See that black rock-looking stuff? That's a mixture of ash, lime, and salt. You have to chew it with the leaves to get any effect."

I bought a small handful of the leaves, got a small piece of the black rock, and tried it. After a few minutes my mouth and lips got numb and I began to drool black liquid from the corners of my mouth. I spit it out and decided I would rather eat food to deaden hunger pains.

I don't remember much more about that first day except that I fell asleep fully clothed and wrapped in a blanket on my cot sometime that afternoon.

Bryant points to the remains of a burned sloth rib in the profile of one of Scotty MacNeish's main excavation pits. The bone, later radiocarbon dated to about 15,000 RCYBP (about 18,000 CALYBP), is supporting evidence for MacNeish's argument that Pikimachay was occupied by some of the very first Paleoamericans.

The next morning, when someone knocked on my bedroom door, I looked out my window and could see peeking over the distant mountains the first rays of sunrise that made an arc in the sky like the background in one of those religious paintings of Jesus. After a quick breakfast and strong Peruvian coffee, Scotty rounded up the rest of the crew and we were off to the cave site of Pikimachay about 25 km north of town.

Another harrowing journey—this time by truck

I had slept in my down jacket and still had it on as I headed for the truck. As I labored to breathe at the high altitude, small puffs of steam formed in front of my face in the chill winter air.

I was in the lead pickup sitting in the front seat next to the chain-smoking Peruvian driver while six other Peruvian workers huddled in the truck bed next to screens, buckets, shovels, and ladders. Behind us in the Land Rover were Scotty and several visiting archaeologists from England. Bringing up the rear was another pickup with the rest of the Peruvian workers.

There is only one narrow gravel road up the mountain from Lima to Ayacucho, and we were speeding on it down the mountain to the site. Lima is about 500 km east of Ayacucho, but it's a 12-hour, bumpy drive—provided there is little traffic. In most places the road narrows to a single lane barely wide enough for a bus or truck, but it widens every few hundred yards so that two-way traffic can pass. The road is cut into the side of a steep mountain. Every curve has a bad washboard ripple and no guard rail along the outside edge.

As we bucketed down the road I peered out my window and looked almost straight down at a long talus slope that ended at a small stream thousands of feet below. There were no trees, only gravel and large boulders on the slope. "My God!" I yelled in Spanish on every curve when the truck's rear end would buck and skid on the washboard surface. "Slow down," I pleaded in Spanish to the driver, who just kept puffing away on a hand-rolled cigarette. "What if someone is driving up the mountain? You'll hit them because it's too narrow for two cars to pass!"

He just smiled and without ever removing his cigarette whispered, "No problem, it has never happened!" His reassurance was little comfort. I knew if it happened we would end up a wrecked pile at the bottom of that steep ravine, just like the many

rusting and crumpled trucks and buses I saw in the rocky streambed as we whizzed around one curve after another. Driving to and from the site was like parachute jumps. I knew all it took was one mistake.

A site rich in prehistory

Pikimachay is a large solution cave hollowed out of limestone about 900 feet below the top of a mountain. I could see the cave clearly from the small side road where we parked. Below the cave were concentric rings of stone walls about 3 feet high. Behind the walls were flat, narrow bands of slope-washed soils where fields of corn, gourds, beans, potatoes and quinoa once grew.

We parked, unloaded, and began walking up a narrow trail to the site. Inside in front were the remains of massive roof falls, with boulders weighing dozens of tons. Thirty feet above the boulders the soot-darkened ceiling arched in a graceful curve until it reached the back of the cave some 180 feet away. On one side near the middle of the cave and in back were several large square pits where the team had begun excavations the previous summer and now continued to dig. The largest pit, next to the roof fall, was about 9 feet wide and 12 feet deep. The straight walls had many rows of parallel scars where iron stakes had been driven into the hard layers to loosen the dirt for screening. These ended at the uneven surface of the cave's bedrock floor. Soon one of the workers arrived and slipped a ladder into the pit so that Scotty and I could climb down and stand on bedrock.

Bryant collects dirt samples from early-Holocene levels of an excavation pit at the Jayamachay site, while Scotty MacNeish behind him describes what he had found at different levels. Like Pikimachay only a few miles away, Jayamachay revealed a long record of human occupation. When Bryant later examined the dirt samples in the laboratory, however, he was unable to find any preserved fossil pollen. He would experience such disappointment many times in his 30-year career in palynology.

I watched him point to one feature after another as his trowel followed along various unevenly drawn lines that defined each zone. "Before we began, it took us several weeks to blast and chisel away a giant boulder that covered this spot," Scotty said. "Next we had to drive steel rods down a few inches at a time to pry loose the calcified soils. It was tough going and took us all summer, but it turned out to be our best pit because we could be certain there was no mixing by rodent burrows."

I was spellbound at Scotty's explanations and by the remains of sloth and horse bones still visible in the sides of one wall. "See this sloth rib?" he said with a smile. "It's burned, and pieces of it dated over 15,000 years old. I'd like some of those Clovis-First boys to try to explain this one!" He chuckled. "Either people built a fire and ate barbecued sloth ribs, or a sloth was hit by lightning, ran into the cave while he was still on fire, and then sat down in a pile of wood that somehow caught fire and burned him to a crisp!"

The mission: Collecting evidence of the earliest New World cultivation

For the next few months I spent much of my time studying the regional vegetation, from the high Puna at 15,000 feet, where the ground was frozen a few inches below the surface, down to the nearby river valleys, where narrow bands of vegetation clung tenaciously to the thin layers of soil. I also visited a host of other archaeological sites Scotty had tested, which he believed would help unravel the mysteries of when and where the first peoples lived in South America and where they would later begin domesticating plants and animals. Throughout that summer I collected a suitcase full of soil samples from excavation pits, from features, and from surfaces in and around the caves. I also collected bags full of suspected human coprolites (preserved feces) and took copious notes about the vegetation.

It was an exciting time in the early days of my career. I was a trained palynologist being given an opportunity to work at what many believed would become the key archaeological sites and region in South America. Scotty MacNeish's name was legendary after his recent discovery of agricultural origins in Mesoamerica at sites in the Tehuacan Valley of Mexico. Using fossil pollen as an interpretive tool in archaeology was still in its infancy, yet Scotty believed it might prove useful and thus had invited me to Peru as part of his archaeological team.

In late summer I packed my bags and four additional suitcases full of dirt and coprolites for another hair-raising plane ride back to Lima. That flight back to Lima, and then trying to get through U.S. customs with four suitcases full of dirt and coprolites, is another story worth telling someday. But not now.

Unexpected results back in the lab

During the next year our pollen lab buzzed with excitement as we carefully and painstakingly unwrapped and processed each sample searching for fossil pollen. Sample after sample told us nothing because each was void of fossil pollen. Where, we wondered, was the fossil pollen? Since the Peruvian surface samples were full of exotic pollen types from South American plants, we knew the samples must have contained pollen at one time. Had we committed errors during our extraction process in the lab? Could we have accidently destroyed the fossil pollen? Carefully we checked and rechecked our samples and procedures.

Finally, when all the samples were finished, we conceded defeat. Except for pollen in some of the coprolites and surface samples, all the other archaeological dirt samples were empty.

Gone was my hope for fame and immortality. I had hoped to

be able to announce to the world the finding of the earliest plant cultigen pollen in the New World. I had hoped to be the first to report on the environmental changes in the Andean region of South America during the late Pleistocene and early Holocene. I had hoped to link my name and research to the many articles and later books that were being written about these famous Peruvian sites. But with no pollen story to tell, I knew I was out of luck.

Ayacucho was to become the first of many disappointments while searching for pollen at sites linked to the Paleoamericans. After Ayacucho I examined numerous soil samples from the Marmes site in Washington State. A decade later Scotty MacNeish gave me samples he had saved from Tehuacan, Tamulipas, and other sites in northern Mexico. During the 1980s, James Adovasio asked me to examine a long sequence of soil samples from the Meadowcroft site in Pennsylvania. Throughout the 1980s I repeatedly sampled profiles of the Lubbock Lake site on the High Plains of Texas and collected and examined soil samples from the Wilson-Leonard site near Austin, Texas. In the late 1990s I collected and examined more soil samples from early cultural levels at the Gault site in central Texas.

Not one of those hundreds of soil samples contained enough fossil pollen to reconstruct any type of important information.

Fossil pollen, an elusive witness

Because fossil pollen can be found by the millions of grains in some deposits and disappears completely in other soils, I have spent more than 30 years searching for the reasons why pollen is preserved in some deposits and disintegrates in others. I haven't worked alone in this quest; others have also searched for answers. Today our combined efforts give us a better idea why fossil pollen is recoverable in some regions and from some soils of the world but not in others. Unfortunately, many of the Paleoamerican sites fall into the "others" group. Bonfire Shelter, as I noted last time (**MT** 18-2, "Pollen and the First Americans"), is one of the few exceptions where fossil pollen could be recovered and where it helped unlock some important mysteries.

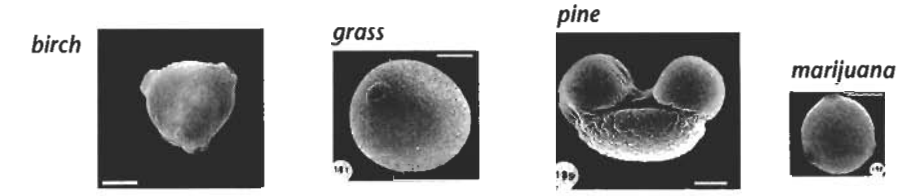
We now know that most open sites, regardless of geographical location, are poor places to hope for fossil pollen recovery. This doesn't mean that the search for fossil pollen should be abandoned at "all" open sites. Instead, it means that most searches will end in disappointment. The soils in open sites are subjected to repeated cycles of wetting and drying, which we have discovered will quickly destroy fossil pollen. The thin walls of pollen, whether fresh or fossil, are like a sponge that will expand or contract, depending on the available moisture. A sponge is soft, and repeated wetting and drying cycles don't injure it. But pollen walls are more brittle, and as they expand and contract they act like a wire bent back and forth until, at some point, it fatigues and breaks. Like an egg, a pollen grain is strong until it is cracked. Once cracked, pollen grains disintegrate into tiny, unrecognizable pieces. Experiments also reveal that a number of microbes (bacteria and fungi) feed on the cytoplasm inside fresh pollen. As they enter pollen grains, they often damage or crack the grain walls. Some tests reveal that even after pollen grains become fossilized, some forms of bacteria will attack the walls in search of nutrients.

Soil pH and Eh also play key roles in determining whether pollen is preserved or destroyed. Soil pH (the ratio of positive H^+ ions to negative OH^- ions) can be negative, positive, or neutral. As the pH, or positive factor, increases, the soil becomes more alkaline and fossil pollen destruction increases. When soil Eh (oxidation/reduction ratio based on oxygen diffusion) is high, it signifies an abundance of oxygen; as aerobic conditions increase, fossil pollen destruction increases.

Finally, there are genetic factors that determine the characteristics of individual pollen grains—how large, strong, thick, and durable they are. Some plants produce very fragile pollen grains that disintegrate quickly even under favorable environmental conditions. Other plants, on the other hand, produce very thick and strong pollen grains that often can be recovered even from some of the harshest soil environments.

Honing our skills at predicting fossil pollen success

Before undertaking fossil pollen studies of any archaeological site, it's essential to



The prize denied at Jayamachay and Pikimachay: fossilized pollen.

Bryant failed to find evidence of ancient pollen in Pleistocene soils in Peru. He would experience repeated disappointments in his career before learning under what conditions fossil pollen, like these samples, is preserved.

Bryant defines fossil pollen: "When a pollen grain is released from its anther we call it a 'fresh' pollen grain. Once it is no longer viable and becomes part of the sediment, we call it a 'fossil' pollen grain. However, when we collect 'fresh' pollen and then subject it to a number of acid treatments in order to remove the cytoplasm and surface waxes and oils, then we call those processed pollen grains 'fossil.'"

These photos, taken with a scanning electronic microscope (the white bar in each photo is equal to 10 microns, or 0.01 mm), are by the authors of *Pollen of the Southeastern United States*. (See Suggested Readings.)

have a thorough knowledge of soil composition and chemistry, environment of deposition, possible climatic cycles during the past, and the potential for soil microbe growth. Once these factors are known, we can often make a fairly accurate guess about the chances of recovering fossil pollen.

So where are the places where we stand the best chance of finding the remains of Paleoamericans associated with well-preserved fossil pollen? Ideal locations are where the soils are powder dry and haven't been exposed to cycles of wetting and drying. Underwater sites (anaerobic locations) are also excellent, especially if the water is near freezing; sites that have been locked in ice for centuries often produce pristine samples of fossil pollen. Sites like Monte Verde in Chile, where bogs have covered the site, usually produce excellent fossil pollen records.

In over 30 years of searching for fossil pollen at Paleoamerican sites I have only been lucky once, at Bonfire Shelter, yet I remain excited and optimistic. During the past several decades we have expanded our search for fossil pollen to include phytoliths (diagnostic silica plant crystals), which preserve under a different set of soil conditions than pollen does. In this century we are adding the search for reserve starch grains (water-insoluble granules produced in copious numbers by some types of plants) and for traces of DNA in our quest to unravel the mysteries of the past.

I firmly believe the best is yet to come. More than 30 years ago when I began my studies, one of the newest techniques was searching for fossil pollen. We still search for fossil pollen at Paleoamerican sites, but now we have a larger arsenal that includes phytoliths, starch grains, and DNA.

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Congressional Intent

continued from page 2

general, those are older remains, gathered for study to piece together the millennium of our unknown beginning. *We do not intend in any way to interfere with this study and science in the bill*" (italics mine).

The Native American community was not entirely silent on the issue of ancient remains, either. They too attempted to get an idea of Congressional opinion as to how the legislation applied to ancient remains. One example of this is implicit in the testimony of Walter Echo-Hawk before several House of Representative committees 20 July 1989. Mr. Echo-Hawk urged Congress to address the disposition of all human remains. The House committees responded by immediately resuming the questioning U.S. Army collection activities in the 19th century.

Various attempts by the testifying parties to get Congress to consider the question of the age of remains and the application of NAGPRA resulted in two generalizations in the legislative history. First, Congress intended for NAGPRA to redress the racism of some 19th-century scientists by returning affiliated remains collected from battlefields of the Indian Wars. Second, Congress did not intend for NAGPRA to affect scientific inquiry into the ancient history of the United States. However, the question of the age of human remains under NAGPRA cannot, in isolation, be used to infer how Congress intended that the law apply.

The second necessary component of the analysis of which human remains Congress intended NAGPRA to apply to is the issue of cultural affiliation. Unfortunately, despite attempts by anthropologists and Native Americans alike to get Congress to address the issue on the record, the question of what Congress means by "cultural affiliation" was left largely unresolved prior to the passage of NAGPRA. Section 2(2) of NAGPRA, however, contains a definition of cultural affiliation: "'Cultural affiliation' means that there is a relationship of shared group identity which can be reasonably traced historically or prehistorically between a present day Indian tribe or Native Hawaiian organization and an identifiable earlier group." However, as the Kennewick Man situation illustrated, where remains are extremely ancient, demonstrating shared group identity becomes difficult.

In the absence of explicit legislative intent in the law, courts often must consider the totality of the context surrounding the creation of a law to divine the intent of Congress. In the *Bonnichsen* case, Judge Jelderks filled this gap in the legislative record by stating that "cultural affiliation" requires evidence of cultural continuity between the ancient group represented by the remains and a modern group. This interpretation of NAGPRA is certainly consonant with the concerns voiced by the Native Americans and the anthropologists testifying before Congress. Examples of these concerns were outlined by Lionel John of the United South and Eastern Tribes in his testimony before Congress. Mr. John was concerned that people making claims for remains "may not necessarily possess the credentials for such claims." Similarly, anthropologists were concerned that human remains might not be accorded due respect if they were returned to the wrong group. Senate Report No. 101-473 seems to acknowledge this concern; it supports the interpretation of cultural affiliation by Judge Jelderks by stating that "the requirement of cultural continuity between present day Indian tribes and materials from historic or prehistoric Indian tribes is intended to ensure that the claimant has a reasonable connection with the materials."

The foregoing review of the legislative history of NAGPRA demonstrates that Congress *was* explicit in its intent that NAGPRA is not to apply to remains that are too ancient and too culturally attenuated to be considered "culturally affiliated" with any modern Native American groups. This intent applies not only to cases such as Kennewick Man, which was discovered in the field after the enaction of NAGPRA, but also to those collections that were excavated prior to NAGPRA and are currently housed in scientific institutions. The Congressional intent for NAGPRA that takes shape after a detailed review of the legislative history is clear: NAGPRA is not intended to interfere with the scientific study of our nation's ancient past.

The opinions expressed in this article are solely those of the author and do not reflect the opinions of the Louisiana Sea Grant Legal Program.

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About the author Ryan M. Seidemann is employed by the Louisiana Sea Grant Legal Program. In 1996 he earned a B.A. in anthropology from Florida State University. Ryan received an M.A. in anthropology from Louisiana State University in 1999 and finished his Juris Doctorate and Bachelor of Civil Law degrees at the Paul M. Hebert Law Center, Louisiana State University, in 2003. Ryan's research interests in anthropology include skeletal analysis, pre-Columbian Caribbean voyaging technology, and cultural expression in cemeteries. Ryan has published the results of his research in the *American Journal of Physical Anthropology*, *Journal of Forensic Sciences*, *The Florida Anthropologist*, and *Norsk Geografisk Tidsskrift*. Ryan, together with his anthropologist/embryologist wife, Ericka, serves on the Baton Rouge Mid-City Historic Cemeteries Coalition Advisory Board. In addition to his anthropological research, Ryan has also researched such legal issues as wetlands preservation, the Native American Graves Protection and Repatriation Act, and the Abandoned Shipwrecks Act. The results of this research have appeared in or are in press with the *Journal of Environmental Law and Litigation*, *Louisiana Law Review*, and *Louisiana Coastal Law*.


ERICKA SEIDEMANN

Most recently, Ryan has drafted several bills on oyster harvesting that are being considered by the Louisiana Legislature in the 2003 Session, authored a manuscript on the Kennewick Man case that is in review for publication and is the basis for this article, and (with Ericka) presented the results of New Orleans cemetery research at the American Culture Association meetings.