MAMMOTH TRUMPET

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Center for the Study of the First Americans
Department of Anthropology, Texas A&M University
College Station, TX 77843-4352

Rock Art—Beautiful, but How Old?

CAROL DIAZ-GRANADOS

Marvin Rowe, professor of chemistry at TAMU, is shown here collecting paint samples from a pictograph at Picture Cave in Missouri. Dating ancient rock art, Rowe cautions, involves more than just ordering radiocarbon-dating tests on scrapings of pigment or charcoal. Rowe and doctoral student Karen Steelman, who use plasma chemistry and AMS radiocarbon dating in their lab, describe alternative methods for teasing a reliable age from rock art, including TL, OSL, ESR, and variants of radiocarbon dating. Examples where tests have yielded suspect or outright false results prove their point, that independent verification is an indispensable part of the dating game. Read their story on page 4.

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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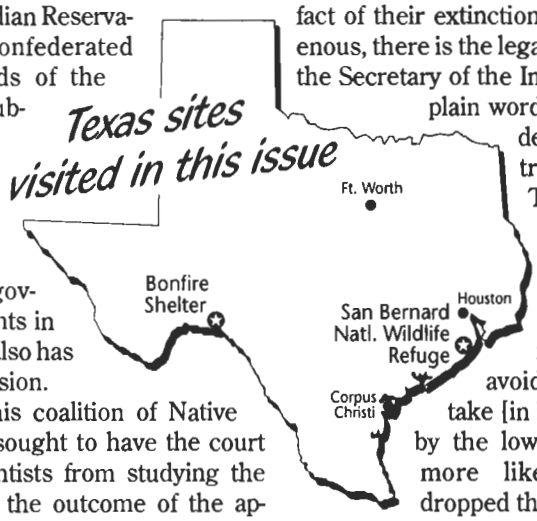
NATIVE AMERICANS APPEAL KENNEWICK MAN DECISION

by Bradley T. Lepper

In the wake of Magistrate Jelderks's August 30 decision to grant the request of Rob Bonnichsen, Director of the **Center for the Study of the First Americans,** and seven other plaintiff scientists to study the remains of Kennewick Man, a coalition of four Native American tribes applied for the right to appeal the decision to the United States Court of Appeals for the Ninth Circuit. This was granted, and the Confederated Tribes of the Colville Reservation, the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes and Bands of the Yakama Nation submitted their notice of appeal. The U.S. Department of the Interior, along with the other government defendants in the original trial, also has appealed the decision.



In addition, this coalition of Native American tribes sought to have the court prohibit the scientists from studying the remains pending the outcome of the appeals. Jelderks denied the motion to postpone the research, but the tribal coalition has now appealed that decision to the U.S. Court of Appeals for the Ninth Circuit.

"Native American"—according to NAGPRA

In its appeal, the tribal coalition argues that Jelderks "erred in rejecting DOI's definition of 'Native American.' " It argues that when Congress defined Native American as "of or relating to, a tribe, people or culture that is indigenous to the United States," they actually meant to include tribes that "were" indigenous as well. Leaving aside the tactical question of how a federal agency might determine which modern tribe could be culturally affiliated with human remains belonging to a group that was, but by the fact of their extinction no longer is, indigenous, there is the legal issue of the right of the Secretary of the Interior to change the plain wording of the law in order to support a contrary interpretation. The tribal coalition claims that the Secretary "dropped the words 'that is' during the formal rule-making process to avoid precisely the mistake [in interpretation] made by the lower court." It seems more likely the Secretary dropped the offending words to correct a mistake he believed Congress had made. Paula Barran and Alan Schneider, attorneys representing the scientists, point out in their response to the tribes' motion that "no matter how serious an asserted problem may be, it is not up to a regulatory agency to undo what Congress chose to do."

The tribal coalition is concerned that the court's definition of Native American "greatly narrows NAGPRA's scope." It would be fairer to say that former Secretary of Interior Bruce Babbit's blatant rewriting of the statute constituted an illegal attempt to broaden greatly the scope of NAGPRA. Jelderks's ruling restores the balance between the interests of Native Ameri-

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cans and the equally legitimate interests of scientists and the general public that Congress originally intended.

The Native American tribal coalition also argues that

- Jelderks "wrongfully applied the APA's [Administrative Procedure Act's] prohibitions on ex parte communications to prevent informal communications between DOI and the claimant tribes."
- Jelderks "narrowly interpreted NAGPRA to prevent joint claims for repatriation even though the Secretary had concluded, based on legislative history, that joint claims for repatriation are permissible under NAGPRA."
- Jelderks misinterpreted cultural affiliation "to require a degree of specificity approaching scientific certainty" when NAGPRA specifically refers only to a "preponderance of evidence."

Barran and Schneider respond that

- The "informal communications" between the tribes and the DOI involved "coordination and close cooperation" that "was so pervasive the District Court characterized it as collusion."
- The plain language of NAGPRA precludes joint claims, and as they have pointedly argued in previous court documents, a record of prior violations of the law does not justify continued violations.
- The Secretary's determination of cultural affiliation was based almost solely on the "extraordinary" claim that "oral history can be used to span nearly 500 generations." Oral tradition is one line of evidence that can be used in making a NAGPRA claim, but the bulk of the evidence in this case indicated no demonstrable cultural affiliation between Kennewick Man and any modern group.

Balance of harm and the public interest

The Native American coalition argues that its members have "a proprietary and deeply personal stake in the protection and preservation of the Ancient One"—their name for Kennewick Man. It believes it will win the appeal and that the scientists should be kept from conducting any research on the remains until and unless their appeal is denied. The tribal coalition asserts that a delay "will cause no injury to the scientists," but if the scientists are allowed to proceed, then the ultimate victory of the tribal coalition "will be a hollow one as the studies the Tribes had sought to prevent since entering the litigation would have already occurred." The balance of harm, then, tips in their favor.

Barran and Schneider respond by listing the "immediate and direct" harm that will come to the plaintiff scientists if they continue to be barred from studying the skeleton. For example,

- Denial of access to the skeleton affects the scientists' ability to synthesize and publish comprehensive comparative studies of early New World skeletal remains.
- "Denial of access to the skeleton affects teaching responsibilities."
- "Denial of access to the skeleton has led directly to the loss of research funding."
- "Lack of access to this skeleton impedes plaintiffs' ability to generate and test new ideas and to develop new avenues for research."

Moreover, the studies the scientists contemplate will only entail minimal damage to the bones of Kennewick Man. The samples the scientists plan to extract are 40 times less than the amount already taken by the Department of the Interior for destructive testing. And, as Barran and Schneider point out, the Native American tribal coalition "did not seek to intervene in the lawsuit to stop the study of the skeleton by the government. . . . As long as scientific study of the skeleton was being used to validate their claim, they supported it."

The tribal coalition argues for its members that the "spirit of the deceased" will

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be harmed if the scientists are allowed to undertake this "invasive and destructive" research. It states, as "a tenet of their beliefs," the claim that those "who have passed on are not to be disturbed and are entitled to a deference in which there should be no disruption of their resting place and their remains." Absent a demonstration of cultural affiliation, however, why should it be assumed that their religious beliefs applied to Kennewick Man?

The balance of harm appears weighted heavily in the plaintiffs' favor, and this does not take into account the public interest. Barran and Schneider affirm that "the interests of the general public in study of archaeological resources is articulated in law and regulations which, as the District Court pointed out, are 'clearly intended to make archeological information available to the public through scientific research.' "

Department of the Interior Appeal

The Department of the Interior has not yet proceeded with its appeal, nor have its attorneys asked the court to keep the scientists from studying the skeleton. The Native American coalition has stated, without contradiction, that the DOI "had no objection" to their request to halt the research pending the outcome of the appeals process. Unless the Court of Appeals steps in and calls a halt to the research, Bonnichsen and his colleagues should be able to proceed with their studies. The Department of the Interior, however, has not agreed to give the scientists access to the skeleton. Barran and Schneider state that "to date, the government has refused to allow plaintiffs even to inspect the skeleton, and there is no indication of when they will permit actual study to begin."

Alan Schneider admits, "This thing is not over by any means." But he isn't discouraged. "The tribes are going to have a difficult time convincing the 9th Circuit that this trial court, that saw the case for six full years, is so wrong they should reverse his ruling." Moreover, the tribes are "running a major risk of converting what otherwise would be a local decision into a precedent . . . that will become law for the entire 9th Circuit."

The full text of the Joint Tribal Claimants Memorandum to Intervene and the Plaintiffs' Reply Memorandum can be found on the Friends of America's Past Web site www.friendsofpast.org/ Updates on the appeals process also will be posted on this site. Other useful sources of information are the *Tri-City Herald* Kennewick Man Virtual Interpretive Center at www.kennewick-man.com/ and the National Park Service Kennewick Man pages www.cr.nps.gov/aad/kennewick/index.htm One of the best sources of background information on the Kennewick Man story is Jim Chatters's book *Ancient Encounters: Kennewick Man and the First Americans* (New York: Simon and Schuster, 2001).

Your phone call to the CSFA office will probably be answered by a voice straight out of the Heart of Texas. That cheerful voice, and this pixie face, belong to **Laurie Lind,** who has taken charge of filling book orders, straightening out subscription snafus, and generally making all of us associated with CSFA look a lot better than we deserve. Her charming accent is congenital—it comes with being born in Bryan, just down the road from College Station. Her awesome efficiency comes from years of experience at making sense out of confusion at the Smithsonian, the San Antonio Museum of Art, her sister's off-campus book store, and (once upon a time) the Texas Agricultural Extension Service at TAMU. Chuck, Laurie's husband, works in the shop that prints publications for the Extension Service. For fun he's a woodworker, and so is she—because she likes the woodworker. Lucky fellow. *–JMC*

COMING CONFERENCES

May 23–26 2003 Annual Meeting of American Rock Art Research Association, hosted by the San Bernardino National Forest and California State University. The meeting will be held at the California State University Campus; the host hotel is the San Bernardino Quality Inn. Schedule: ▪ Saturday, May 24: Reception at the San Bernardino County Museum ▪ Sunday, May 25: Banquet featuring internationally known archaeologist Christoper Chippindale ▪ Monday, May 26: Field trips to sites in the area. Call for papers in the traditional format for rock art research and recording; papers will be presented May 24–25. Deadline for registration is March 15.

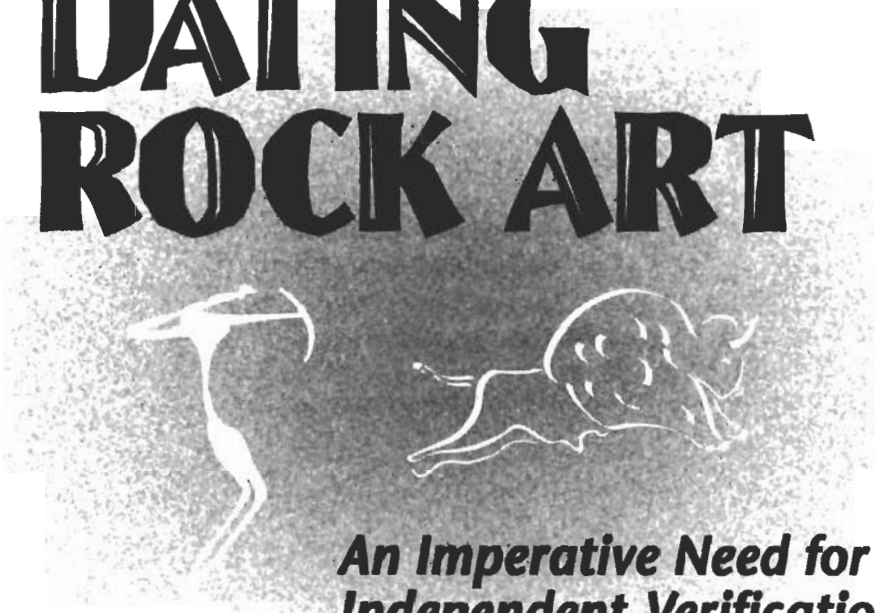
Contact: Program chairman Mavis Greer, 2599 So. Paradise Dr., Casper, WY 82604, e-mail mavis@GreerServices.com Direct e-mail inquiries to stick711@worldnet.att.net

May 24–29 2003, 3rd International Mammoth Conference, Dawson City and Whitehorse, Yukon Territory. Topics include mammoths and their environment (evolution and phylogeny, ecology and physiology, and indicators of late-Quaternary climate change); special preservation of remains in the Arctic/Subarctic; and mammoth faunas. Planned activities include an evening reception at Beringia Centre, Whitehorse; technical sessions at Dawson City; and a Klondike field trip.

Contact: Beth King, phone 1-867-667-5386, fax 1-867-667-8023, e-mail beth.king@gov.yk.ca; or John Storer, phone 1-867-667-8089, fax 1-867-667-8007, e-mail jstorer@gov.yk.ca. For registration fees, deadlines, and other information check Web site www.yukonmuseums.ca/mammoth/index.htm

Send conference notices to Editor, Mammoth Trumpet, 93 Range Road, Blue Hill, ME 04614; e-mail wordsmiths@acadia.net

DATING ROCK ART



An Imperative Need for Independent Verification

by Marvin W. Rowe and Karen L. Steelman

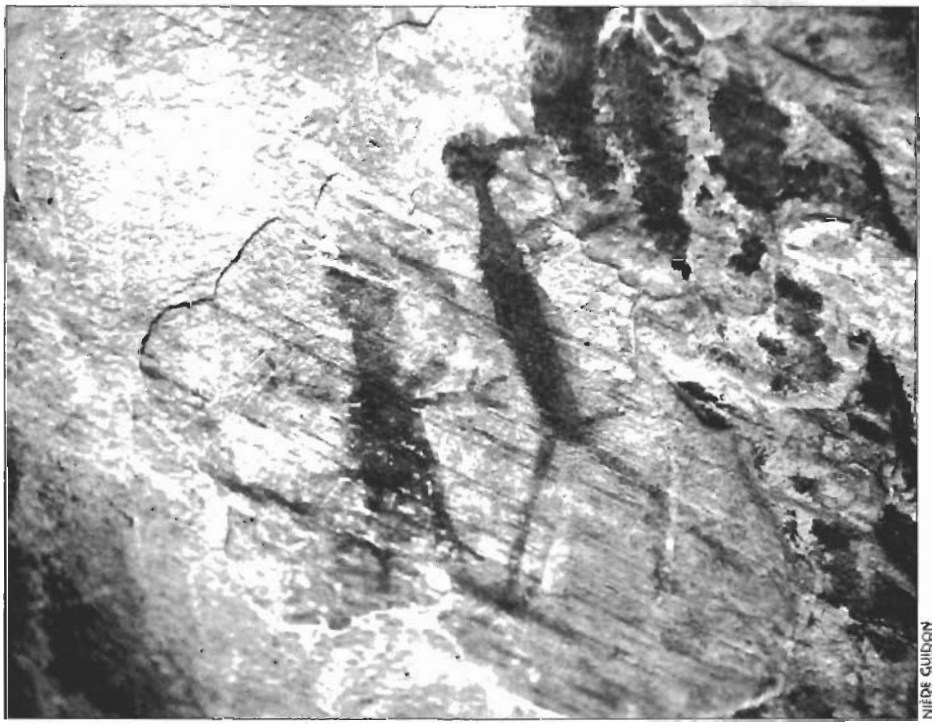
UNTIL RECENTLY, rock art was largely subjugated to the role of providing pretty book covers. That situation was dictated by two assumptions held by most archaeologists: it was thought impossible to date rock art directly or to ascertain meanings behind paintings. Although advances have been made in interpreting rock art images in many locations, our research and this article concentrate on dating pictographs.

Introduction of accelerator mass spectrometry (AMS) in 1982 greatly reduced the amount of carbon necessary for radiocarbon analysis, making it possible for the first time to date small paint samples. For radiocarbon (^{14}C) to be used as a chronometer ("clock"), paint must be composed of organic material temporally related to the painting event—charcoal pigment, for example, or an organic binder/vehicle added during paint manufacture. Since 1990, over 300 radiocarbon dates have been obtained on rock paintings. We focus on rock paintings (pictographs), an area where more progress has been made than with rock carvings (petroglyphs). Whether petroglyphs can be reliably dated is a contentious issue at present.

Radiocarbon-dating techniques in rock art

Material analyzed for radiocarbon dating must relate to the event of interest. To date the creation of a painted image on a rock surface, organic material in paint must be separated from other carbon-containing interferences that affect age determination. Dating pictographs is a challenge for several reasons: (1) images are often painted on limestone, a carbon-containing mineral that *must* be excluded from dated material; (2) the amount of available carbon is small—much less than typical archaeological artifacts and small enough to challenge AMS analysis; (3) virtually nothing is known about binders/vehicles used in ancient paints; (4) contamination at microgram levels must be avoided; and (5) organic material not associated with painting can occur naturally in unpainted rock, sometimes masking binders/vehicles in paint. These problems, some still not totally resolved after a decade of research, add additional uncertainty to pictograph dating.

In pictographs worldwide, inorganic pigments are more frequent than charcoal; reds, oranges, browns, and yellows are usually iron oxide/hydroxide minerals, and black is often manganese oxide/hydroxide rather than charcoal. No inorganic materials (except calcium oxalate accretions often associated with picto-



NIÈDE GUIDON

The anthropomorph on the left (both are red) was the focus of a dating project by the Rowe team at Toco do Serrote da Bastiana, Brazil.

graphs) can be radiocarbon dated, but pictographs with inorganic pigments potentially can be dated *if* organic matter was initially added to the paints.

Very rarely have researchers identified organic materials added to inorganic pigments during paint manufacture. Many materials have been *suggested* as binders or vehicles; a partial list includes animal oils, blood, egg whites, egg yolks, honey, milk, plant juices, plant resins, seed oils, and urine—but almost always without chemical analysis for confirmation. More work is needed in the area of pigment binder/vehicle chemical composition.

Because pictographs are painted on rocks, frequently limestone, thin accretions containing calcium carbonate and calcium oxalate often cover painted images over time, making it virtually impossible to physically separate a paint layer from surrounding minerals when collecting a sample. Carbonate and oxalate minerals are typically much more abundant than paint. Two recent studies, one from our laboratory, show that acid treatment traditionally used in radiocarbon dating to remove carbonates is not sufficient in some cases to completely remove *oxalates*.

JANE KOLBER

Marvin Rowe collects paint at the open rockshelter at La Pulsera, Sonora, Mexico.

Significant progress has been made in radiocarbon dating rock paintings. Assigning painted images to a particular time period, and thus to a prehistoric culture, gives archaeologists information on artistic, cultural, technical, and religious aspects of a people. Instead of being ignored, rock art can be included in a study of other cultural remains.

Four methods have been used to radiocarbon date pictographs thus far. We briefly discuss these, focusing on plasma extraction developed in our archaeological chemistry laboratory at Texas A&M University.

Radiocarbon dating: Plasma extraction In the late 1980s, the Rowe group developed a method to extract organic matter from ancient pictograph paints for radiocarbon dating without interference from carbon-containing minerals. An oxygen plasma converts solid organic material in paint samples to carbon dioxide, which is collected for radiocarbon dating. An oxygen plasma is simply electrically excited oxygen gas that is reactive with organic matter, but at low enough temperature (≤150°C) that carbon-containing minerals do not decompose. These gentle conditions alleviate problems caused by ubiquitous carbonates and oxalates in rock art samples (and in many other archaeological samples as well). In contrast, combustion at about 750° C is typically used to collect carbon from archaeological samples for radiocarbon dating. Because combustion decomposes *any* carbon-bearing minerals, if they are not completely removed before combustion they will skew radiocarbon-dating results .

Our approach to dating pictographs relies upon the presence of organic carbon either from charcoal pigments or from added binder/vehicle organic components. Pictographs painted with inorganic pigments can only be directly dated by plasma extraction. Charcoal and other organic pigments, on the other hand, can be dated either by plasma extraction or traditional radiocarbon measurement.

We have obtained dates from over 30 pictographs painted with red or black inorganic pigments from Arizona, Brazil, Texas, Mexico, Montana, Utah, and Wyoming. Replicate measurements suggest an uncertainty of ± 250 years for inorganic pigmented paintings. Almost all successful dates on paintings with inorganic pigments were those on limestone walls; we find that sandstone almost invariably contains too much organic contamination to yield reliable dates.

We have dated approximately 60 charcoal drawings from Angola, Arizona, Australia, Belize, Brazil, California, France, Guatemala, Missouri, Russia, Texas, Utah, and Wisconsin. Replicate measurements in our laboratory suggest that an uncertainty of about ± 100 years is possible for *charcoal* dates, depending on the amount of carbon sampled.

There have been only two independent dates for pictographs dated using plasma extraction. In one case, Russ and his coworkers dated oxalate accretions surrounding a pigment layer of a Texas Pecos River–style pictograph; these oxalate dates bracket our radiocarbon results for the same style. Unfortunately, in the other case ("Independent dates from a Brazilian rock art site" below) there is complete disagreement between results from our laboratory and results from thermoluminescence dating methods. The need for additional independent studies cannot be overemphasized.

Radiocarbon dating: Charcoal pigments Most radiocarbon dates on pictographs worldwide have been made on pigments made of charcoal, the most common dated archaeological material. Radiocarbon dating charcoal paints yields a ***maximum*** age because it dates the death of the plant from which the charcoal was made, not necessarily the time when the image was created. It's possible wood collected from a live plant was immediately burned to make charcoal paint; in this instance the radiocarbon date for the charcoal would coincide with that for the painting. However, situations can occur involving *old wood* (wood dead long before it was burned to make charcoal) and *old charcoal* (wood burned at a much earlier time before the resultant charcoal was used to execute a painting). Caution is necessary when interpreting charcoal-derived radiocarbon dates, and the possible existence of old wood or old charcoal must be considered in each situation.

How old charcoal can produce misleading results is illustrated by a study our group made in Australia. We used plasma extraction to date historic charcoal graffiti, "Mr. C. B. Ross," written in a rockshelter, to 1310 RCYBP (radiocarbon year before present, 1950 in radiocarbon terms). Since the Ross family had lived in the region only since the late 1800s, a much more recent result was expected. The mystery was solved when two samples of near-surface charcoal from the shelter floor yielded dates of 690 and 1470 RCYBP. Thus, old charcoal was readily available to modern people.

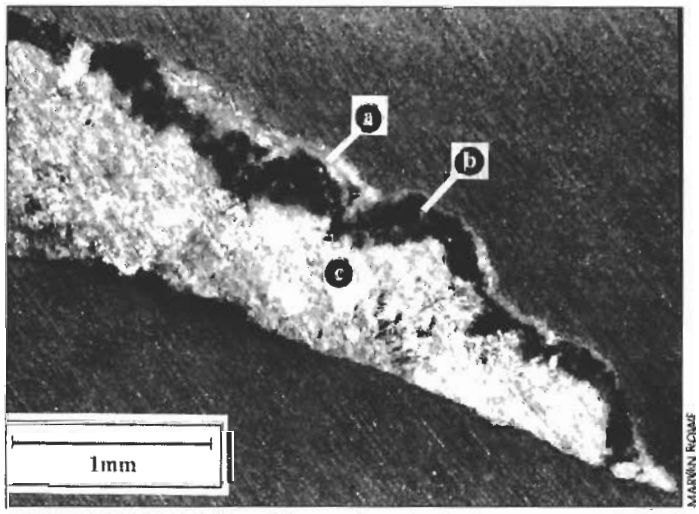
In Western European Paleolithic caves, French and Spanish researchers have concentrated entirely on dating spectacular rock paintings by dating charcoal pigments, charcoal being the principal ingredient used by ancient artists to make black paints. More than 60 dates have been obtained by Hélène Valladas, Jean Clottes, and coworkers. They adopted the procedure for dating archaeological charcoal virtually without change, using acid to remove carbonates and combustion to collect carbon for dating. There are, however, two unresolved issues in dating European cave paintings. First, old charcoal is especially problematic in Paleolithic caves, where substantial quantities of charcoal are found on cave floors. Second, another problem, not yet investigated, is the possible presence of oxalate mineral deposits potentially associated with dated charcoal paint samples. When acid-alkali-acid treatments are used, carbon-containing oxalates may not be completely removed from dated charcoal paint samples and age estimates may therefore be incorrect. We have just begun collaborating with French researchers to determine whether oxalates introduce significant errors in the radiocarbon dates of the French and Spanish rock paintings.

Radiocarbon dating: Beeswax pictographs Canadian professor Erle Nelson and his coworkers compiled in a CD more than 135 dates for beeswax rock art, an ancient art form found only in northern Australia. Their age determinations ranged from modern to approximately 4,000 years old, with most paintings dating to less than 750 years old. A duplicate measurement for one of the dated beeswax figures was made by Alan Watchman. The pretreatment he used differed enough from Nelson's that they probably constitute independent determinations. Their results don't agree: Nelson et al., 4040 ± 80 RCYBP; Watchman et al., 4460 ± 80 RCYBP. We would have expected statistical agreement, but even when calibrated the two ages don't agree at 95 percent probability (2σ). A difference of 10 percent between the two results indicates that more work is needed.

Radiocarbon dating: Oxalate mineral coatings Oxalate minerals associated with rock art have been dated by the independent research groups of Jon Russ, Alan Watchman, the authors, and their collaborators. Since calcium oxalate (CaC_2O_4) is a mineral formed from atmospheric carbon, the age of carbon in oxalate accretions is contemporaneous with its formation. By radiocarbon dating calcium oxalate strata overlying and underlying pigment layers, it's possible to determine maximum and minimum ages for a pictograph. Watchman et al. have written about using oxalates to date rock art and reported several dates. Russ et al. published oxalate dates associated with Texas Pecos River–style inorganic-pigmented pictographs; his results are consistent with radiocarbon dates we obtained using plasma extraction on organic matter in paint at these same sites. However, the age ranges involved in dating oxalates are too large to *confirm* the accuracy of plasma extraction results.

Radiation damage dating techniques: TL, ESR, and OSL

When crystalline materials are exposed to natural radiation, electron traps accumulate. Although the concentration of electron traps produced in a crystal depends upon the material and the radiation dosage, the *rate* of electron trap formation is constant over time as long as the radiation dose remains constant. If the rate of electron trap formation is known, the age of the material can be calculated by measuring the concentration of electron traps. Luminescence methods measure the amount of light energy released by crystalline solids when heated (thermoluminescence, or TL) or exposed to light (optically stimulated luminescence, or OSL). This amount of energy is related to the concentration of electron traps released, thus to the time elapsed since time zero. Electron spin resonance (ESR) directly measures the concentration of electron traps in a material. Care must be taken when handling archaeological objects to be dated by these methods, since the "clock" may be inadvertently reset to time zero if material is heated to high temperature or exposed to sunlight.



Cross section of a rock fragment from a Pecos River–style pictograph found in an open rockshelter in Texas, showing calcite and calcium oxalate deposited over (a) and underneath (c) the pigment layer (b). This example shows why it is frequently impossible to separate pigments from adjacent mineral deposits.

TL, ESR, and OSL, which have only recently been applied to dating rock art, usually yield an indirect minimum age rather than a definite date. Since they are simply different methods for measuring the concentration of electron traps in an inorganic crystalline sample, these techniques cannot be considered independent of one another.

In dating rock art, TL and ESR methods measure the formation age of mineral coatings over (or under) a paint layer. As a mineral deposit accretes on a rock surface from solution, its

In Memoriam
ROBERT E. FUNK
1932–2002

Robert Funk, 70, New York State Archaeologist Emeritus, died unexpectedly last September 25 in Albany, N.Y. He was born in Rome, N.Y., and received BA (1953), MA (1955), and Ph.D. (1966) degrees in Anthropology from Columbia University. Funk trained under Glenn Black at the Indiana University field school at Angel Mounds. In 1960 he joined William A. Ritchie's settlement pattern project and began 33 years' tenure at the New York State Museum. On Ritchie's retirement in 1971 Funk was appointed New York State Archaeologist, a position he held until 1993. He remained highly active in fieldwork and scholarship until his passing.

Funk led extensive field investigations in the Susquehanna, Hudson, and Mohawk River Valleys and on Fishers Island, N.Y., off the coast of Connecticut. He trained a generation of archaeologists in field schools and in graduate studies at the University at Albany. His vast contribution to the prehistory of the Northeast earned the respect of professional and avocational colleagues; his enthusiasm, inclusiveness, and generosity with his time and knowledge won their friendship. He contributed a humorous autobiography to a two-volume 1996 Festschrift honoring his retirement, where you can find a list of his publications through 1994.

Funk's research is notable for the use of rigorous stratigraphic control in deep deposits to clarify the succession of archaeological cultures. During doctoral research his excavations at the Sylvan Lake rockshelter reversed Ritchie's sequence of the Narrow-point (Lamoka) tradition preceding the Laurentian tradition in the Hudson Valley. He greatly advanced paleoenvironmental and geological research in reconstructing the adaptive contexts of prehistoric inhabitants of New York. Work at the Paleoindian quarry-workshop-campsite on West Athens Hill in the Hudson Valley epitomizes his early-culture concentration, which carried through *Archaeological and Paleoenvironmental Investigations in the Dutchess Quarry Caves, Orange County, New York* (1994, with David W. Steadman) and related articles such as one forthcoming on the Zapavigna site, also near the Wallkill River. Funk's other books comprise three classics: *Aboriginal Settlement Patterns in the Northeast* (1973, with William A. Ritchie), *Recent Contributions to Hudson Valley Prehistory* (1976), and *Archaeological Investigations in the Upper Susquehanna Valley, New York State* (two volumes, 1993 and 1999, multiple coauthors). He was instrumental in developing for the State Museum's New York Hall life-group exhibitions of Native Peoples, one of which depicts the West Athens Hill site.

Bob is survived by his wife, Nadine Fowers Funk; son, Alfred; daughter-in-law, Latisha Azweem; his sister, Nancy Savage, and her daughter, Marlene. The family requests that contributions in Bob's honor be sent to the Robert E. Funk Memorial Archaeology Foundation, administered by the New York State Museum Institute, and the two statewide organizations, the New York Archaeological Council and the New York State Archaeological Association, to support research in New York through a grants program.

–Christopher Lindner, John P. Hart, Beth Wellman

crystal lattice is newly formed and contains no electron traps. Thus, formation of an accretion is datable by either TL or ESR. However, we suspect that particulate material with previously formed electron traps can be incorporated into surface accretions. An important and unavoidable assumption when using radiation damage dating methods is that all electron traps in the material were released by the event of interest, that the "clock" was set to zero for the event you want to date.

OSL measures the time elapsed since the last exposure of a crystalline solid to sunlight; the "clock" starts ticking when the object is buried deep enough to shield it from light. When Roberts et al. discovered wasp nests underneath or covering rock art in Australia they wanted to date, they used OSL to date quartz grains in mud from the wasp nests.

Independent verification

There is an urgent need for independent dating projects if dating rock art is to proceed to the next level of confidence as a scientific endeavor. We suggest a focus upon replicate measurements, inter-laboratory comparisons, and independent dating methods.

Independent dates from a Brazilian rock art site: A case study

The area around Pedra Furada (Piaui, Brazil) is of remarkable, although controversial, archaeological interest. Niéde Guidon and her colleagues have uncovered considerable evidence of human occupation at Pedra Furada as far back as 50,000 years ago. Pigments and pictograph fragments were found in excavated levels in Pedra Furada that date to almost

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POLLEN and the First Americans

by Vaughn M. Bryant

FORTY YEARS AGO just before Christmas I was driving from Austin, Texas, to go skiing at Vail, Colorado. As I inched along the icy highway leading toward Raton, New Mexico, a fierce snowstorm swept down across the High Plains and nearly blew my VW off the road. Ahead through the blinding snow and twilight of late afternoon I saw a small side road and a sign saying FOLSOM 8 MILES. Incredible! Just eight miles to the right was the exciting archaeological site that had opened the door to our search for how and when the first Americans began to colonize the New World.

As I slithered along the icy side road, my mind flashed back to the textbook and archaeology course I had just completed, and to the existing theories about our ancient ancestors we call Folsom, Clovis, and pre-Clovis. Ahead, under the overcast sky and blowing snow lay a small group of abandoned stores, a rundown hotel, some weather-beaten frame houses, and a tiny grocery store with two pickups parked in front that doubled as a post office and gas station. A block away and across the street loomed an old frame building with a wooden sidewalk in front and a battered sign hanging at an angle by a single nail that read MUSEUM.

On the inside of the frosted-glass door was a small OPEN sign. As I entered, I noticed that I was alone in a dimly lit, unheated room full of displays from pioneer farming days to World War II relics. Scattered on tables, hanging on walls, and in various dusty display cases were tools, broken toys, military uniforms, old dresses, a display of rusty guns, faded black-and-white photos, and a corner display of what a kitchen might have looked like during the mid 1800s. Open on a small table, next to an empty pickle jar with a faded sign saying DONATIONS, lay an open guest register with curling pages; its last entry was more than six months old.

In a far corner of the next room I saw the skull of an extinct bison hanging on the wall with rusting shovels and other excavation tools below it in a roped-off area. Next to it was a hand-labeled display laid out under the clouded glass of a display case. Neatly arranged in rows were stone artifacts and badly faded photos of the 1920s excavation of the nearby Folsom site that revolutionized American archaeology.

In the third room were more stone artifacts, mostly from modern Indian groups, and a large painted mural on the back wall. There, almost lifelike, was a painting of a large wounded mammoth surrounded by lightly clad hunters hurling spears. A sign on the wall said CLOVIS MAN.

As I walked around on the creaking wooden floors and shivered in the cold, I read the many handwritten labels in other display cases. It was an eerie place and I felt as if I had stepped back in time. Each breath left a small cloud in the cold air and the only sounds were the howling wind outside and the banging of a distant window shutter.

After closing the front door I just stood there on the wooden sidewalk staring down the street at what once was a bustling community, but had long ago been all but abandoned. I was overcome by wonder. Was I really here? Was this really the place that my professor had called "the most important archaeological breakthrough in the history of North America"?

Following the pollen trail to the first Americans

I didn't know it then, but I was hooked. In the years after my visit I would go on to finish my education and then be part of the search for early Americans at sites in Texas such as Bonfire Shelter, Lubbock Lake, and Gault; in the Northeast at Meadowcroft; in the Pacific Northwest at the Marmes site; and in Peru at the site of Pikimachay. I worked at those and other sites not as an archaeologist, but as a palynologist, a person searching for microscopic clues of fossil pollen that might help us understand the paleoclimate, subsistence patterns, and ancient vegetations that affected the lives of early Americans and the animals they hunted.

During the past two decades pollen research has become common and expected at most archaeological excavations, but this has not always been true. Initially, archaeologists were slow to include pollen studies as part of their excavation plan and were slow to embrace the importance of the data fossil pollen could provide. Part of the hesitation was a lack of understanding of how pollen data might help interpret the past and a lack of understanding of how and why fossil pollen studies were valid avenues of scientific research.

Palynology in its infancy

A good place to begin our story of pollen is with a lecture presented in 1916 at a meeting of Scandinavian scientists. At that meeting, Lennart von Post, a Swedish geologist, shocked his colleagues by saying that the recovery of fossil pollen from buried sediments was the most precise method yet developed for interpreting past vegetational regimes and determining cycles of vegetational change. Scientists had seen fossil pollen in ancient de-

posits, but no one had found a way to interpret them effectively. As he lectured, von Post set forth the basic theory of pollen analysis and explained why pollen was the ideal tool for studying changes in past vegetation and, by inference, climate. First, he pointed out that many plants produce great quantities of pollen or spores that are dispersed by wind currents. Second, he noted that pollen and spores have very durable outer walls that can often remain preserved for thousands or even millions of years. Third, his research had indicated that the unique morphological features of each type of pollen and spore remain consistent within each species, yet each different species produces its own specific form. Fourth, as ecologists had already discovered, each pollen- and spore-producing plant is restricted in its distribution by environmental conditions that include moisture, temperature, and soil type. As such, each species is most plentiful in areas that best meet the plant's optimal needs. And fifth, von Post determined that most wind-dispersed pollen and spores rarely travel very far; most fall to the earth's surface within a small radius (50 km) from their dispersed source. Thus, by counting a sufficient number of fossil pollen and spores recovered from each stratum in a deposit, one could reconstruct the types and abundance of plants represented by those fossil grains.

BOTH: HARRY SHAFER

Left, view of Bonfire Shelter (dark area in center). Bison were stampeded over the cliff into the notch, then fell 75 ft onto large boulders in front of the shelter. Most animals then rolled into the shelter, where they were butchered. Below, articulated bison bones in situ at one of the two major bison jumps in Bonfire Shelter. The answer to the question that baffled archaeologists—why did bison slaughters occur in two brief, violent episodes separated by 8,500 years?—was supplied by palynology. (The principal bison jump at Bonfire Shelter, called the "Plunge of Death," was first excavated by archaeologists from the University of Texas–Austin in 1963–64; for more information visit their Web site, cosponsored by the Texas Archeological Society, at www.texasbeyondhistory.net/bonfire/index.html)

Using the principles he set forth in his lecture, von Post then detailed how he was able to use his pollen studies of bog deposits in central Sweden to reconstruct the sequence of vegetational changes for that region. He pointed out that his data detailed thousands of years of change beginning with the early vegetation of pioneering plants that grew in the region immediately after the continental glaciers receded, through various stages of forest succession, and ending with the present climax forests of spruce and pines. Subsequent research confirmed the validity of von Post's research.

Pollen in varying quantities

The magnitude of pollen production by some plants staggers the imagination. Many plants rely upon the wind to carry spores or pollen to their intended destinations, yet wind pollination is an inefficient method. Thus, to insure fertilization plants must produce great volumes of pollen in hopes that at least a small fraction will find its intended destination. So great is the pollen production of conifer trees that current Swedish scientists estimate the forests in the southern third of their country annually disperse over 75,000 tons of microscopic pollen into the atmosphere. Heavy pollen production is not limited to conifers. For example, in the United States plants such as marijuana (*Cannabis*) produce over 70,000 pollen grains per anther and a single branch on a male marijuana plant can produce more than 500 million pollen grains.

Around 100 million years ago during the Cretaceous Period, a large number of plants began to develop more efficient methods of pollen dispersal that relied on insects and small mammals instead of the wind. With this change came a vast reduction in the need to produce pollen grains. This reduction became so great that some modern, insect-pollinated plants such as clover need to produce no more than 200 pollen grains per anther to insure pollination. Others in this group, including maple trees, have found that around 1,000 pollen grains per anther are ample to ensure proper seed production. These types of plants now far outnumber the ancient wind-pollinated types and now form the major components of many plant communities.

Almost all the pollen von Post found in his analysis of Swedish peat deposits was from wind-pollinated plants. Herein lies one of the limitations of pollen analysis. Pollen records are excellent

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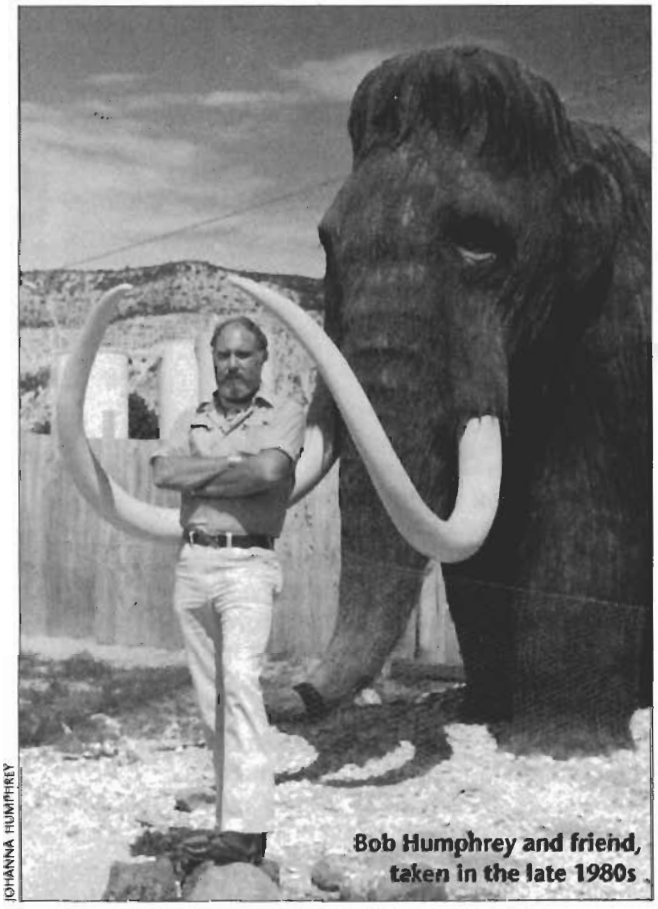
MAMMOTH RENDERINGS

Remembering Robert Humphrey (1939–2002)

IN THE FALL OF 1965, I arrived in Albuquerque as an eager, yet naive graduate student at the University of New Mexico. I was excited about being at UNM, where the cadre of graduate students and professors was impressive. Jerry Dawson was excavating the Rio Rancho Folsom site; Jim Judge was contemplating his survey of Paleoindian sites in the middle Rio Grande Valley; and Bob Humphrey, a big bear of a man, had just returned from his first summer's field work in the Western Brooks Range of Alaska. Bob was seeking evidence for the origins of the First Americans—Clovis.

At that time, we all knew that Clovis people were the First Americans. They came from Northeast Asia at the end of the last ice age. They crossed the Bering Land Bridge and waited in Alaska for the gates of the Ice Free corridor to swing open. When it did, they scampered southward to populate the New World, eating up all the unsuspecting megafauna along the way. Although this was only a hypothesis, the story had been told and retold and published so many times it was considered fact by most. But Bob was off to prove it. Clovis-like points had been found on the Utokuk River in the early '50s, and this was clearly the most likely area to produce the evidence needed to substantiate the hypothesis. Bob's first field season failed to find fluted points, and it appeared his dissertation topic might be a bust.

That fall Bob and I became close friends; we would meet for morning coffee at University Drugs and discuss highly important anthropological things. After class we were usually found at Oklahoma Joe's, better known as Okie's, a watering hole situated near the Anthropology Building. Here graduate students and an occasional faculty member gathered to absorb the day's anthropological knowledge with generous servings of beer.



JOHANNA HUMPHREY

Bob Humphrey and friend, taken in the late 1980s

At Okie's we became acquainted with one of Bob's amazing talents: he embellished the napkins on which we drew our grand maps and diagrams with appropriate cartoons of bellowing bison and trumpeting mammoths being attacked by pesky Clovis guys. I wished I had saved a few of those scraps of paper. A talented artist, Bob honed his skill for portraying the many moods of elephants while illustrating a Republican Party newsletter, edited by his father. He just gave the poor animal a furry coat and longer curved tusks, and *Mammuthus americanus Humphreii* was created.

As plans progressed for the next field season, Bob asked me if I would come along as his field assistant. I jumped at the chance—going to Alaska—becoming an Arctic explorer—looking for the first Americans! What more could a beginning graduate student want? It ended up being a summer of firsts for me: Alaska; my first airplane rides in a 707 and a DC-3, and several harrowing trips in a small Cessna 182 with a cigar-smoking bush pilot named Guy B. Sheppard; Fairbanks, with unpaved streets; Jim Crouder and his hotel, located next to the Goldrush Saloon; and the Great North Country—all these I would grow to love.

Supported by the Office of Naval Research out of Point Barrow, Alaska, our plan was to be dropped off on the upper Utokuk River, float downstream, and find highly important archaeological sites. And that's sort of just what we did.

In late June, after stern lectures on bush safety from Max Brewer, the Director of the Naval Arctic Research Lab (NARL), we were literally dumped off on the large sand bar where Driftwood Creek braided and twisted its way into the Utokuk. As the plane disappeared into the distance, we realized we were alone—no one was within hundreds of miles in any direction. Moreover, ice break-up was in progress, and the Utokuk was a raging river, swiftly running bank to bank; large slabs of ice

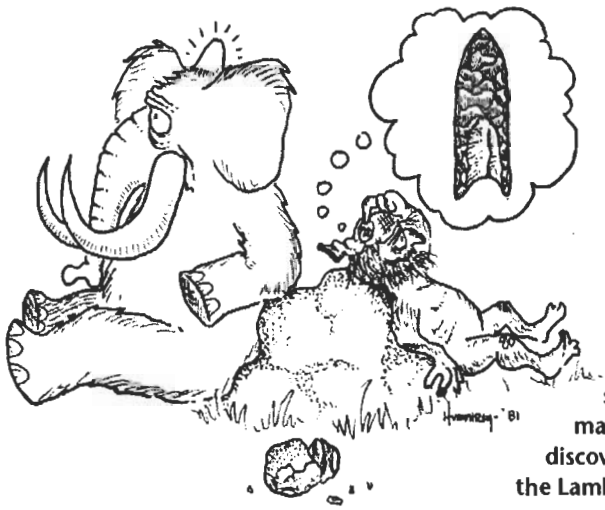
were hurtling past us downstream toward the Arctic Ocean. We set up our tents and unpacked the dreaded "Arctic Fold Boat," a boat made of canvas that stretched over a metal frame—all of which collapsed so that it could be carried in a small aircraft. We put the boat together and organized our stuff.

For several days we eyed the boat warily and explored for sites along our side of the river, met the local grizzly George P., a name I still use for visiting bruins. The day finally arrived to go downstream, but rather than abating, the river had actually begun to rise. We loaded up our gear, and with each box the boat settled deeper and deeper into the water. When finally loaded, we climbed aboard. Neither of us being particularly small, we probably added at least another 400 lbs. to the load. There was less than 2 inches of freeboard left! We looked at each other and glanced out at the ice flow. Bob said, "Let's get the scotch and discuss this situation." Several hours later, our courage supported by the scotch and youthful optimism, we climbed back in and shoved off.

At this point, Bob said, "Do you know how to paddle a canoe?" "No," I said, "don't you?" "No," he teased. After swirling and bobbing along with the ice, we finally achieved a modest amount of control and crossed to the other side of the river. We disembarked and unloaded—enough for one day and we were still alive. We set up camp and finished the bottle of scotch to celebrate something. George P. swam over to see if we were all right. Later, snuggled up in my dry bedroll, all I could think about was the 200 or so miles down river to our pick-up point.

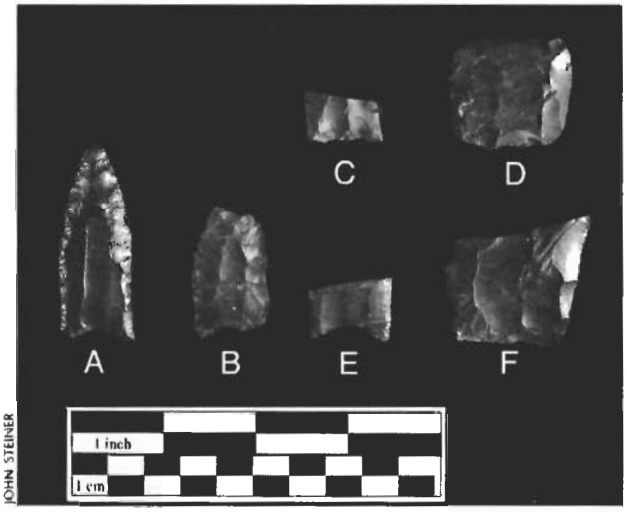
The next morning we set off to explore this side of the river. Just above our camp, a high ridge projected out toward the Utokuk. As we ascended the ridge to take a look around, we began to find chips of flint, stone tools, then a projectile point preform, broken while being fluted, and eventually several fluted point bases. Although the points were fluted, they were different from either Clovis or Folsom and we thought they were likely pre-Clovis—other tools included burins, blades, and a whole host of Asian-like technologies. We even discovered mammoth bones eroding out of a bank below the hill. Our excitement was beyond measure. We had found it!

Later a radiocarbon assay of the mammoth tusk produced a date of over 17,000 years old. Earlier than we thought pre-Clovis should be, but who knows how long the mighty Clovis hunters cooled their heals while waiting for gates of the Ice Free Corridor to swing open. Our discoveries made a great dissertation for Bob, and he published a summary paper (Humphrey 1966, "The Prehistory of the Utokuk River Region Arctic Alaska: Early Fluted Point Tradition with Old World Relationships," *Current Anthropology* 7(5): 586–88).



A pre-Clovis hunter ponders a better system for hunting mammoths (drawn after the discovery of a 33-lb boulder at the Lamb Spring site in Colorado).

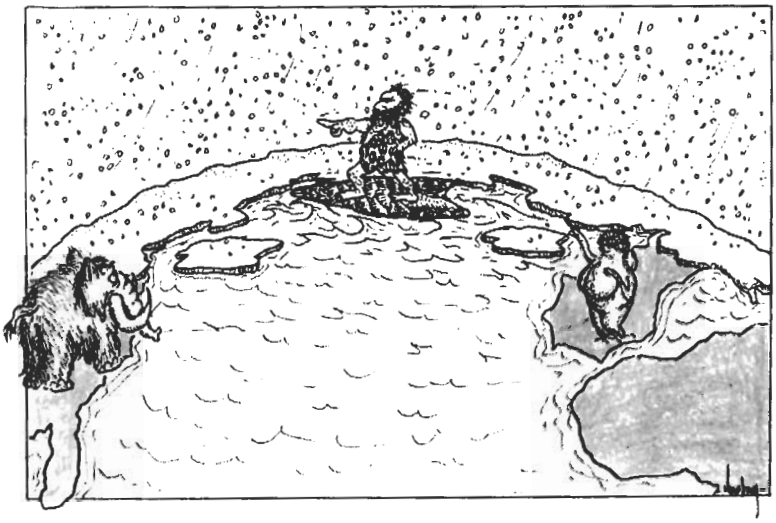
And that's the way it was for 20 years. But now, other sites have produced similar fluted points with radiocarbon dates. Charlie Creek Lake Cave, located along the path of the Ice Free Corridor in northeastern British Columbia, yielded a date of 10,500 years ago, and at the Putu site in northern Alaska, fluted points found above the Mesa complex were younger than 10,000 years old. The Alaskan fluted points are definitely not ancestral to Clovis.



A and B, fluted points found by R. M. Thompson on the Utokuk; C–F, fluted points and preforms found on 1966 Utokuk expedition.

At the end of the 1966 field season, Bob flew out of the bush before I did—he had the goodies and most of our equipment. Guy Sheppard was going to pick me up on the return trip. Unfortunately for me, a storm set in; it was five days before Guy made it back. By the time I arrived at NARL, Bob was long gone, but a cartoon adorned Max Brewer's door. It depicted two young scientists who resembled us. One of them was standing by a pile of equipment and looking at a small plane disappearing over the horizon. His words: "Just think, there isn't anyone within 500 miles and the plane won't be back for a whole month." The other chagrined explorer, sitting on a box, was comparing his NARL-issue boots—both were for the same foot. From then on, as I continued to work out of NARL, that cartoon, along with a quote attributed to Vilhjalmur Stefansson to the effect of "there are no adventures in the Arctic, just bad planning," graced the door of Max's office.

Bob graduated from UNM and was hired by George Washington University. There he taught popular archaeological classes for 30 years, was chairman of the Department several times, and created a pioneering graduate program in museum



Poking fun at the Solutrean migration theory.

studies. But having been baptized in Arctic research and being no fool, especially after our experiences on the Utokuk, Bob switched his research gears to focus his attention on Mesoamerican archaeology. In this regard, Bob came up with the mobile Mesoamerican archaeological field school, a prototype for the now popular "Eco-trips." A graduate of this field school gained a great understanding of Mesoamerican archaeology, experienced first-hand international affairs, and gained memories for a lifetime . . . not to mention spending evenings below Mayan ruins, sipping margaritas while sitting in Bougainvillea-draped courtyards bathed by starlight skies of the Yucatan.

In 1972, I became an Associate Curator at the Smithsonian, and Bob and I were neighbors in a nine-acre enclave called Roseanne Lane in McLean, Virginia. Here we lamented the Vietnam War to ballads sung by John Pryne and drove antique British roadsters (his a dashing Morgan, mine a Triumph, both British racing green). We made great plans. We organized a series of lectures on the "Peopling of the Americas" for the Anthropological Society of Washington. We invited all the "Big Guns," especially those working on the edge, R. S. MacNeish, James Adovasio, and Dick Morlan, to name a few. We published these lectures in *Pre-Llano Cultures of the Americas: Paradoxes and Possibilities* (Humphrey and Stanford, eds. 1979).

We contemplated working on a joint publication in the genre of Harold Gladwin's book *Men out of Asia.* Ours too would be a publication concerning the peopling of the New World, but richly illustrated by Bob's cartoons. Just one of those things we talked about for 30 years, yet never got around to. However, a collection of Bob's cartoons was published in 1990 by the Friends of the National Zoo in a book called *The Last Elephant.*

Bob was also for 24 years the illustrator of *AnthroNotes,* the popular publication of the Department of Anthropology at the Smithsonian Institution. Since *AnthroNotes* has a mailing list distribution of over 9,000 anthropologists, archaeologists, and teachers, Bob's cartoons have been widely appreciated through the years. Selected articles from *AnthroNotes,* along with Bob's cartoons and new chapter updates, were published in 1998 in a book titled *Anthropology Explored: The Best of Smithsonian AnthroNotes* (Ruth O. Selig and Marilyn R. London, eds.). The first edition became a Natural Science Book Club selection, and an expanded second edition is currently in press, with many new articles and many more Humphrey cartoons.

Bob's cartoons for *AnthroNotes* are replete with themes and lessons that reflect major events and scholarly trends in anthropology, but the underlying message warns us, especially when we begin to take ourselves or our ideas too seriously, to stand back, reassess, and contemplate reality. In 2000, Bob, along with the *AnthroNotes* editors (Alison Brooks, Ann Kaupp, JoAnne Lanouette, and Ruth Selig), accepted the Society for American Archaeology Award for Excellence in Public Education "for presenting archaeological and anthropological research to the public in an engaging and accessible style." I believe his cartoons and their messages will live on through the generations.

Recently, while building his retirement house on Cape Breton, Nova Scotia, Bob heard about Clovis fluted points found by a local collector—a whole continent away from Driftwood Creek. If these artifacts were indeed Clovis, they would be very significant, since Clovis people could only have gotten to Cape Breton by watercraft, and if they had boats, it would change the way we assess their ability to move about the world. Bob and I were thinking that documenting these specimens and maybe even finding a Clovis site on this remote northern locality would make another exciting joint project.

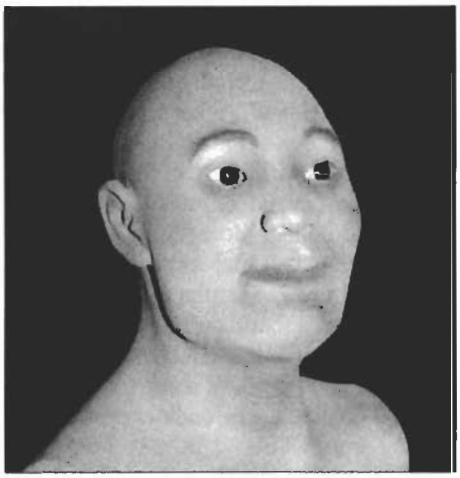
Cathy Griggs, a mutual friend, went north with Bob last fall to help put the finishing touches on his house. She told me Bob did check out the collection and felt that the specimens were indeed Clovis artifacts. Bob passed away during his trip home. Farewell, dear friend.

–Dennis Stanford

International Symposium on the Peopling of the Basin of Mexico

AN INTERNATIONAL SYMPOSIUM entitled "El Hombre Temprano en America y sus implicaciones en el Poblamiento de la Cuenca de Mexico" (Early Man in America and the Implications in the Peopling of the Basin of Mexico), sponsored and organized by the Physical Anthropology Department (DAF) of the Instituto Nacional de Antropología e Historia (INAH), was held at the impressive National Museum of Anthropology in Mexico City last August 7–9. The organizing committee, consisting of José Concepción Jiménez López, Silvia Gonzalez, José A. Pompa y Padilla, and Francisco Ortiz Pedraza, registered 40 official speakers. The audience of about 80 students and members of the public heard 32 papers presented in plenary sessions. Most were by Mexican researchers; others were by scholars from the U.K., Canada, U.S., Colombia, Chile, and Argentina.

The objective of the symposium was to inform the international scientific community of a wealth of recent, largely unpublicized research on early human skeletal remains and paleoenvironmental and archaeological evidence in Mexico, particularly around the area of the Basin of Mexico (where Mexico City is located today).



BOTH: DAF, INAH, MEXICO CITY

The Peñon Woman skull and facial reconstruction displayed at the symposium.

The sessions started with papers on the history of studies of the early inhabitants of Mexico, followed by papers examining the paleoenvironmental changes in climate, hydrology, flora, and fauna in Mexico over the past 40,000 years. Later papers reviewed linguistic evidence (Leonardo Manrique), dental evidence (Ricardo Lascurain), controversial DNA evidence (Angelica Gonzalez-Oliver and Adrian Martinez-Meza)—which will have to be corroborated by other laboratories—and the relevance of examples of worked bone (Oscar Polaco). Several papers discussed early sites in different parts of the Americas, including the U.S., Colombia, Chile, and Argentina. Speakers included Arturo Romano, Rob Bonnichsen, Mike Waters, Douglas Owsley, Nicholas Hermann, Ruth Gruhn, Alan Bryan, Jim Ohman, Eileen Johnson, Virgina Steen-McIntyre, David Huddart, Laura Miotti, Monica Salemme, Cristobal Gnecco, Luis F. Bate, and Ivan Muñoz.

Several papers explored active volcanism in the late Pleistocene/early Holocene, its profound impact on climatic changes and subsequent effect on flora, fauna, and early human populations in the Basin of Mexico. Several major explosive volcanic eruptions occurred during this time, producing a number of ash falls, pyroclastic flows, and lahars. The Basin at times was a very hazardous place to live! Fortunately a tephrachronology has been defined for the area that establishes a detailed stratigraphic sequence. Examples of tephra markers with a wide distribution throughout the Basin include the Great Basaltic Ash dated at 29,000 years RCYBP; the Pumice with Andesite at 14,450 years RCYBP, and the Upper Toluca Pumice at 10,500 years RCYBP. Faunal remains, artifacts, and human skeletons found in association with these distinctive ash layers can now be easily dated.

Remains of four humans from the Basin of Mexico reliably dated older than 10,000 years RCYBP constitute a major share of all known early human skeletal material in the New World. The four individuals were found during construction excavations around Mexico City; some of the find sites were later scientifically excavated and studied. Currently the oldest Mexican is Peñon Woman, an almost complete female skeleton directly radiocarbon-dated to 10,755 ± 75 RCYBP (about 12,700 CALYBP). Also directly radiocarbon-dated is the Tlapacoya male skull, dated at 10,200 ± 65 RCYBP (about 12,000 CALYBP). A third find, known as the Metro Balderas Man, was too mineralized to allow radiocarbon dating; however, the skull was embedded in volcanic ash of the Upper Toluca Pumice marker horizon and therefore can be dated to around 10,500 RCYBP. The male Chimalhuacan skull, also found in association with the upper Toluca Pumice horizon, likewise dates to around 10,500 RCYBP (about 12,500 CALYBP), not 33,000 years old as had been suggested previously by obsidian hydration dating.

All four of these early crania are long and narrow (dolichocephalic), like other early crania known from North America, and different from later brachycephalic crania from Archaic and Preclassic contexts in the Basin of Mexico. All these crania were displayed in the foyer of the museum in an exhibit entitled "El Hombre Temprano en Mexico" (Early Man in Mexico) for the benefit of symposium participants and museum visitors. Lorena Valencia and Maria Villanueva, in their presentation, showed a facial reconstruction of the Peñon Woman skull.

According to research presented at the meeting, central Mexico during the late Pleistocene had a Rancholabrean-type fauna that included Columbian mammoth, mastodon, bison, horse, camel, sloth, glyptodon, and saber-toothed cat. At least 30 localities around the Basin have yielded mammoth bones, and about half show evidence of human presence in the form of modified bone or associated lithics. The Tocuila Mammoth site, for example, with direct radiocarbon dates on mammoth bone of

11,100 ± 80 RCYBP, shows evidence of deliberate bone modification by humans. The La Villa site, which yielded a mammoth bone covered in cut marks and directly dated at 11,300 RCYBP, is further evidence of human presence in the Basin of Mexico contemporaneous with the Clovis culture of the American Southwest. Known to the scientific community since the late 1950s are two sites near Santa Isabel Iztapan, where Scottsbluff-like and Angostura-like points were found in direct association with mammoth skeletons. Unfortunately these two sites are still not securely dated owing to lack of collagen in the bones.

It had been 15 years since the last congress dedicated to the study of early humans in America was held in Mexico. The symposium last summer demonstrated the wide breadth of scientific research being conducted in Mexico on the First Americans and their environments. We hope it will mark the beginning of a new era of discoveries and research in the area, and will serve to foster the collaboration of researchers from the whole of North and South America.

The organizing committee is editing a special peer-reviewed volume of the symposium proceedings. Address inquiries by e-mail to josejimenez_daf@hotmail.com

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Dating Rock Art

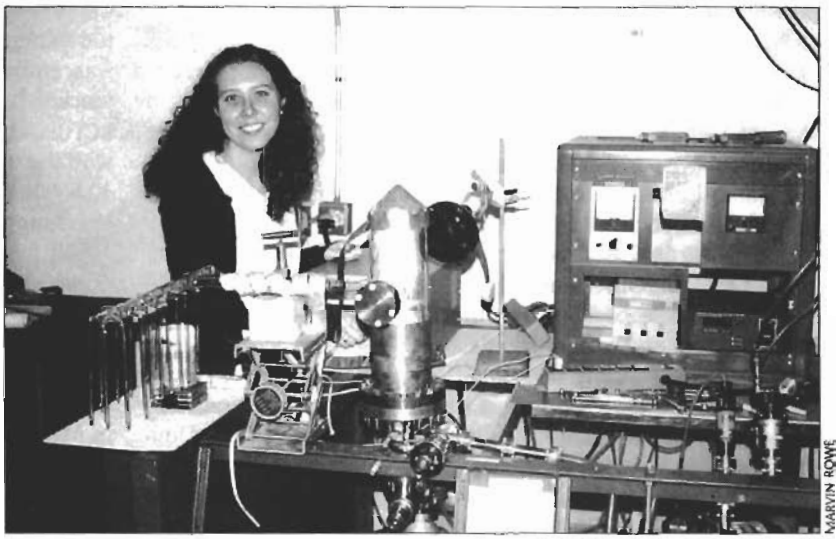
continued from page 7

30,000 years ago. The possibility of extreme antiquity for humans in this area was reviewed by A. Russell Nelson (**MT** 17-4, "Paleoindians in Northeastern Brazil").

In a 1998 visit to Pedra Furada by MWR, we were asked by Dr. Guidon to date some rock art in the region. Of particular interest was the small limestone shelter, Toca do Serrote da Bastiana. A red (iron ocher) anthropomorphic pictograph (see photo) was covered by a thin, translucent layer of calcite (calcium carbonate). Using ESR and TL, University of São Paulo physicist S. Watanabe and his colleagues measured the crystallization age of the calcite layer. An age of 35,000 years or older was determined for the formation of the calcite. (See "Suggested Readings," S. Watanabe et al.) Thus, the pictograph covered by this mineral layer must be even older—an exceedingly exciting prospect. If confirmed, this would provide compelling evidence for early human settlement in the area, substantiating other evidence discussed in Dr. Nelson's article.

Recognizing the great archaeological implication of the ESR and TL dates, we and our colleagues investigated the antiquity of pictographs at Toca do Serrote da Bastiana using a four-pronged approach. (See "Suggested Readings," K. L. Steelman et al.) Most directly, we radiocarbon-dated organic material extracted from paint of the anthropomorphic figure covered by the calcite. Secondly, we examined the composition of the calcite coating using two chemical techniques, Fourier transform infrared spectroscopy and X-ray diffraction, and found that calcium oxalate was also present in the accretion layer. Unlike calcite, calcium oxalate is formed from ambient carbon. It is therefore possible to radiocarbon date the "time" of its deposition, essentially the same event dated by ESR and TL. Dating oxalate gives a good check on ESR and TL dates because the assumptions and conditions involved in radiocarbon dating are very different from those of ESR and TL, both of which are based on similar assumptions and conditions. Of the three techniques, radiocarbon dating is the most thoroughly tested and yields the most reliable dates. Thirdly, we took samples of four other pictographs from the same small shelter (each within 2 m of the calcite-dated image) to be directly dated via plasma extraction of organic carbon. Two of these four additional pictographs were made with charcoal pigments; the other two had red iron oxide pigments. Finally, we dated four other pictographs from other painted sites in the area, some with charcoal and some with red ocher pigmentation.

Our results uniformly argue against an extreme antiquity of 35,000 years or more for the pictographs at Toca do Serrote da Bastiana. The radiocarbon date of the calcite-covered painting was 3730 ± 90 RCYBP. Furthermore, radiocarbon analysis on calcium oxalate extracted from the accretion layer covering that painting yielded a minimum date of 2490 ± 30 RCYBP for the painting. Since this is a weighted average for formation of the calcium oxalate layer over time, it's expected to be more recent than the painting itself. In addition, radiocarbon dates on four other images in the same shelter were 1880 ± 60, 2280 ± 110, 2970 ± 300, and 3320 ± 50 RCYBP. Finally, dates on four other paintings/pigments from other shelters in the region yielded ages of only a few thousand years: at Toca do Sitio do Meio, 2700



MARVIN ROWE

Co-author Karen Steelman with the homemade plasma system used in the laboratory at TAMU.

± 110 RCYBP; at Pedra Furada, 2120 ± 110 and 3570 ± 50 RCYBP; and at Toca do Extreme, 1230 ± 50 RCYBP.

Regrettably, since our radiocarbon results strongly disagree with a 30,000-year-old age of the calcite accretion obtained by ESR and TL dating, we question those results. Given our present state of knowledge, those ESR and TL results should not be used as evidence to support very early human occupation in Brazil near Pedra Furada. Our results do not negate the possibility of human occupation in the area 50,000 years ago; they only mean that radiocarbon-dated paintings on shelter walls are not nearly of that antiquity. Once again, and most dramatically, this study points out the necessity of independent studies in dating rock art.

–Marvin W. Rowe and Karen L. Steelman

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Suggested Readings

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About the authors Karen L. Steelman is a Ph.D. candidate in the Department of Chemistry at Texas A&M University. Her dissertation research focuses on using plasma extraction to nondestructively collect carbon from perishable artifacts for radiocarbon dating. She received a B.A. in Chemistry from Hendrix College in Arkansas. As a Watson Fellow, she traveled to Costa Rica, Chile, Australia, and Great Britain to observe conservation and conservation science departments in museums.

Marvin W. Rowe is Professor of Chemistry at Texas A&M University. He received a B.S. in Petroleum Engineering at New Mexico Tech, Socorro. He won the Nininger Award while working for Los Alamos National Laboratory's Biomedical Research Group. He received a Ph.D. in Nuclear Chemistry from the University of Arkansas, Fayetteville, winning the Nininger Award again for his dissertation research in which he detected extinct ^{244}plutonium in meteorites. Dr. Rowe was named a Miller Institute Fellow in Basic Research, University of California–Berkeley, for two years of post-doctoral research in the Physics Department. Rowe joined Texas A&M University in 1969. His research, developing a method for dating rock paintings, received the Castleton Award from the American Association of Rock Art Research in 1998 (with Dr. Marian Hyman). He has published over 200 scientific papers.

Pollen and the First Americans

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capsules of information about which "wind-pollinated" species once lived in a region, yet these same records tell us almost nothing about the insect-pollinated plants that were also present. This imbalance of preserved pollen information is not as limiting in some environments as in others. For example, most of the vegetation in boreal forests is wind-pollinated; therefore the fossil pollen record captures a fairly good image of that ancient vegetation. However, in other regions, such as those dominated by tundra and deserts, most plants are insect-pollinated and therefore those deposits contain a very sketchy fossil pollen record.

Applying pollen studies to early American sites

Many Paleoamerican sites in the New World do not contain fossil pollen because of their environmental location. I think this phenomenon is sufficiently complex to cover in a separate article. Here I would rather focus on the Paleoamerican site of Bonfire Shelter and show how fossil pollen solved an important mystery.

Bonfire Shelter is a unique site in southwest Texas located hundreds of miles south of the Great Plains. During the late Pleistocene and Holocene that region of southwest Texas was outside the normal grazing range of most bison herds, yet Bonfire Shelter is famous for being a site where large herds of ancient bison were stampeded over a cliff to their death.

When excavated, Bonfire Shelter presented a puzzle for archaeologists. In the bottommost cultural deposits there were broken bones of Pleistocene megafauna and hints that they had been killed by Paleoamericans. In two separate intervals above those deposits there are thick layers of fossil bison bones. Each of those two zones contains the remains of hundreds of bison that were driven to their deaths in multiple jumps. Archaeological evidence suggests that the bison jumps took place fairly quickly and that the bones in each of the two intervals accumulated during a period of no more than about 100 years.

The lower, thick deposits of bison bones are dated to the Folsom era and are associated with artifacts from that Paleoamerican period around 11,500 years ago. The upper bison bone layer contains stone tools from fairly modern Indians and the deposits have been dated as being around 2,500 years old. What puzzled archaeologists was why Bonfire Shelter had been used as a bison jump site during only two short intervals. Also puzzling was why, for the 8,500 years in between those bone deposits, the site had been completely abandoned.

Fossil pollen studies of the deposits in Bonfire Shelter and from sediments in other nearby archaeological sites revealed the answer. It seems that during the past 12,000 years the climate in southwest Texas was initially cooler and vegetation contained sufficient grass and brushy vegetation to support various species of Pleistocene megafauna. Later, the brushy vegetation was replaced by grasses that reached their maximum coverage only twice. In other words, local grazing conditions were ideally suited for large bison herds only twice, each for only a brief interval, during the last 10,000 years. During each maximum grass period bison jumps occurred at Bonfire Shelter. Strangely, at other nearby archaeological sites, which were occupied during both of these maximum grass intervals, bison bones are absent or exceedingly rare. These data suggest that even though bison were plentiful, they were not hunted by local Indians living in the Bonfire Shelter region. Instead, archaeologists now believe that only skilled, nomadic hunters who followed the bison herds south understood how to kill bison and that twice they discovered that the cliff above Bonfire Shelter was an ideal location for bison jumps. At other sites near Bonfire Shelter it appears that local groups hunted smaller animals such as deer, rabbits, and a variety of small rodents throughout the last 10,000 years.

The pollen records at Bonfire Shelter are important for another reason. The Devil's Mouth site is located on the banks of the Rio Grande River 60 miles southeast of Bonfire Shelter. When it was first excavated, radiocarbon dating was not possible for most of the upper strata. Fortunately, fossil pollen was preserved in those upper zones at the Devil's Mouth site, and the pollen types were found to be similar to those found at Bonfire Shelter. By matching similarities in both pollen records, it was possible to assign estimated dates for some deposits at the Devil's Mouth site. More than a decade later when renewed excavations at the Devil's Mouth site uncovered charcoal-filled hearths, the resulting radiocarbon dates revealed that the ages of those deposits differed by less than 100 years from the estimated dates previously assigned to them by the pollen record. Fossil pollen cross-dating of archaeological sites does not always work this well, but when it does it is impressive.

Unfortunately, few of the earliest sites associated with the first Americans and Paleoamericans have been thoroughly tested for fossil pollen. Of the few sites where fossil pollen studies have been conducted, some, like Bonfire Shelter, have yielded stunning results. However, at most sites the pollen results have been inconclusive or controversial. Next time I will examine the problems of pollen sampling, pollen preservation, and pollen interpretations as they apply to the myriad sites associated with the first Americans and other Paleoamericans.

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About the author Vaughn M. Bryant, director of the Palynology Laboratory at TAMU, regularly teaches introductory-level anthropology courses to large sections (250-plus students) as well as specialized graduate courses. Dr. Bryant was educated at the University of Texas in Austin, where he received a B.A. in geography, an M.A. in anthropology, and in 1969 his Ph.D. in botany. He began his tenure at TAMU in 1971, when he taught the first anthropology courses to small classes of students. Bryant was instrumental in forming the Department of Anthropology at TAMU. Appointed the first Department head, he held that leadership position until 1999, when he stepped down to become the Director of the Center for Ecological Archaeology on campus. In 1990 he received the Distinguished Achievement Award for Administration. Only one such award is presented by TAMU annually.

Bryant is internationally known for his research in pollen analysis and prehistoric diet reconstruction, and for his work in reconstructing paleoenvironments. He has won world acclaim for his pioneering efforts in using pollen data to track and combat agricultural insect pests, to verify premium grades of honey and confirm the geographical origin of commercially imported and exported honey, and as a forensic tool in criminal and civil legal cases. He coauthored *Pollen of the Southeastern United States* and coedited *Pollen Records of North American Quaternary Sediments*; his book *Through the Looking Glass,* now in the second edition, is a popular text used in introductory anthropology courses. Articles by him and about his research have appeared in many popular U.S. and international magazines including *Scientific American, People, Reader's Digest, National Geographic World, Der Spiegel,* and *The World and I.* Bryant has been a guest on many local and network TV programs including the *Today Show, 1-2-3 Contact,* and *Fox-Network News*; his research was the focus of BBC and *Discovery* program specials that aired in 2002.


VAUGHN M. BRYANT

Bryant has served as journal editor, managing editor, vice president, and president of the American Association of Stratigraphic Palynologists. In 1994 he chaired the Organizational Committee of the 9th International Palynological Congress. Currently he serves as a trustee and the Secretary for the American Association of Stratigraphic Palynologists Foundation. In 1999 he was the recipient of the Distinguished Service Award granted by the American Association of Stratigraphic Palynologists—only 12 such awards have been presented during the 30-year history of the society.

Texas Marsh Reveals 13,000-year-old Human Remains

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Cocklebur Slough near the BZT-1 site gives an idea of the beautiful—and treacherous—terrain where Brazoria Woman met her fate during the Ice Age.

ALONG THE COASTAL PLAIN OF TEXAS, where the humid summer air hangs limp over the flat land, the ground appears deceptively solid. Beneath the grass- and sedge-covered surface lie ancient sloughs and ponds now filled with quick mud. Almost invisible from eye level, the quick mud traps anything or anyone heavy enough to break through the thin vegetated crust. Local legends tell of unlucky people slipping suddenly under the surface. Sometimes their bodies are recovered, but often they disappear without a trace.

In April 1999, fragments of bone were discovered in the wall of a borrow ditch at San Bernard Wildlife Refuge, on the coastal plain in Brazoria County southwest of Houston. The backhoe operator wasn't certain the bones were human, but the fragmented skullcap was certainly the right size and shape. When Refuge superintendent Jack Crabtree learned of the discovery, he couldn't guess the antiquity of the bones or the terrible fate of their owner.

The U.S. Fish and Wildlife Service hired CRC, International Archaeology and Ecology, LLC, from Spring, Texas, to investigate the skull. In April 2001, CRC principal investigator Bob d'Aigle and lab director Nataliya Hryshechko got their first look at the remains. For two years the remains had lain undisturbed beneath layers of gray, sticky mud and plastic sheeting. When the covering was pulled back from the sloping side of the borrow ditch, white bone fragments caught d'Aigle's eye. The bones were confined to a circular area about 15 cm across. Around the perimeter, bone fragments standing on edge suggested the rest of the skull lay buried in the ground. After photographing the skull, d'Aigle and Crabtree replaced the plastic and mud over the remains. The site was assigned designation BZT-1.

Starting to unravel the mystery

A month later, d'Aigle was back at the site. The borrow ditch had been dug in a dry marsh crisscrossed with sloughs. In the ditch wall, d'Aigle could see two layers of gray marsh sediment separated by a darker gray soil. The bones were located just beneath the soil in wet clay, which bore no evidence of a grave. He thought the bones were at least as old as the dirt encasing them

and that the soil was probably the same as found in other ditches throughout the region, which had been dated to 5000 years ago. d'Aigle therefore confidently assumed the bones were mid-Holocene in age. Just to be sure, he collected a few bone fragments for radiocarbon dating.

Because of the weathered condition of the bones, d'Aigle wasn't convinced they were human. He sent a few bone fragments to the Paleo Research Institute in Colorado, where the protein content of the bone could be analyzed. If human protein was preserved in the bones, it would confirm their origin.

d'Aigle also sent sediment samples to Paleo Research. Because the bones didn't appear to be in a grave, the remains may have washed in from a burial elsewhere. However, presence of human protein in the sediment surrounding the skull would be a strong indication that the flesh surrounding the skull had decomposed in place—which would open the possibility that the entire body had come to rest there. Perhaps there was more to this find than just the top of a skull.

In June, Paleo Research confirmed that protein in the bone fragment was exclusively human and that dirt next to the skull also contained human protein: the skull was human, and the body might be in the ground. Absent a grave, the evidence from Paleo Research suggested that, however the person had died, the body had been rapidly buried by natural processes.

The news on a bone fragment sent to Beta Analytic for radiocarbon dating was disappointing: the bone fragments were too weathered to date. Unless d'Aigle could obtain teeth, which are more resistant to weathering and might be datable, he would have to forgo radiocarbon dating. He weighed his options; he had met the requirements of the project scope of work and had long ago exceeded the project budget, but something still nagged him about the site. He was convinced there was more to this person's story. Dipping into CRC coffers, he found funds for additional work.

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The Brazoria Woman skull as first seen by d'Aigle and Hryshechko.

In mid July, d'Aigle returned to the BZT-1 site with forensic anthropologist D. Gentry Steele of Texas A&M University. If anyone could piece together the story of how this individual had come to be buried in the Texas coastal plain, Dr. Steele could do it. Together they unearthed the rest of the skull. Directly underneath it, they found the jawbone with some teeth still attached, along with two vertebrae and a piece of collarbone. From all indications, the rest of the body was preserved in the ground beneath the skull as if the individual had been buried standing or sitting up.

Back in the lab, Steele arranged the bone fragments in anatomical position. Delicate facial features led him to believe the person was female; the pattern of bone suturing suggested she was in her early- to mid-twenties at death. The teeth were in good condition and without cavities. Hyperplasias, markings on teeth that indicate periods of starvation during childhood, were completely absent. There was no evidence of head trauma that might have caused death and no evidence of cremation.

A tragic discovery

d'Aigle still didn't have a clear picture of how this person—now dubbed Brazoria Woman—had come to die in this lonely expanse of marsh. Absence of trauma to the skull argued against a violent death, although without the rest of the skeleton it was hard to be sure. She hadn't been cremated, and there was no evidence of a grave. It was as if the woman had been rapidly buried by the earth, almost consumed by it.

Then it struck him. If she had been walking through the marshlands and strayed from solid ground, could she have become mired in a patch of quick mud? Ground penetrating radar would later reveal the presence of an ancient slough running through the site. Brazoria Woman's skeleton was located along the margin of the slough, her head positioned just beneath its ancient surface.

A haunting picture emerged. Brazoria Woman, almost certainly a mother given her age, may have been traversing the marshland, picking her way through the grasses and sedges, when she missed her footing and plunged feet-first into the thick mud of the slough. She would have struggled to exhaustion against the mud's terrible drag downward, her calls for help becoming more frantic as her strength ebbed, until finally her head slid beneath the surface.

Surprising answers—and more questions

Who was this woman who died such a lonely death on the marshlands of Texas? Where did she and her people come from? What can she tell us about her kinfolk, the people who must have

searched the marsh for her and left with heavy hearts?

During Steele's visit, d'Aigle sent additional samples for radiocarbon dating at the University of Arizona. Still convinced the remains dated to the middle Holocene, d'Aigle was stunned when he received the results: 10,740 ± 760 RCYBP, about 13,000 CALYBP. The remains aren't just old. They are the oldest known human remains in Texas and among the oldest known from the Americas.

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Teeth from Brazoria Woman.

d'Aigle knew then that he wanted to return to the site, for there was so much this woman could tell us about the earliest Americans. Her bones might tell us about patterns of disease and aging among these earliest Texans. DNA extracted from samples of bone or teeth might link her to other groups who first peopled the southern U.S. and Mexico. Genetic studies might also link her to ancestral populations in Asia and help to solve the question of Native American origins. The tools she carried with her, if recovered, might suggest the kinds of tasks she performed; they would also reveal what one woman's toolkit looked like, which might give valuable clues for interpreting stone tools found at other archaeological sites.

The University of Arizona radiocarbon analyses held another surprise for d'Aigle: isotopic clues about Brazoria Woman's diet hint she'd traveled far before dying on this bit of coastline. One of the measurements made in the process of radiocarbon dating is the relative amounts of carbon-13 and carbon-12 isotopes present in the organic (non-mineral) portion of a bone sample, known as the $\delta^{13}C$ value. Like its much more common cousin carbon-12, carbon-13 occurs in the atmosphere and is taken up by plants and the animals that feed on them. Grasses and succulents native to hot environments (known as C_4 plants) take up carbon-13 and carbon-12 in noticeably different proportions than do plants such as trees, bushes, and roots (C_3 plants). Therefore an individual who consumes only desert grasses can be readily distinguished from one who never eats them by the relative amounts of carbon-13 and carbon-12 in their bones. The $\delta^{13}C$ value for one whose diet consists entirely of marine resources lies approximately midway between these two endpoints.

The typical maximum $\delta^{13}C$ value for the bones of a person whose diet consists entirely of fruits, nuts, roots, temperate grasses, and animals dependent on these resources is about -21‰ (-21 parts per thousand). The Brazoria Woman bone fragment measured by the University of Arizona has a $\delta^{13}C$ value of -26.5‰.

d'Aigle was baffled, for he believed such an extreme $\delta^{13}C$ value would only be possible if Brazoria Woman had spent the previous several years in a tropical forest, where the closed canopy reduces air circulation and thereby alters the relative amounts of carbon isotopes available for uptake by plants. But there is no evidence of tropical forests in Texas 13,000 years ago. At the time Brazoria Woman lived, the Texas Gulf looked very much as it does today, although lowered sea levels had moved the coastline about 100 miles farther into the Gulf. Perhaps, d'Aigle thought, she had come from farther south, perhaps from around the Yucatan Peninsula, where tropical forests existed during her lifetime.

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Bob d'Aigle and Nataliya Hryshechko.

The mystery deepened when he received quite contradictory isotope analysis results on tooth samples sent to Robert Tykot at the University of Florida. The $\delta^{13}C$ value of adult teeth reveals the diet during childhood, when the teeth develop. Dr. Tykot's analysis of one of Brazoria Woman's molars indicates a diet of a mix of marine foods and terrestrial plants that might be expected of someone living along the Gulf coast. These data suggest that Brazoria Woman was raised along the coast, away from interior tropical forests, perhaps even near where she died.

There are several ways to look at the isotope data. One is to argue, as d'Aigle does, that the bone data are right and that weathering of the teeth has altered the original isotope ratio,

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Hryshechko and d'Aigle take sediment samples for protein, chemical, and mineralogical analysis.

yielding a false $\delta^{13}C$ determination. An alternative explanation, held by Tykot, is that the bones may have been weathered, resulting in an anomalously large $\delta^{13}C$ value.

A third possibility is that both $\delta^{13}C$ values are correct. The early inhabitants of the Americas were probably few in number and spread out widely across the continents. In hunter-gatherer groups, a woman may marry out of her family group and move quite far from her kin over the course of a lifetime spent with her new family. Brazoria Woman may have been raised along the Gulf coast and thereafter spent much of her adult life in the tropical forests of the Yucatan Peninsula or Central America. Perhaps she married into a group living in such an environment. Perhaps, with no boundaries to restrict movement, she and her group had recently ventured into the food-rich marshlands of the Gulf coast.

Additional isotopic analyses might determine which of these scenarios is closest to the truth. Tykot has suggested comparing the ratios of strontium isotopes in the bones and teeth to see if they formed in similar environments; equally revealing would be bone analysis to determine if weathering can account for the observed $\delta^{13}C$ value.

d'Aigle is open to new tests, but for now he is optimistic that the bone data will be proven correct. Compared with the migration into the Americas, the journey from Central America to Texas would have been short. Such a trip, he argues, "would not have been difficult, particularly give the relatively uniform environment of the Gulf Coast."

–Ariane Pinson

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Suggested Readings

Additional information about BZT-1

d'Aigle, R. P., and N. V. Hryshechko, *Cultural Resources Investigation, Intensive Survey and Site Testing At BZT-1, San Bernard National Wildlife Refuge, Brazoria County, Texas*, published by CRC, International Archaeology & Ecology, LLC, for the United States Department of the Interior Fish and Wildlife Service, July 2002, Contract No. 201811M159. The report is available online at www.culturalresource.com/pan.html

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About the author Ariane Pinson writes about archaeological, geological, and paleoenvironmental issues. Dr. Pinson is the founder of Renaissance Science Consulting (Web site www.rensci.com) and is Adjunct Assistant Professor of Anthropology at the University of New Mexico, where she received her doctorate in 1999.