MAMMOTH TRUMPET

Volume 22, Number 3 ▪ July, 2007

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

LARRY AGENBROAD

Human kill or natural cataclysm?

Students work at the bison bonebed at the Hudson-Meng site in northern Nebraska in the 1973 field season, which saw the largest one-time exposure of bones. For geoarchaeologist Larry Agenbroad, who directed initial excavations in 1968, the bonebed is unmistakable evidence of a massive kill event. Equally convinced, however, are archaeologists Larry Todd and David Rapson that artifacts found at the site were left by humans who visited the bonebed after the bison had died, most likely in a natural disaster. Opposing sides state their cases in our story on page 14.

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.

MAMMOTH TRUMPET

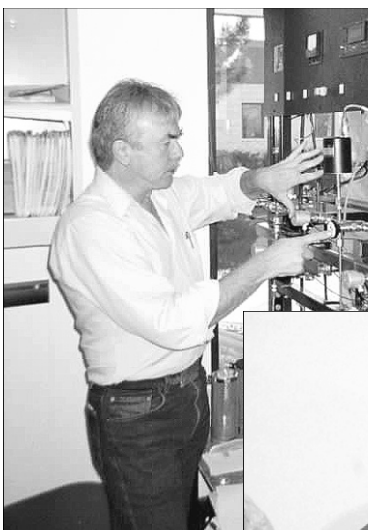
Volume 22, Number 3 | Center for the Study of the First Americans | Department of Anthropology
July, 2007 | Texas A&M University, 4352 TAMU, College Station, TX 77843-4352 | ISSN 8755-6898

World Wide Web site http://centerfirstamericans.org and http://anthropology.tamu.edu

Clovis Dethroned

A New Perspective on the First Americans—Part 1 of 2

NO MATTER HOW BELOVED or well supported a theory may be, ultimately it's just a hypothesis and must yield to any data that prove it wrong. The Copernican Revolution firmly placed the Earth in orbit around the Sun, shattering the thousand-year-old Ptolemaic theory of the universe; similarly, medical science has proven beyond doubt that microbes and metabolic disorders cause diseases, not evil spirits or excesses of ill humors. Like any science, American archaeology has its own long-standing and cherished theories; and in the face of new evidence, it appears that one of the most abiding, the Clovis-First model, must now bow out of the debate. According to research published in the 23 February 2007 issue of *Science* by CSFA Director Mike Waters and geochronologist Tom Stafford, it's impossible for the Clovis people to have been the First Americans.



THOMAS STAFFORD

MICHAEL R. WATERS

Tom Stafford (*above*) and Mike Waters

Time for a paradigm shift?

For nearly a century, distinctive artifacts of the Clovis culture have been found at archaeological sites throughout the continental United States, with a few outliers in southern Canada and northern Mexico. The radiocarbon record for these early occupations has led most researchers to

INSIDE

4 On the trail of early humans in the Great Basin
Joel Janetski has evidence of occupations dating to the early Archaic—and he hasn't reached the lowest levels of the North Creek Shelter in southern Utah.

7 The Snake River claims a tantalizing Clovis-age site
Dammed waters have swallowed the Marmes Rockshelter, whose occupants were among the earliest in Washington State.

11 Clues to Pleistocene extinctions
Why did some megafauna species in the Far North survive when others didn't? A scientist assesses the roles of humans and changing climate and plants.

14 What killed the bison?
Authorities disagree on whether a massive bonebed in Nebraska is the aftermath of a human kill or the result of a natural event.

17 Converting radiocarbon years to calendar years, with ever-increasing accuracy.
In his lab at UC–Irvine, John R. Southon is continually honing the tools we use for dating ancient organic materials.

believe that Clovis reigned from approximately 11,500 to 10,900 RCYBP; consequently, it was widely believed that Clovis represented not just the oldest widespread culture in the Americas. Clovis was unequivocally the oldest culture. Period. Sure, evidence suggesting pre-Clovis occupations has always existed, but in the past it was considered spotty at best, or could be convincingly explained away.

But credible pre-Clovis evidence has now been piling up for decades, and many researchers in the field have become convinced that people were in the New World well before Clovis—possibly millennia before. Then in February came the report in *Science*, matter-of-factly titled "Redefining the Age of Clovis: Implications for the Peopling of the Americas." In fewer than five pages, Waters and Stafford have demonstrated that the Clovis heyday occurred much later, and for a shorter period of time, than previously realized.

This revelation came about as a result of their general dissatisfaction with the state of the existing Clovis radiocarbon record. "This dating project started because we realized that the age of Clovis was based on radiocarbon dates that had been generated over a forty-year time period using changing technologies," Dr. Waters explains. "When we looked at the Clovis date record, we discovered that many of the dates were generated using old radiocarbon technologies or on unreliable sample types. Also, the standard deviations on many of them were very large." Some of the original Clovis dates had standard deviations of up to 250 years; these days, geochronologists can tighten up a standard deviation to as little as 25–30 years.

In order to accurately determine the age range for Clovis, Waters and Dr. Stafford acquired as many samples as possible from documented Clovis sites. "We contacted Adrien Hannus, George Frison, and others," Waters says, "and they graciously provided samples for dating." When they couldn't redate a particular site, Waters and Stafford examined the site's existing radiocarbon date set and culled dates that were obviously flawed. Ultimately, they collected 43 radiocarbon dates on all the known, datable Clovis sites, 10 of which were either redated or dated for the first time. Data from other early sites were also included in the study.

The new dates obtained by Waters and Stafford were generated on bone, charcoal, and seeds, using highly accurate accelerator mass spectrometer (AMS) dating methods. "We're both stratigraphers and geoarchaeologists," Stafford says, "and between the two of us we had seen, worked at, or been otherwise directly involved in the fieldwork at the newly dated sites. This geological experience enabled us to prevent collection errors, assess differences in geological opinions among archaeologists, geologists and paleontologists, and thereby focus the final dating on materials and horizons that would definitely provide data to answer our questions."

Unexpected results

Waters and Stafford found that their new dates fell between a minimum range of 13,125–12,925 CALYBP and a maximum

MAMMOTH TRUMPET

The Mammoth Trumpet (ISSN 8755-6898) is published quarterly by the **Center for the Study of the First Americans,** Department of Anthropology, Texas A&M University, College Station, TX 77843-4352. Phone (979) 845-4046; fax (979) 845-4070; e-mail csfa@tamu.edu. Periodical postage paid at College Station, TX 77843-4352 and at additional mailing offices.

POSTMASTER: Send address changes to:

Mammoth Trumpet
Department of Anthropology, Texas A&M University
4352 TAMU
College Station, TX 77843-4352

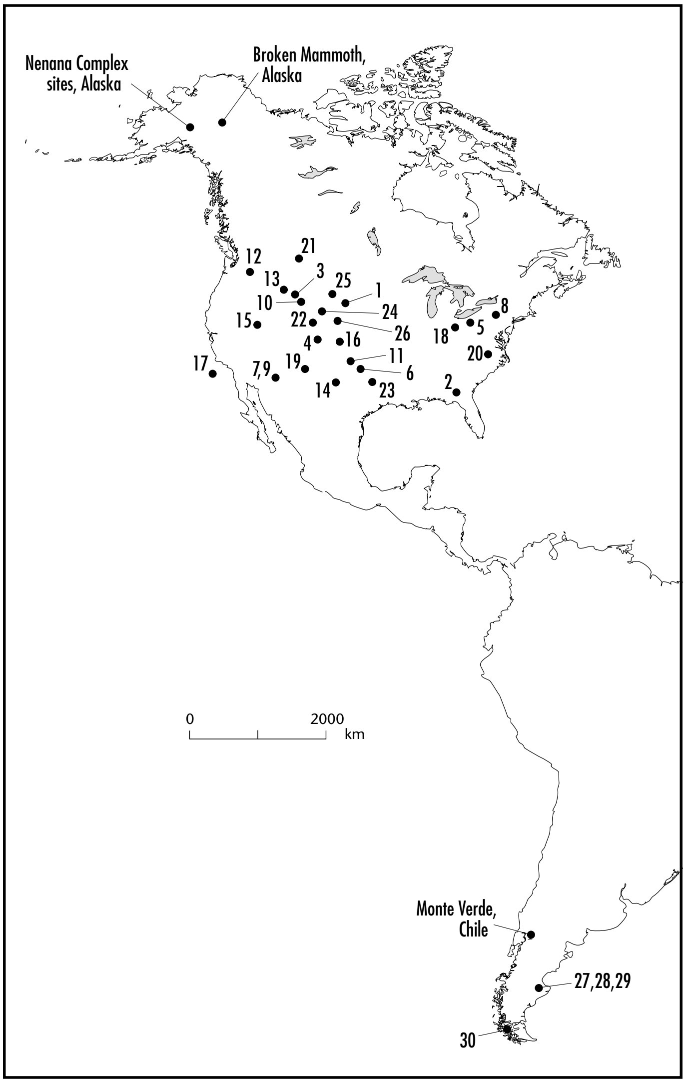
Mammoth Trumpet, Statement of Our Policy

Many years may pass between the time an important discovery is made and the acceptance of research results by the scientific community. To facilitate communication among all parties interested in staying abreast of breaking news in First Americans studies, the **Mammoth Trumpet**, a science news magazine, provides a forum for reporting and discussing new and potentially controversial information important to understanding the peopling of the Americas. We encourage submission of articles to the Managing Editor and letters to the Editor. Views published in the **Mammoth Trumpet** are the views of contributors, and do not reflect the views of the editor or **Center** personnel.

–Michael R. Waters, Director

range of 13,250–12,800 CALYBP. This gave Clovis a duration of some 200 to 450 years, a relative eye-blink in archaeological terms. As Waters points out, this creates several problems for the Clovis-First model. First of all, he says, "There are credible sites in South America that are the same age as Clovis. The dates from these sites are solid, and most archaeologists haven't found fault with them. We have people living in North and South America at the same time. So how could Clovis be first?"

Then there are the demographic objections: According to published models, it's unlikely that hunter-gatherers entering the New World from the north could have traveled to the southern tip of South America in less than 500 years. "It just wasn't enough time for people to adapt to the new environments they encountered," says Waters. "These people would have crossed through forests, grasslands, deserts, and rain forests. In each of these they had to find raw materials for tools, learn the behavior of new animal species, and learn which plants were edible. When you look at the evidence for Clovis, these people seem to be settled into the landscape. They knew the environments they were in; they knew where the good flints and cherts were located. This just didn't make sense if Clovis were the first to enter the Americas."



Clovis and other early sites. Numbers correspond to those in table at right.

The most convincing data, of course, were the dates themselves. "What really pushed me over the edge was the really young ages from the Clovis sites," Waters admits. "I was stunned that the age of Clovis collapsed from 11,500–10,900 to 11,050–10,800 RCYBP."

Summary of ^{14}C dates from Clovis and Clovis-age sites. All dates are given at one standard deviation; n = number of dates.

Site	Date (RCYBP)
Clovis sites (credible ages and Clovis diagnostics)	
1. Lange-Ferguson, SD (n = 3)	11,080 ± 40
2. Sloth Hole, FL (n = 1)	11,050 ± 50
3. Anzick, MT (foreshaft ages) (n = 2)	11,040 ± 35
4. Dent, CO (n = 3)	10,990 ± 25
5. Paleo Crossing, OH (n = 3)	10,980 ± 75
6. Domebo, OK (n = 1)	10,960 ± 30
7. Lehner, AZ (n = 12)	10,950 ± 40
8. Shawnee-Minisink, PA (n = 5)	10,935 ± 15
9. Murray Springs, AZ (n = 8)	10,885 ± 50
10. Colby, WY (n = 2)	10,870 ± 20
11. Jake Bluff, OK (n = 3)	10,765 ± 25
Clovis sites (indirectly dated and Clovis diagnostics)	
12. East Wenatchee, WA (n = 1)	<11,125 ± 130
Clovis-age sites (credible ages but no Clovis diagnostics)	
13. Indian Creek, MT (n = 1)	10,980 ± 110
14. Lubbock Lake, TX (n = 2)	11,100 ± 60
15. Bonneville Estates, NV (n = 1)	11,010 ± 40
16. Kanorado, KS (n = 2)	10,980 ± 40
17. Arlington Springs, CA (n = 1)	10,960 ± 80
Problematic Clovis and Clovis-age sites	
18. Sheriden Cave, OH (above artifacts, n = 5)	10,600 ± 30
Sheriden Cave, OH (below artifacts, n = 2)	10,920 ± 50
19. Blackwater Draw, NM (n = 3)	11,300 ± 235
20. Cactus Hill, VA (n = 1)	10,920 ± 250
21. Wally's Beach, Canada (n = 4)	11,350 ± 80 to 10,980 ± 80
22. Union Pacific, WY (n = 1)	11,280 ± 350
23. Aubrey, TX (n = 2)	11,570 ± 70
24. Sheaman, WY (n = 3)	10,305 ± 15
Ages from other early sites	
25. Mill Iron, MT (Goshen) (n = 4)	10,840 ± 60
26. Hell Gap, WY (Goshen) (n = 1)	10,955 ± 135
27. Cerro Tres Tetas, Argentina (pre-Fishtail, n = 5)	10,935 ± 35
28. Cuevas Casa del Minero, Argentina (pre-Fishtail, n = 2)	10,985 ± 40
29. Piedra Museo, Argentina (pre-Fishtail, n = 2)	10,960 ± 45
30. Fell's Cave, Chile (Fishtail, n = 1)	11,000 ± 170

Just like that, Clovis was no longer first, and there were sites in the Americas that were indubitably older. The proof of a genuine pre-Clovis occupation is something that many of us have been prepared to face for quite some time; indeed, some would say it's overdue, since the weight of the evidence has been tilting in that direction for years. In addition to the South American localities Waters cites, there are solidly dated sites in Alaska that are older than Clovis, especially those belonging to the Nenana complex. Other sites with arguable radiocarbon

continued on page 20

Early Americans in Utah: They're Getting Earlier

Project director Janetski watches as University of Nevada Ph.D. candidate David Yoder clears pits associated with the early-Archaic use surface, 2006 season.

A ROCKSHELTER IN SOUTHERN UTAH is offering a rare and tantalizing glimpse of survival strategies used by people occupying the northern Colorado Plateau near the sunset of the last Ice Age.

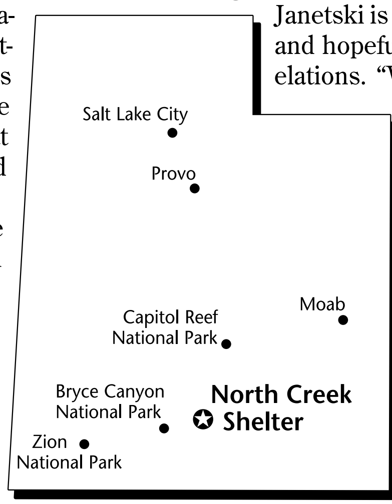
After three seasons excavating at North Creek Shelter just west of Escalante, researchers still haven't reached the bottom of cultural deposits showing evidence of human habitation 9,500 radiocarbon years before present (RCYBP), or about 11,000 calendar years ago. Finding culturally rich soils 3.2 m below ground surface raises hopes that excavations in 2007 will yield further clues to when people entered the area during the terminal Pleistocene/early Holocene, according to Joel C. Janetski, a professor at Brigham Young University and the project's principal investigator.

Particularly significant has been the discovery of a heavily used living floor, possibly a pit house, with multiple pits, hearth, and surrounding tool scatter showing occupation around 8000 RCYBP—about 9000 CALYBP—putting it solidly in the early-Archaic period, a rare Great Basin find.

Excavators hope to define more clearly the feature this season, says Dr. Janetski, who outlined the project's preliminary findings at the 2006 Great Basin Archaeological Conference in Las Vegas, Nevada.

The changing picture of early-Archaic peoples

If researchers declare the feature a pit house, it will reinforce a growing, although as yet sparse, regional database suggesting early-Archaic peoples repeatedly used sites over extended periods; this marks a substantial departure, says Janetski, from the common view suggested by earlier research that they only left ephemeral traces in their rapid passage across the land.



There's no question that these early people were hunters and that large animals were a rich source of their protein. When faunal evidence gathered from this living floor—and possible pit house feature—is analyzed, Janetski is confident the results will show that these early-Archaic people preyed heavily on large game animals, primarily deer. That would imply a subsistence pattern quite different from that envisioned by earlier studies, which theorized a survival strategy for early-Archaic peoples that was dominated by small game. "We don't really know what to make of that," Janetski concedes. "I tend to follow an evolutionary ecology model that says if large game was available they [early peoples] were going to take it" in preference to smaller animals.

The feature comprising the intensive-use area also contains numerous artifacts, including a scattering of Pinto shouldered points diagnostic of early-Archaic occupation.

Excavators also have retrieved extensive floral evidence from the deeper levels, Janetski reports. Although analysis of those data, and theories of how they may fit into subsistence patterns and environmental conditions, await the arrival of more research money, preliminary inquiry has already given researchers some new paleoenvironmental insights. Charred fragments of Douglas fir and aspen, for example, suggest a moist environment at the site akin to that found at higher elevations on the Colorado Plateau. Increased moisture would also produce a greater rate of soil deposition around the rockshelter during early occupational periods, he adds. Research has revealed that 2 m of sediments accumulated over a 2,000-year period of the early Holocene, and less than 1 m over the subsequent 9,000 years.

A good start with bright long-term prospects

Janetski is excited by what the project has so far yielded and hopeful about its potential prospects for future revelations. "What we have here is unique," he explains. "There are simply no data for the area like this." This project, he feels, "will give us a glimpse into a time period that we simply haven't had before. . . . We don't have any conception of how people used this area because we don't have any dates from this time in this area."

Prospects for the project are certainly good, particularly with respect to the site's choice location. At 1,875 m elevation, the site is on private land at the base of a sandstone cliff 400 m east of North Creek, which flows into the Escalante River a few hundred meters southwest of the site. The site is also adjacent to Grand Staircase–Escalante National Monument excavations with which Janetski has a long association.

"North Creek is the largest tributary of the Escalante River and would have provided a reliable water source in the past," Janetski writes in his paper. Since the site has a south-to-southwest-facing aspect, it may have benefited from solar heating much of the year. In fact, a graduate student is conducting a full year of tests to determine the efficacy of solar heating for the site. It is just one of many student projects sired by the excavations.

Native Americans left evidence of a long presence in the area. Abundant examples of painted and pecked rock art with Fremont- and Archaic-style elements festoon the overlooking


BRADLEY NEWBOLD

cliff face, and a broad assortment of chipped-stone debris, ground stone, ceramics, bone fragments, and historic dung dot the land around the base of the cliff containing the rockshelter. Researchers also have found several Fremont-age granaries in the area.

Intensive study began there in 2004, Janetski recalls, when BYU's field school received permission to dig from landowners Jeffrey and Joette Rex. Excavations in 2004 and 2005 primarily outside the drip line of the rockshelter uncovered rich evidence of Fremont and Archaic materials. The 2006 excavations, which expanded on previous excavations and focused on deeper levels, yielded the possible pit house and more deeply buried paleoarchaic materials. Janetski, charting future research efforts, intends to focus more intensely on these earlier materials and levels.

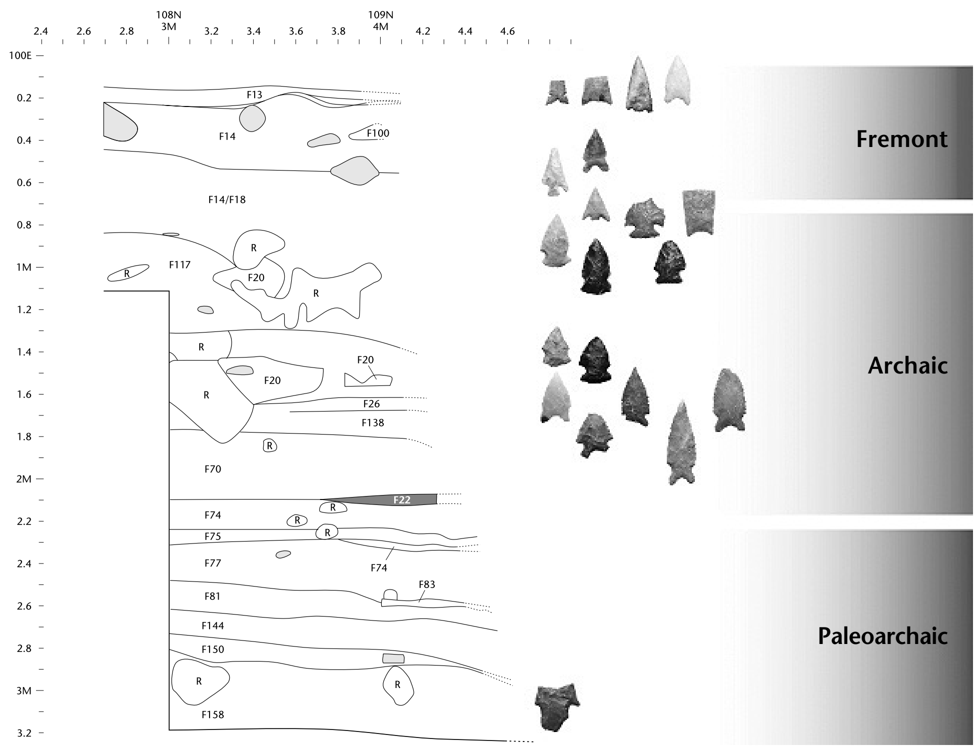
How far back can we date the earliest settlers?

Although existing evidence falls short of putting this site unequivocally in the realm of Paleoamerican occupations, Janetski hopes that Clovis-age materials may yet surface. Indisputable Paleoamerican status, he reminds us, demands evidence of extinct animals and tools consistent with Paleoamerican usage, such as fluted projectile points. He is quick to note, however, that researchers have already perceived a distinct shift from bifacially flaked to unifacially flaked tools in the lowest levels and a decrease in the number of grinding tools, unmistakable signals that they have penetrated older cultural strata.

Janetski recalls that interest heightened dramatically when researchers found the intensely used living surface and possible pit house, which also contained a hearth and what may be post holes, recesses for storage, and possible cooking pits. The pits, Janetski explains, average 35 to 40 cm in diameter. Several have reddened rims, suggesting they were used for food processing; others aren't reddened and may have been used for storage. The shallow hearth contains considerable charcoal. Nearby artifacts include two unifacially flaked cobbles and a mano.

Research interest peaked on the last day of the 2006 excavation, when researchers hit the basal fragment of a shouldered and stemmed projectile point made of bright red chert in an area below the level of the possible pit house. The toolstone is exotic to the immediate area, but similar to that found in the Glen Canyon/Capital Reef areas to the east, still within Utah. "When you don't hit bottom [of the cultural layer] and you find a stemmed point made of exotic material, it really heightens your interest, I can tell you," Janetski tells us.

The deepest levels of the excavation also revealed an unusual scraper with steep edge angles, similar to Paleoamerican tools called turtle-



AFTER JOEL JANETSKI

Projectile points associated with the levels where they were found in the North Creek Shelter.

MAMMOTH TRUMPET

Volume 22 ■ Number 3

backed scrapers, that Janetski believes was used to scrape hides. Researchers also are teased by numerous uniface tools, which are often indicative of Paleoamerican occupation. "This is very rare dirt that we are into," Janetski declares, "and we are taking it slow, five centimeters at a time, and taking lots of soil samples for analysis."

Janetski's presentation before the Great Basin Archaeological Conference states that the North Creek Shelter has yielded "the earliest evidence of human occupation on the northern Colorado Plateau, as no sites with dates in excess of 9000 RCYBP on human occupation are reported in this area, and only a handful date to before 8000 RCYBP." (There is an earlier site on the Rainbow Plateau, another part of the Colorado Plateau in northern Arizona.) However, Cowboy Cave in Canyonlands to the east of Escalante does offer some "tantalizing" prospects, for excavators have recovered from it mammoth dung, mammoth tusk fragments, and bones of bison, camel, and sloth, with the oldest dates approaching 13,040 years ago.

Unfortunately, the oldest date at Cowboy Cave associated with human occupation is only 8200 RCYBP. To put this date and the age of North Creek Shelter into perspective, Janetski names sites in the eastern Great Basin, notably Danger Cave, Smith Creek Cave, Wendover, and Bonneville Estates Rockshelter, that have posted dates showing human occupation predating 10,000 RCYBP.

Excitement is growing with the news that other, extremely old Great Basin sites with verified human occupation are beginning to emerge. For example, Paisley Caves in the northern Great Basin region of south-central Oregon has posted dates pushing 14,000 calendar years old. Janetski believes the dates—associated with DNA-verified human dung, and announced at the Great Basin conference—are nudging open the pre-Clovis door in the Great Basin, and may be a harbinger of what's out there waiting to be found. "It is certainly possible we could have some very early stuff down here [at North Creek] because we haven't gotten to the bottom yet," he says. Whether it will reach Paleoamerican age remains to be seen.

But there's certainly plenty of room to expand excavations at North Creek Shelter while looking for a Paleoamerican presence. "This site is massive," Janetski boasts. "I'm sure it covers hundreds of square meters." Excavation so far has exposed about 26 m^2, with only about 3 m^2 opened at the deepest level. Janetski says excavators also hope to explore more intensely the area under the rockshelter overhang.

Janetski is seeking National Science Foundation money for the coming season. Present work has been financed with funds cobbled together from several sources. Students from BYU and the University of Nevada, Las Vegas, conducted most of the excavation; students from the University of Washington assisted in faunal work.

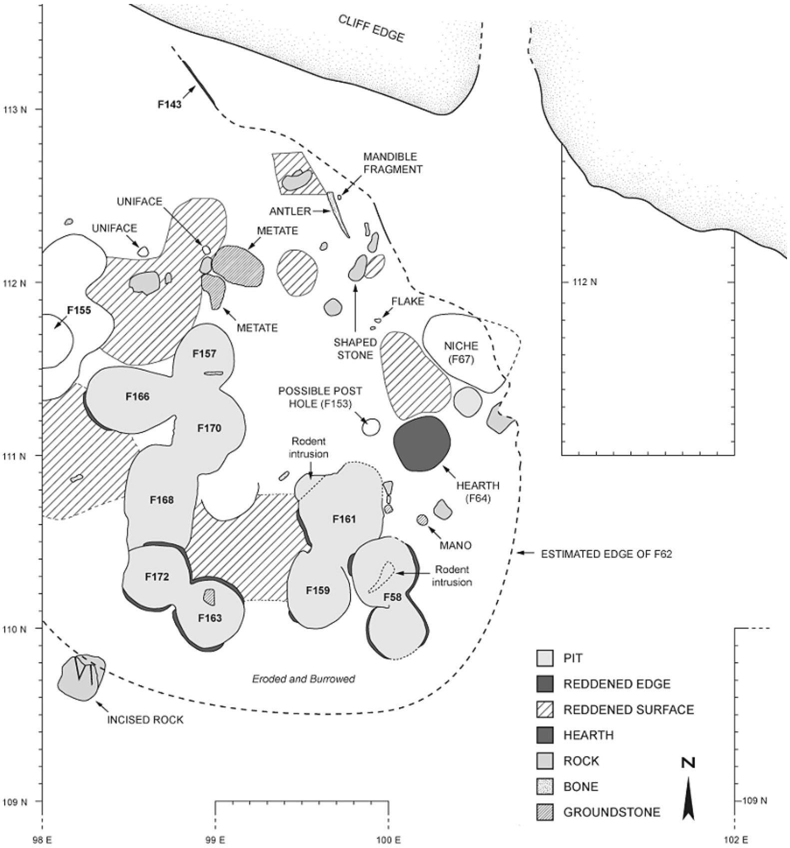
High praise from colleagues

At the Great Basin conference, Janetski's enthusiasm for his project was infectious. Ted Goebel, Associate Director of the Center for Study of First Americans at Texas A&M university, regards it as significant and valuable work in the quest to answer questions surrounding the peopling of the Americas. "We really don't know much about early peoples in that part of the West," says Dr. Goebel, who has been excavating at Bonneville Estates Rockshelter. "We know tons about later cultures such as Fremont, Anasazi, pueblo people, and Archaic hunters and gatherers, but we know little or nothing about Paleoindians there. Just to have a dot on the map and have a site with these kinds of radiocarbon ages and associated features is really a significant thing.

"Really remarkable," says Goebel of Janetski's presentation. "Just the scale of the excavation in and around the shelter and the preservation of the features, maybe even a living surface and pit house of some sort, why, that is unheard of in that region. Usually excavators find small scatters of lithics and animal bones around a hearth, but nothing as substantial as what Joel seems to be finding there."

There is, however, a cautionary rider to Goebel's effusive praise: He considers it possible, judging by results at other Great Basin sites, that extinct fauna may never be found at

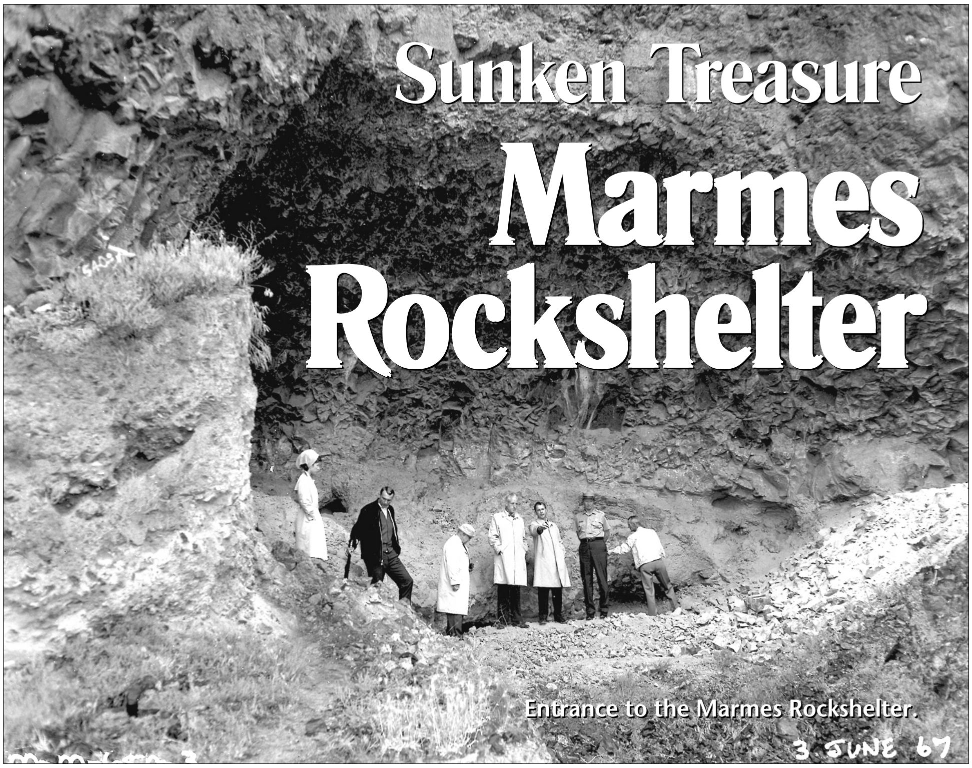
continued on page 13



JOEL JANETSKI

Plan map of F62, the estimated edge of the early-Archaic use surface. The 8000-year-old use surface contained a hearth as well as several small pits with reddened edges, suggesting they may have been used for roasting. A number of chipped- and ground-stone artifacts were lying on the surface.

Sunken Treasure
Marmes Rockshelter



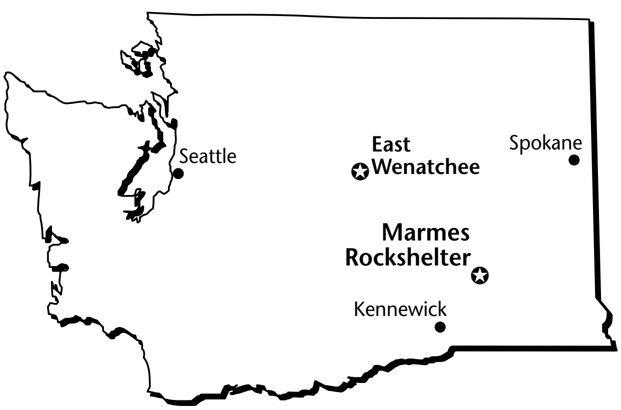
Entrance to the Marmes Rockshelter.

WASHINGTON STATE UNIVERSITY

SUBMERGED UNDER 40 FEET of water in southeast Washington's Lower Palouse River Canyon lies one of the nation's most significant treasures—an archaeological site older than previously thought, and one offering a unique window on Stone Age life.

Marmes Rockshelter (45FR50)—encompassing the rockshelter, a slope in front of it, and an adjacent floodplain—was inundated in 1969 following construction of the Lower Monumental Dam on the Snake River, about 1½ miles to the south. Before the site disappeared, archaeologists hurriedly pulled from it finds that suggest the natural cave and its surroundings were used for shelter, storage, and burials for at least 10,000 years, possibly longer.

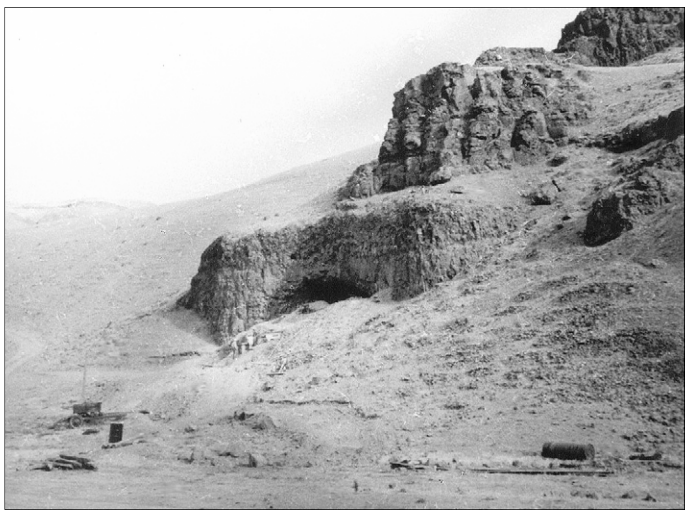
Finds reported at the time included a cremation hearth and the remains of prehistoric people, the oldest of which was believed to have died more than 10,000 years ago—making the bones some of the oldest documented human remains then found in North America. Researchers also bagged thousands of additional artifacts, including animal and bird bones, olivella beads, a bone sewing needle, and an astonishing number of stone tools and debitage.



The rush to retrieve evidence

Led by Dr. Richard Daugherty of Washington State University, a team of researchers conducted emergency salvage operations. Tantalizing hints of the potential for older bones and unfounded suggestions of possible cannibalism at the site sent sensationalist reporters from the national press swarming over the story. Meanwhile, politicians led by then Washington Senator Warren G. Magnuson pried loose federal money to shore up the cash-strapped project—an effort that focused public attention on the need for cultural resource preservation and influenced the passage of antiquities protection laws that included the National Historic Preservation Act of 1966.

Despite these frantic last-ditch efforts to recover Marmes's secrets, archaeologists were forced to abandon the project in 1969 and stood by helplessly as the site was swallowed by swirling brown water. Half-submerged remains of a cofferdam, hastily built in 1968 to protect the site, are today visible from an interpretive overlook at Lyons Ferry State Park.



WASHINGTON STATE UNIVERSITY

Marmes Rockshelter in 1962. View is to the northwest.

But the story didn't end there.

Setting the record straight

More than three decades later the Confederated Tribes of the Colville Reservation, comprising 12 regional tribes, spurred the U.S. Army Corps of Engineers to help finance a reexamination of material recovered from the site and to produce a final

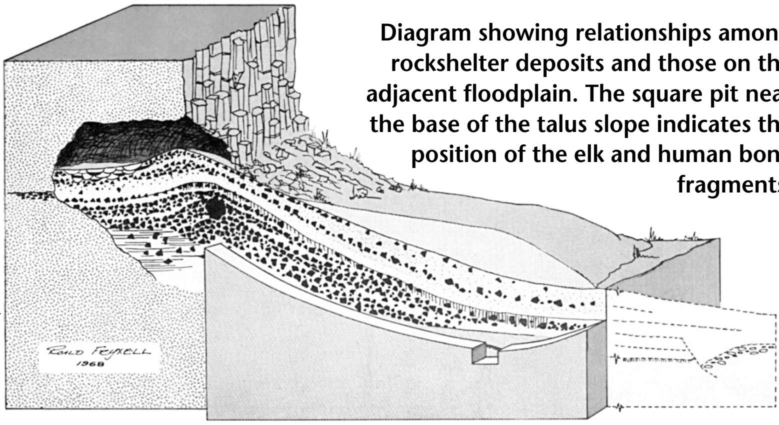
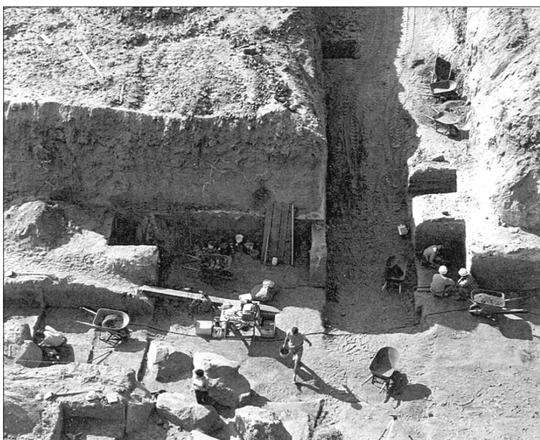


Diagram showing relationships among rockshelter deposits and those on the adjacent floodplain. The square pit near the base of the talus slope indicates the position of the elk and human bone fragments.

AFTER FRYXELL, FROM GUSTAFSON 1972

report that had never been completed. Brent Hicks, now a Seattle-based archaeologist for a private consulting company, headed the effort as archaeologist for the Colville Tribes.

Washington State University published his 446-page final document in 2004, climaxing a 5-year study that analyzed and interpreted the curated archaeological collection and its associated records. The Interpretation section of his final report sets the earliest date for human evidence at Marmes Rockshelter at 11,230 ± 50 RCYBP (Beta-156698), older than the previously announced date of 10,810 ± 50 RCYBP. The new, older date is especially significant because, as Hicks's report notes, it also "push[es] back further the time period when land forms in the Palouse Canyon and the lower Snake River drainage became available for human use after dewatering from the last of the glacial-era floods that had backed up behind Wallula Gap downstream on the Columbia River."



RUTH KIRK

View of the east end of the floodplain ▲ excavation area. Fryxell's original bulldozer trench is at center-right.

WASHINGTON STATE UNIVERSITY

View across the berm of Marmes ▶ Rockshelter, facing west.

The new date comes from a swan bone found atop ponded lake sediments in the lowest portion of the excavation. It's unlikely, says Hicks, that a swan would have wandered into the shelter on its own. In addition, he cites stone toolmaking debitage from associated strata and another swan bone "just above it" that showed signs of butchering as "some pretty good evidence" for the site's revised age. The new date makes Marmes habitation comparable in age to the Richey-Roberts Clovis Cache site in East Wenatchee, Washington. Hicks is quick to state, however, that a precise comparison cannot be made, since no Clovis material was recovered from Marmes. Lacking distinctive Clovis lithic technology, the site might better be compared with other regional sites, such as the Cooper's Ferry site along Idaho's Lower Salmon River, which has a parallel age range and projectile point types of a similar Western stemmed tradition (**MT 13-4,** "Cooper's Ferry Spear Cache One of NW's Oldest Sites").

A humbling experience for a young scientist

Hicks's report refines and enhances data contained in earlier analysis and reporting. Most importantly, he emphasizes, for the first time the artifact catalog, maps, and stratigraphic drawings have been assembled and organized in digital form easily accessible by future researchers.

"I probably will never get another opportunity in my lifetime to do something that I feel is as substantial as this," says Hicks, who notes that he wasn't born yet when Daugherty first dug at Marmes. It was, he says, a daunting task to assemble and analyze widely dispersed data from a project more than 30 years old. "I was fortunate," he says modestly, "to get a lot of the best archaeologists in the Northwest to contribute to this effort."

The task proved frustrating at the outset because artifact collection methodology was rudimentary in 1962 compared with today's standards. For example, the standard then was to use quarter-inch mesh screens to sift excavated dirt. Today researchers use eighth-inch mesh, and sometimes finer, to recover fish, bird, and animal bones and tiny cultural fragments that would slip through a larger screen. Hicks concludes that valuable information likely was lost through the earlier screening.

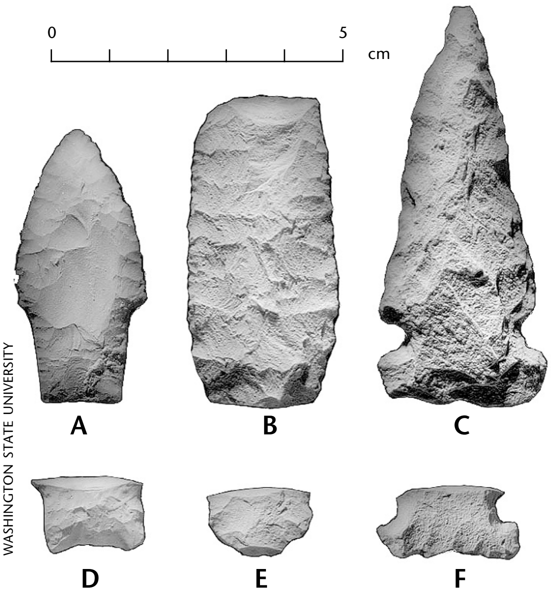
Record keeping also fell short of today's standards. Field notes were often missing or limited in detail. Sadly, the hectic final push to collect information in the face of rising water contributed to data gaps. Excavators had to rush the work as pressure mounted. A lot of material was only partially screened in the field, shoveled into bags, and trucked back to Washington State University and stored. One bright light, however, emerges since, as Hicks notes, part of the recent study included the inventory of the contents of some of those samples.

A hurried history

Although digging at Marmes officially began in 1962, its discovery dates to 1952, when residents along the Lower Snake River showed Daugherty a rockshelter they believed was once occupied by ancient people. It lay on property owned by Roland

Marmes, from whom the site takes its name. It took Daugherty a decade to return, a task made urgent when, in 1961, the Corps of Engineers began building Lower Monumental Dam. In 1962, Daugherty's crew worked 18-hour days with hand tools to uncover the site; a tent city soon surrounded the site and the rockshelter proper, an alcove 12 m wide and 8 m deep beneath an overhanging basalt ledge.

Evidence of consistent human use suggests the rockshelter was a "tethered" occupation site—one to which people regularly returned. The first digging season produced numerous storage pits lined with reed mats as well as the skeletons of 11 people. Associated volcanic ash and other sediment layers suggested they were 8,000 years old, making them among the oldest then found in the West.



WASHINGTON STATE UNIVERSITY

Windust (A, D), Cascade (B, E), and Cold Springs (C, F) points from Marmes Rockshelter, illustrating impact fracture patterns.

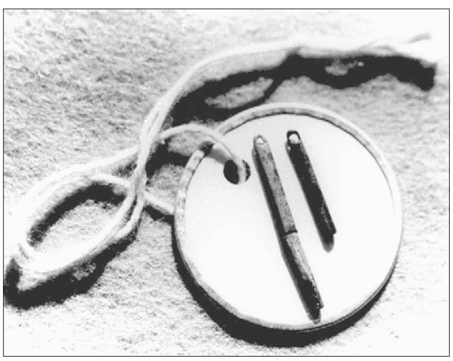
Despite the potential for astonishing archaeological discoveries at Marmes, researchers were strapped by lack of funds. Moreover, they were desperate, since 80 other sites identified within the area scheduled for flooding cried for their attention. According to Washington State University reports, initial excavations ended at Marmes in 1964. Fortunately, geologist Roald Fryxell, a member of Daugherty's original team, returned in 1965 to study geologic strata, using a bulldozer for part of the work. When the bulldozer uncovered more human bones, confusion arose over whether the bones had originally lain where they were found outside the rockshelter, and whether they had fallen there from higher sediments layers exposed in the trench walls. Fryxell returned for two more seasons. In 1968 he uncovered more bones that were clearly undisturbed and determined to be 10,000 years old. That's when emergency salvage operations began in earnest—and when news of the discovery of such old remains drew reporters and hordes of interested observers to the site.

The site soon swarmed with activity. More than $700,000 in federal money Senator Magnuson obtained was spent to build the cofferdam around the site in a last-ditch, but ultimately unsuccessful, effort to protect it from rising waters. Speed became paramount: the usual painstaking work of the archaeologist was abandoned as investigators scrambled to beat the swelling reservoir. Bulldozers and backhoes sometimes augmented shovels and trowels as research tools.

A find fraught with controversy

Despite such forgivable shortcomings, many new discoveries flowed from the effort. Among the most prominent was the cremation hearth containing fragments of burnt human bone, which continued to fan rumors of cannibalism. Since burials are an extremely sensitive issue for the tribes, Hicks says his team did not revisit the human bones or the cannibalism issue when compiling their final report. He frankly admits that "we went out of our way not to analyze any material associated with the human burials," and he concludes bluntly that "we weren't going to do anything that could turn a scientific endeavor into a political one."

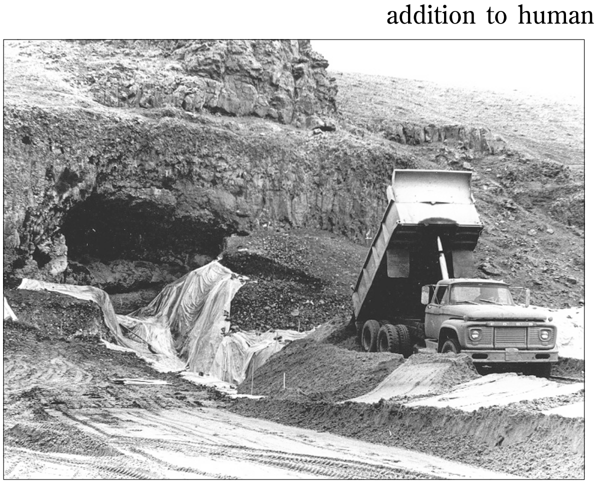
Now, having completed the project, Hicks declares that he has found no evidence in the record indicating cannibalism played a part in the history of the Marmes Rockshelter. There is just too little known about prehistoric cremations, and too little material evidence from Marmes, Hicks adds, for scientists to conclude or even speculate that cannibalism played a part in the life of people who lived there. As a cautionary note, he observes that in addition to human bones, the hearth also contained broken nonhuman bone, which suggests a wide range of uses for the hearths.



WASHINGTON STATE UNIVERSITY

Bone needles recovered from lower floodplain cultural levels at Marmes Rockshelter.

Hicks's report addresses the issue of the hearth: "The cremation hearth indicates some level of socio-religious structure that at least extended to treatment of the dead," tempered by the statement that suggests cannibalism "has not been demonstrated." The report further states that they cannot confirm an earlier interpretation that the cremation hearth was used only for burials.



WASHINGTON STATE UNIVERSITY

Plastic sheeting and sand being laid to protect the Marmes Rockshelter site from rising water. View is the northeast.

A record of changing environment and cultures

The record marks the presence of many species of amphibians, reptiles, birds, and mammals at Marmes, including the peeping tree frog, common leopard frog, gopher snake, rattlesnake, lizard, duck, Cassin's auklet, flycatcher, magpie, bluebird, rabbit and hare, marmot, ground squirrel, mouse, beaver, vole, dog, coyote, wolf, Arctic fox and red fox, bear, weasel, skunk, bobcat, elk, deer, antelope, and domestic cattle. The regional fauna changed as the landscape changed with the climate, from a sagebrush-dominated locale beset with cold and dry winters about 12,000 years ago, to the semidesert of today's warmer and drier climate. Researchers did not determine which species was the primary food source for Marmes Paleoamerican inhabitants.

Stone tool assemblages (projectile points range from types characteristic of the Windust phase to those of the late prehistoric period) and debitage analysis from the site strongly suggest that people occupying Marmes performed a wide range of domestic tasks. Not only does recent analysis support contentions that early occupants were tethered foragers, it also suggests that this activity continued for a longer period than was initially hypothesized.

The levee around the submerged Marmes Rockshelter (*arrow*) affords a measure of protection from waters of the Snake River backed up from the Lower Monumental Dam.

WASHINGTON STATE UNIVERSITY

Hicks notes that changes in the Marmes lithic assemblage over time appear to be an in situ response to technological change and not the result of a population displaced by a different culture. These changes are reflected in the tool types collected, from large, heavy early projectile points that would have tipped spear shafts, through mid-sized dart points hurled with atlatls, down to the smaller, finely crafted points hafted to slender shafts shot from bows. He believes that the people who occupied the Clovis Cache site and Marmes likely were members of a cultural continuum rather than distinct cultures. It's also credible for Hicks that they may have known and interacted with each other—just as it's possible that Kennewick Man, whose 9,300-year-old skeleton was discovered 40 miles away along the Columbia River in 1986, may have been familiar with the rockshelter and its people.

Are there more Marmes Rockshelters?

The Marmes Rockshelter may not be the only window on Paleoamerican life in the area. The locale contains many other caves that may yield even more important information than did Marmes . . . but only if, Hicks cautions, they can be protected from looters, whose activities are in evidence. Other sites in the area likely contain evidence of the Marmes residents' "catchment area," where early people found plenty of good water, various flora and fauna for food, and toolstone for making tools for hunting and for processing resources. He cites as a notable example Porcupine Cave, where site testing conducted by Hicks and the Corps in 1995 ended at a depth of about 10 ft after recovering material 5,000 years old. The site has the potential for yielding cultural finds as old as those from Marmes, but Hicks warns that getting to them will be an expensive venture.

It's also possible that the dams on the Lower Snake River may someday be removed, inviting future archaeologists to continue exploring the Marmes site. As a parting gesture to this possibility, Fryxell and his team built heavy protective wooden cribs around two unexcavated squares at Marmes that appeared particularly promising. They also lined existing trenches with plastic sheeting, then covered the plastic with a generous layer of sand. Hicks has no illusions that renewed digging at now-submerged Marmes Rockshelter would be easy, in view of the fact that impurities in the water and soil after years of submersion could confound attempts to obtain reliable dates from recovered material. "Anyone who digs there again will have to take that into consideration," he says.

There is little doubt in Hicks's mind that Marmes Rockshelter, by focusing national attention on the need to protect cultural resources, galvanized legislators into enacting effective CRM laws. "I can't discount the timing of it," Hicks says. "Yes, this site did have a lot to do with why things are different now."

Thank you, Marmes Rockshelter.

–George Wisner

How to contact the principal of this article:
Brent A. Hicks
Historic Research Associates
1904 Third Avenue, Suite 240
Seattle, WA 98101
e-mail: bhicks@hrassoc.com

Suggested Readings

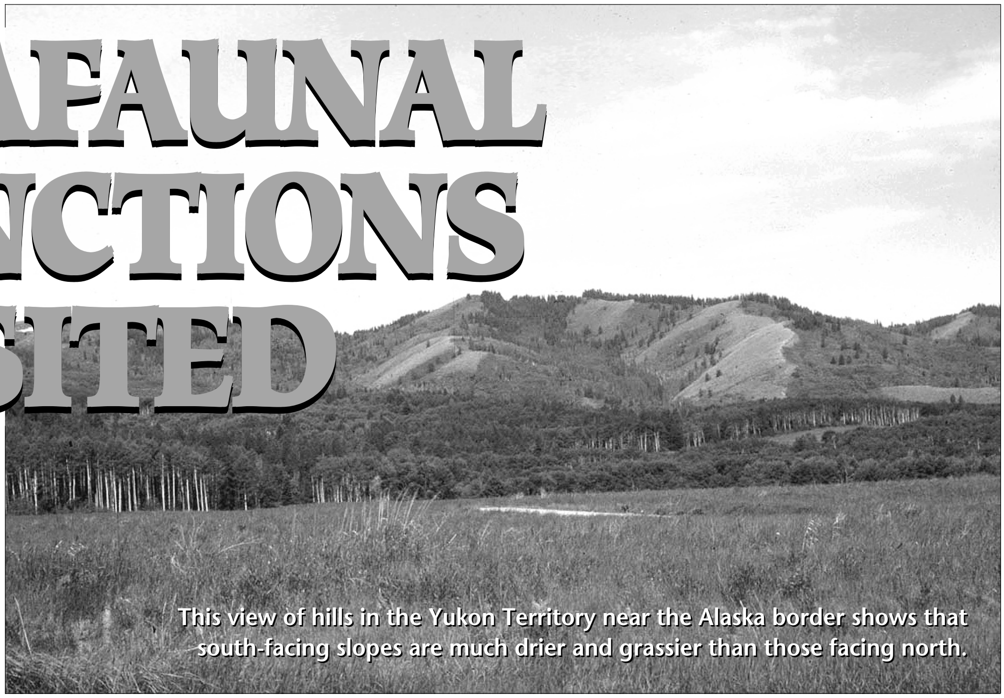
Hicks, B., ed. 2004 "Marmes Rockshelter: A Final Report on 11,000 Years of Cultural Use." Pullman: Washington State University Press. Contributors: Virginia L. Butler, John L. Fagan, Pamela J. Ford, Shawn Gibson, Carl E. Gustafson, Brent A. Hicks, Gary Huckleberry, Joy Mastrogiuseppe, Guy Moura, Terry L. Ozbun, Matthew J. Root, Daniel O. Stueber, Robert M. Wegener, Peter E. Wigand, and Maureen Zehendner.

The online encyclopedia of Washington State: **HistoryLink.org**

History Web site: **www.historylink.org/essays/output.cfm**

Megafaunal Extinctions Revisited

The Evidence from Alaska *and the* Yukon Territory



This view of hills in the Yukon Territory near the Alaska border shows that south-facing slopes are much drier and grassier than those facing north.

R. DALE GUTHRIE

As a species, we humans have a habit of sowing ecological discord wherever we go—a fault most people recognize as one of our great collective failings. On the other hand, we also have a tendency to look back and blame ourselves for things that weren't necessarily our fault. Take, for example, the great wave of large-mammal extinctions that rippled through the Americas at the end of the Pleistocene epoch. Recent research by one expert, the University of Alaska's R. Dale Guthrie, suggests that humans were less responsible for these extinctions than previously thought.

For years, a coterie of paleontologists, geologists, and archaeologists have postulated that human colonization of the New World was *the* causative agent for the extinctions of the last remaining American populations of mammoth, mastodon, horses, camelids, musk oxen, saiga antelope, and several other large mammal species, collectively termed "megafauna." This did in fact seem likely, since humans appeared in North America in appreciable numbers shortly before most of the American megafauna exited the stage. The idea was that the Paleoamericans entered a New World, where hunting was unknown, and proceeded to explode across North and South America, wiping out animal populations as their own populations skyrocketed. The so-called "blitzkrieg" theory makes for a nice, neat paleontological package, but it does have its problems—not the least of which is the fact that some large mammal species proceeded to proliferate rather than die out. Bison and caribou, for example, became more populous than ever, wapiti (elk) were common until well after the arrival of the Europeans, moose held steady, pronghorn antelopes remained endemic to High Plains, and deer of both the mule and white-tailed variety are still prolific all over North America.

Recent research, mostly focusing on radiocarbon studies of skeletal remains, suggests that other factors may have led to the decline of the largest mammals. As far as anyone can tell, most of the lost megafauna disappeared *before* humans entered the New World, with the mammoth and mastodon following somewhat later. (For details on the story, see **MT 21-4,** "Earlier Than You Think: The Timing Of Megafaunal Extinctions in North America.") According to Dr. Guthrie's work, it was climate changes that put the kibosh on some megafauna populations, at least in the region we now call Alaska and the Yukon Territory.

U.S. GEOLOGICAL SURVEY

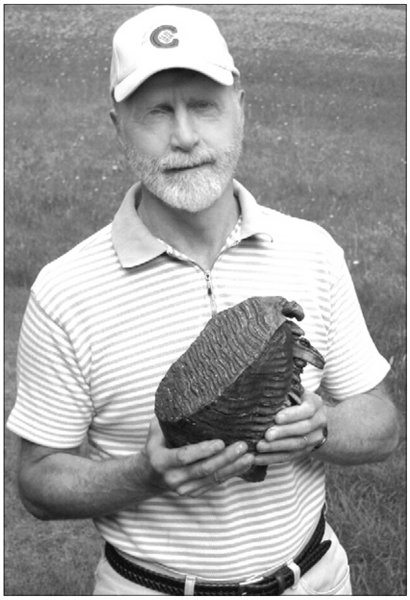
Guthrie's letter in the May 2006 issue of *Nature* presents compelling data that document the reasons for megafaunal decline in the Far North at the end of the Pleistocene. Contrary to popular belief, both radiocarbon and microbotanical evidence suggests that megamammals died out because plant species—including those that already declining populations depended upon for survival—simply vanished, the result of wide-ranging botanical regime shifts triggered by the terminal-Pleistocene warming trend.

The saiga antelope is a megafauna species that became locally extinct in AK-YT during the terminal Pleistocene.

The northern turnstile

Guthrie's research specialty is the evolution and paleoecology of large mammals of the Far North, many of which underwent profound anatomical and ecological changes throughout the period datable by radiocarbon analysis, particularly during the Pleistocene-Holocene transition. Although Guthrie is hesitant to apply his data to the entire New World, he does point out that "AK-YT [Alaska and the Yukon Territory] are, of course, the turnstile through which large terrestrial mammals enter or exit the two hemispheres." In Guthrie's interpretation, "large terrestrial mammals" includes human beings. But he believes that just because humans came to the New World during the same general time period as much of the megafauna became extinct doesn't necessarily mean they had a hand in it—and he's got the data to back up his theory.

One thing that mustn't be forgotten is the fact that even as humans were entering the New World, the last great Ice Age was coming to an end. The gradual recession of glaciers may have aided their migration, either through the development of an ice-free corridor between the Cordilleran and Laurentide ice sheets, or by creating coastal refugia that benefited early mariners. Given the huge environmental changes that were occurring, it's not unreasonable to suspect that concurrent biological changes—especially in the types of plant species endemic to the AK-YT steppe—might have played a significant role in wiping out now-extinct species. Those that survived—the more compact *Bison bison* that evolved from older *Bison priscus* populations, elk, moose, deer, caribou, and, for a while, native proboscideans—were able to prosper on the new vegetation regime. As one publication recently put it, Guthrie's data suggest that the mystery is more of a "whatdunit" than a "whodunit." Apparently, whatdunit was small trees and other inedible tundra growths, particularly a shrub called *Betula nana*, the dwarf birch.



Guthrie holds a mammoth tooth.

R. DALE GUTHRIE

What the data say

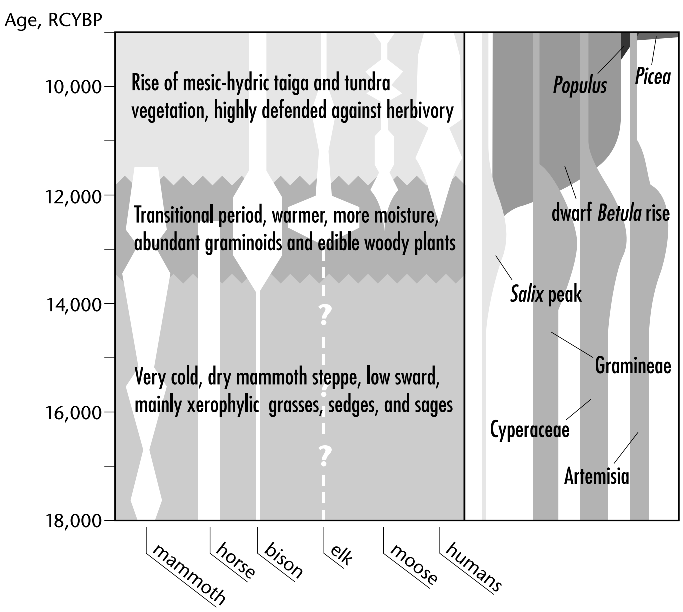
Guthrie pursued two basic lines of evidence to his conclusions. One he developed by examining pollen profiles from the appropriate time period, specifically those collected from sites with precise accelerator mass spectrometry (AMS) dates. In addition, he examined a large number of radiocarbon dates of skeletal remains and added hundreds from his own faunal collection to the regional database. "In order to understand [AK-YT] changes and extinctions it was necessary to understand chronology, so I have conducted a large carbon-dating project over the years," he explains. In fact, he's dated more than 600 samples from specimens that died at or near the Pleistocene/Holocene transition in Alaska and the Yukon.

Taken individually, the animal and plant components of his database are intriguing. Mammoth, bison, horse, and possibly elk seem to have been long-term residents of the region, surviving everything nature threw at them. Then humans and moose suddenly appear at about the same time, possibly drawn to this part of Beringia by plentiful food. Horses make a quick disappearance; mammoths seem to continue on for another thousand years or so before making their exit. Humans, bison, moose, and elk, however, all survive just fine, right on into historical times.

Meanwhile, a significant shift is occurring at the botanical level: the plant communities change relatively quickly from a short cold-weather grass-sedge-sage steppe regime to one dominated by grasses and edible woody plants favoring warmer conditions, then fairly soon thereafter to a boggy, taiga/tundra vegetation regime, where the surviving plants are protected against herbivory by toxicity and other deterrents.

It's when the two lines of evidence are taken together that they prove particularly interesting. Existing long-term herbivorous species are doing just fine until the climate changes in the terminal Pleistocene (around 13,500 RCYBP), becoming warmer and wetter and making high-energy grasses and willows more easily available—whereupon their populations increase significantly, at least for a while. Horses disappear in the middle of this smorgasbord period, about the time that humans show up in significant numbers. As Guthrie points out, though, there's no evidence that humans hunted horses in AK-YT or even in eastern Siberia, although there's plenty of evidence that they hunted bison and elk (which aren't extinct). Says Guthrie, "I imagine humans had a profound effect on the biota of the regions they were expanding into, but it's hard to sort out the precise forces at play from other causes."

Humans may have hunted mammoth in the region (the data are inconclusive), but those giants didn't disappear until almost a thousand years after humans came on the scene. It was then, about 11,500 RCYBP, that the Pleistocene/Holocene transition came to an end and the protective tundra/taiga vegetation became firmly established. This vegetation regime, characterized by species poisonous to many herbivores, couldn't support



AFTER R. DALE GUTHRIE

Mammal populations (*left*) and pollen profiles in the terminal Pleistocene.

nearly so large an animal population as before. Mammoths, despite their gut configuration that enabled them to thrive on a rapid throughput of low-energy steppe grasses, couldn't get enough to eat—and so they perished. During the transitional period, bison and elk populations had expanded, with elk becoming especially widespread after equines became locally extinct; after the transition was over, their populations decreased, but they remained common.

The data, as they now stand, point toward a double pulse of extinction observed by other researchers (**MT 22-1,** "The Timing of Megafaunal Extinctions in North America: Earlier Than You Think"), but Guthrie cautions that "there are not enough dates for that pattern to be totally clear in AK-YT. There are a lot of general similarities with the rest of the New World, but there are also lots of differences. The dry grasslands necessary to support such animals as saiga and horses have been pretty much eliminated from AK-YT by ecological changes, but that doesn't seem true further south."

Why the old explanations don't work anymore

Not only do Guthrie's data handily fill in some empty spots in the radiocarbon record, they also poke a few more holes in theories of megafaunal extinction that used to be widely accepted. At this reading, for instance, it's much less obvious than it used to be that the First Americans killed off the biggest mammals in a blitzkrieg of overkill, literally eating themselves out of several major food resources. Instead, it now appears that natural selection ushered mammoth, horses, and the other extinct megafauna off life's stage, at least in AK-YT, though it's possible that humans may have played a minor part in their final downfall. It's difficult to quantify the human contribution because at this point there's no firm evidence that bison and mammoth were hunted in AK-YT at all, whereas there's plenty of evidence for elk, bison, and moose predation. This doesn't mean, however, that it was human predation that caused those particular species to prosper; rather, it's more likely they survived (and in some cases prospered) because they were able to adapt to the new diet initiated by climate change, whereas species like the horse and mammoth were not.

Another theory that doesn't hold water in AK-YT is the "keystone species" theory. Applied to Pleistocene megafauna in North America, it suggests that mammoths were an essential species that kept the ecology in equilibrium, and that when they were extinguished the other megafauna died out in a sort of ecological domino effect. Although the theory at first blush seems plausible, radiocarbon reconstructions of the era—by Guthrie and others—just don't support this idea. There's growing evidence that mammoths died out in a second pulse of extinction, well after the other now-extinct megafauna. In fact, mammoths, in such isolated locations as Wrangel Island in the Arctic, may have survived several thousand years into the Holocene. Obviously proboscideans never served as a keystone species in Alaska and the Yukon, although it could be argued that the horse or another common species might have done.

Then there are other local extinct megafauna, which apparently didn't survive even past the Last Glacial Maximum, about 18,000 years ago. The possibility that humans were involved in those extinctions dwindles to the vanishing point, since the most reliable evidence to date places pre-Clovis peoples in the Americas no earlier than about 15,000 years ago (if they were here at all, say the die-hard Clovis-First boosters). In fact, the first colonizers might have been unable even to penetrate AK-YT before then, given natural geographic and environmental barriers in place. Humans aren't absolved of responsibility for later extinctions, but it's now clear that natural, climate-induced changes were the principal cause of significant levels of extinction at the Pleistocene/Holocene transition.

Although satisfied with his part in consigning bankrupt theories to history's trash bin, Guthrie isn't convinced we have all the answers yet. Like any good researcher, he's willing to consider all the angles. For, if the scientific method has taught us anything, it's that good research often reveals how much we *don't* know about something. As Guthrie puts it, "I have learned that paleo-reconstruction is a business fraught with much complexity, and that we have to keep an open mind. The forces of change affect each species differently, and there are several interacting vectors that are producing change. Yet some patterns are just beginning to emerge, or at least that's suggested by the dates plotted in my last paper in *Nature*.

"Perhaps, on the whole," he concludes, "my research has led to more new questions than answers." MT

–Floyd Largent

How to contact the principal of this article:
R. Dale Guthrie, Professor Emeritus
Institute of Arctic Biology
University of Alaska, Fairbanks
Fairbanks, AK 99709
e-mail: ffrdg@uaf.edu

Early Americans in Utah

continued from page 6

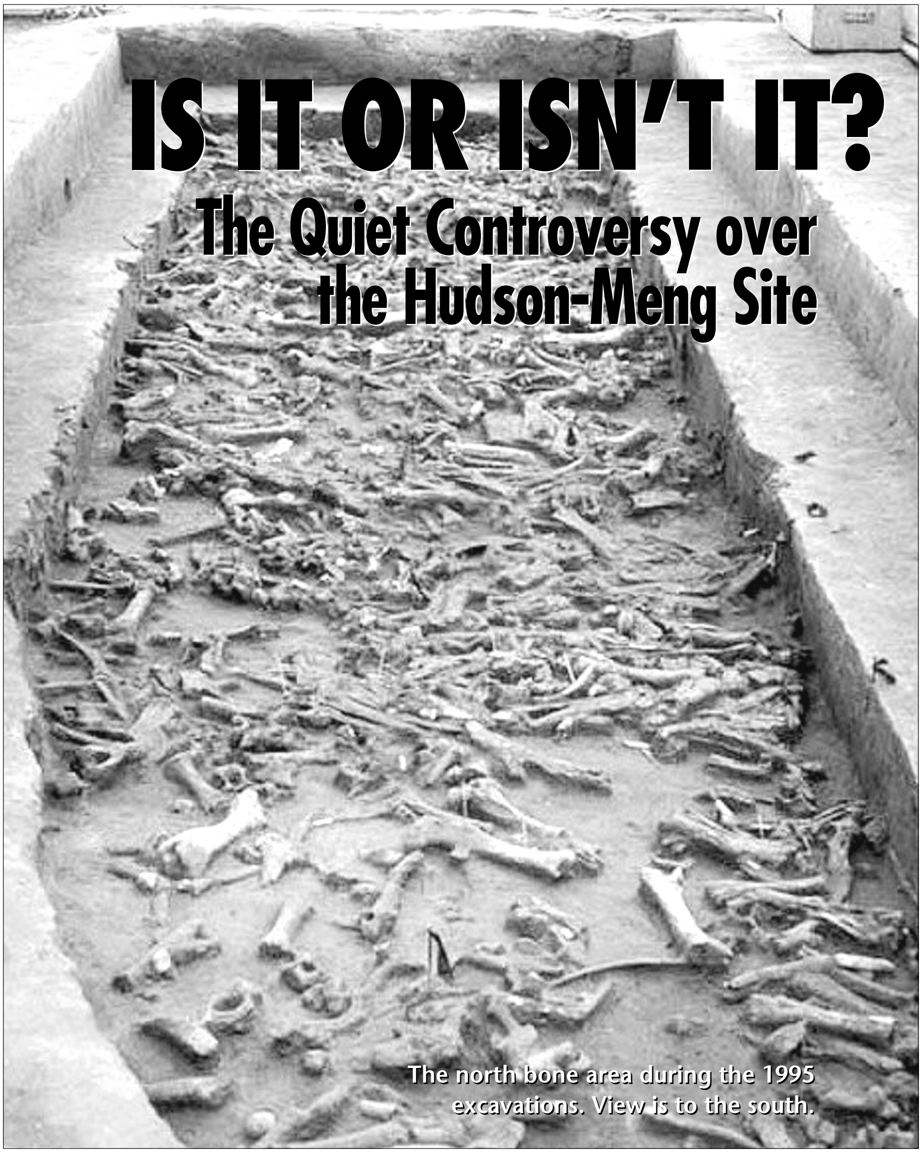
North Creek Shelter. "Even in the caves archaeologists have been digging in eastern Nevada that are pushing 11,000 years ago," he explains, "they are not finding extinct fauna. It may be that by the time people were wandering around there [North Creek], these extinct animals were already extinct." MT

–George Wisner

How to contact the principal of this article:
Joel C. Janetski
Brigham Young University
Department of Anthropology
Room 946 SWKT, Brigham Young University
Provo, UT 84602-0002
e-mail: joel_janetski@byu.edu

IS IT OR ISN'T IT?

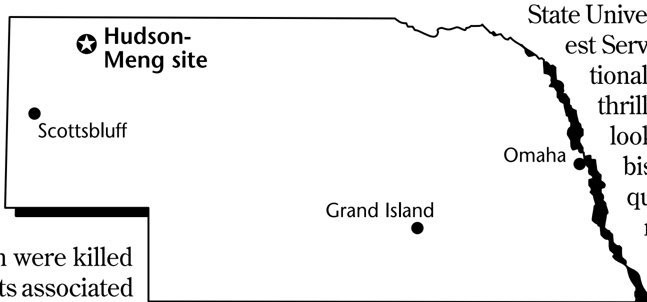
The Quiet Controversy over the Hudson-Meng Site



The north bone area during the 1995 excavations. View is to the south.

LARRY TODD

IT'S A TRUISM IN SCIENCE (some would say, in life in general) that the same evidence can be interpreted differently by different observers, depending on the perspective and experiences of the person doing the looking. Case in point: the Hudson-Meng site, an extensive bison bonebed with associated human artifacts located in the rolling hills of Nebraska. The scientist who initially excavated the site is convinced it represents the remains of a deliberate bison kill dating back almost 10,000 years. Later researchers, however, beg to differ: In their opinion, the bison were killed in a natural event and the human artifacts associated with the bonebed were left by later occupants who may have been unaware that hundreds of skeletal bison underlay their campsite. Both sides of the debate are firm in their beliefs, and the result is a quietly brewing controversy that has only recently come to the public eye.



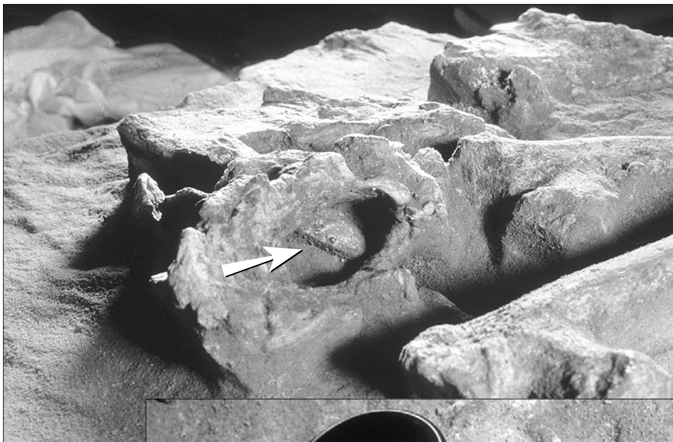
Investigations at the Hudson-Meng site

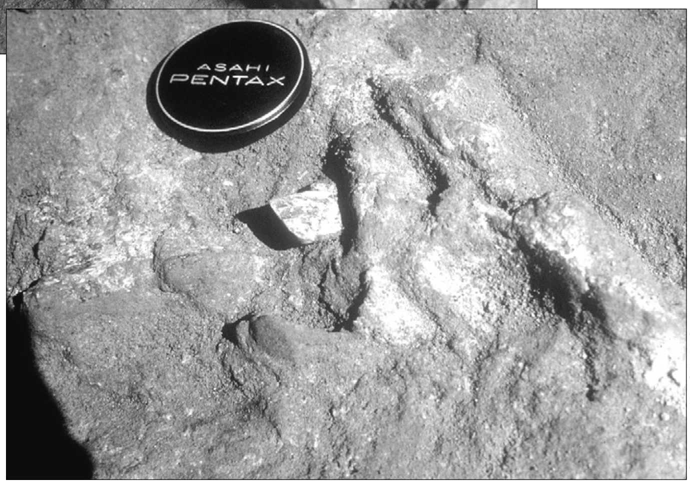
The bonebed in question was first discovered in 1954 during the construction of a stock pond near Crawford, Nebraska. After some initial confusion, it was decided that the bones were those of sheep, left behind by an early settler. Local rancher Albert Meng disagreed; he thought they were too large, and in the past he'd found artifacts eroding out of the ground at that location. For years, Meng and his friend Bill Hudson tried to get a professional to examine the site; but it was only in 1967, when Hudson was mayor of Crawford, that they persuaded a new arrival at nearby Chadron State College to come take a look. That new arrival, geoarchaeologist Larry Agenbroad, was intrigued by what he found. Excavations begun in 1968 eventually revealed the remains of more than 500 bison in association with Paleoamerican stone tools. "We recovered 20 Alberta points or point fragments," Dr. Agenbroad recalls, "plus bone and stone tools, and 3,500-plus stone flakes in, under, and penetrating bison bones."

He was soon convinced that humans had killed the bison, probably by herding them over a nearby cliff, and processed the meat on site. The Alberta-Cody–complex artifacts found in association with the bones indicated that this had occurred at least as early as 9500 RCYBP. In 1977, after 10 field seasons at the site and 464 m^2 of excavations, Agenbroad and his team completed their investigations, leaving much of the site undisturbed for posterity's sake. "In my opinion, there was no question that there was human activity in the creation of the Hudson-Meng bison bonebed, with its intimately associated artifacts," says Agenbroad. "I think humans killed and processed the bison."

Not everyone agrees. In 1991, Larry Todd (now with Colorado State University) was contacted by the Forest Service about the potential for additional work at Hudson-Meng. "I was thrilled at the chance to get a better look at a fascinating Paleoindian bison kill site," Dr. Todd says, and quickly recruited David Rapson, now with Iowa State University, to join him on the project. They spent 11 field seasons, 1991–1996 and 1998–2002, working at and around the site, with a respite in 1997 while the Forest Service built an enclosure around a portion of the bonebed. Excavating an additional 170 m^2 exposed much of the bone that Agenbroad's team had left in situ. Todd and Dr. Rapson mapped everything larger than 1 cm, using electronic surveying technology, and compiled three-dimensional data on 75,000 points.

Their final conclusions couldn't have been more different from Agenbroad's. In their opinion, the evidence was more consistent with a natural event that killed the bison in one fell swoop, whereas the cultural material was derived from a later occupation that occurred after the remains had been mostly or completely buried by wind-blown loess. Suddenly, Hudson-Meng's status as a cultural site was in grave doubt.





BOTH: LARRY AGENBROAD

◀ **An Alberta projectile point (*arrow*) penetrating a bison vertebra, both in situ, at the Hudson-Meng site.**

▼ **An Alberta projectile point and associated bison bone, both in situ, at the Hudson-Meng site.**

A new interpretation

"There was no one Eureka! moment to point to, but instead a growing sense of uncertainty that developed over a several-year period as to what the projectile point and artifact associations documented in the 1970s meant," Todd says today. "Our first suspicion was *not* that it wasn't a kill, but instead that not nearly as much meat may have been removed as initially suggested." It wasn't until 1994 that concrete doubts about the site's status as a bison kill began to develop. To Todd and Rapson, the evidence just didn't add up. For example, when long bones are broken during life or shortly after death, they display "green bone" fractures that spiral around the surface of the bone. Most of the Hudson-Meng remains exhibit sharp breaks, suggesting that the animals died in place and that the bones were broken post-mortem, most likely by trampling. There were few butchering marks, and most of the skeletons appeared to be articulated—not what you'd expect if the animals had been butchered.

LARRY TODD

Impact-fractured bone (*right*) above main bonebed, supporting Todd and Rapson's argument that the human occupation occurred later.

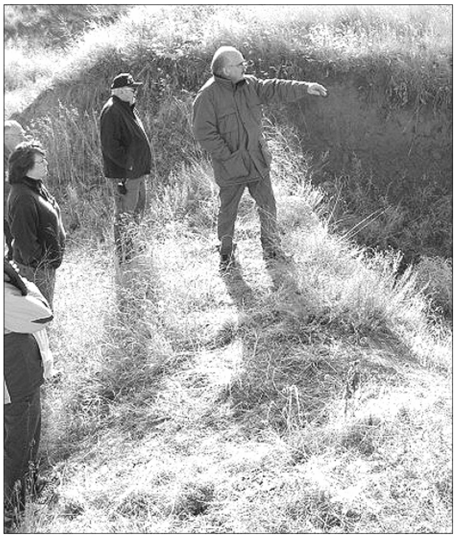
Then there's the problem of the cliff. The only nearby bedrock outcrop high enough for the animals to be stampeded over is about 80 m away. During the course of their investigation, Todd and Rapson dug two trenches from the bonebed toward the cliff. The results were sobering. "We were able to follow the paleosol [in which the bonebed occurs] up onto the bedrock," Rapson notes. "It mantles the bedrock, which means there *was* no cliff there 9,500 years ago." There was no bison bone there, either; it pinched out before reaching the base of the cliff, further evidence that the bison had died in place, rather than from being stampeded over the cliff.

So what happened?

"I flat out don't know," admits Larry Todd. "I'm not at all sure how the animals died—and that does not exclude human agency—but I think that should be a key topic to investigate, rather than considered as established fact." Rapson adds, "The site doesn't follow what we think we know about humanly produced bison bonebeds." He cites as evidence the relative scarcity of stone tools, the apparent absence of a jump location, and several other odd features of the site—not least, the fact that the observed lithic debitage concentrations were not directly associated with the bison bone, as might have been expected if the hunters were sharpening their tools as they processed the animals.

It's difficult to say what killed the bison if humans didn't, though the evidence leans toward a prairie fire. The dentition of the calves in the assemblage indicates they died in midsummer, when blizzards and catastrophic storms are rare. It's clear that fire played at least a minor part in the Hudson-Meng site formation process. "You can see intense burned areas where part of a bison carcass was literally burned away to small bone fragments," explains Rapson. "We think they were related to something that happened after the animal died and dried out; the rumen and stomach contents would have been good fuel for a later prairie fire."

But what about the Alberta artifacts? Todd and Rapson believe they aren't directly associated with the bonebed at all. According to their data, most of the artifacts were located at least 12 cm above the bonebed, and so were the few bones with cut marks, impact fractures, and green-bone breaks—hallmarks of human modification. They believe the artifacts found in the bonebed worked their way down through the loose soil through natural means, such as trampling, freeze-thaw processes, and animal burrowing.



LARRY AGENBROAD

Agenbroad leads a tour of the Hudson-Meng site in February 2006.

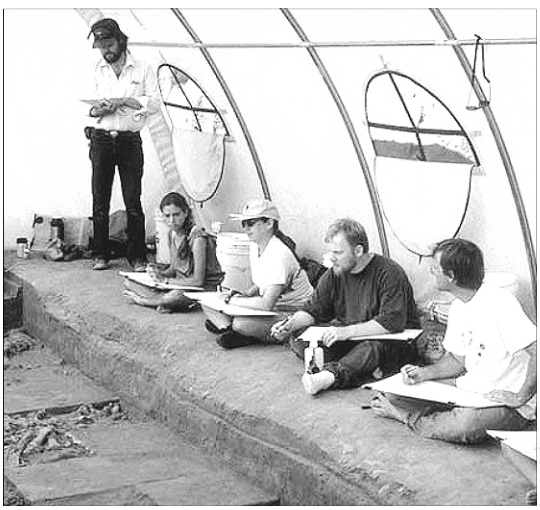
Point, counterpoint

Todd and Rapson looked at the same site and, in many cases, exactly the same skeletal remains as Agenbroad. So how can their conclusions be so diametrically opposed? Rapson thinks it's because archaeological understanding of site formation processes evolved rapidly in the 20 years between the two investigations. "In my opinion," he says, "our debate boils down to a fundamental question about context—so even though we've looked at the same archaeology, the way we assign meanings to the patterns we see is fundamentally different. As often happens in the history of science, research perspectives change, and so do the views on what the basic data mean."

ANTHROPOLOGY DEPARTMENT, COLORADO STATE UNIVERSITY

Larry Todd.

Meanwhile Agenbroad, who is now professor emeritus of Northern Arizona University and director of the Mammoth Site of Hot Springs, South Dakota, still firmly believes that Hudson-Meng is a kill site. In fact, he has evidence that challenges every point raised by Todd and Rapson, from how they interpreted their finds to how they performed their excavations. "The initial 13.5 meters of bonebed exposed was approximately 50 percent devoid of major bone," he points out. "That small sample, from the higher-elevation, less-dense portion of the bonebed, was used to 'verify' a natural death assemblage—as contrasted to 464 square meters of bonebed investigated in the 1970s." In addition, he says that Todd and Rapson were simply wrong about the elevation of the cultural material: "When the range of elevations for bones and chipped stone is plotted for the same excavation units, it can be demonstrated that the majority of chipped stone was included within the thickness of bison bone (the bonebed). My BS is in Engineering; I can guarantee that our surveying techniques were better than a plus-or-minus 12 cm error." Moreover, he's convinced that Todd and Rapson misread some of the data from their own excavations: "A recent study reworking screen-wash samples, collected but never analyzed by Todd and Rapson, concludes that there was intimate association of bison bones and chipped stone in some of the sampled squares."



LARRY TODD

Rapson (*standing*) instructs field school students at the Hudson-Meng site in 1995.

According to Agenbroad's measurements, the bedrock cliff is located 17 m away from the west end of his 1970s trench; and excavations in 2006 are casting doubt on the existence of the bedrock that Todd and Rapson observed mantling it. Nor is Agenbroad impressed by their site formation arguments. "Stone moves upward due to frost action; it doesn't trickle down through sediments. Rodents also move stone upward more often than downward. Rill erosion would have removed lithic waste flakes, and couldn't have emplaced the projectile points in the associations with bones in which they were discovered and photo-documented."

More significant is his contention that some of the Alberta tools found at Hudson-Meng were actually imbedded in bison bone. "One cervical vertebra had an Alberta point penetration that would have been a fatal wound—not one that was inflicted elsewhere and the animal died later, at this spot. It's interesting to note that although 35mm slides of the projectile points in the bison bone were available at the local Forest Service office, they weren't shown to the 1990s field crews. I've interviewed some of those crew members, and they were shocked to see the photographic evidence for the first time."

Agenbroad believes, in short, that the research by Todd and Rapson was seriously flawed. "The 1990s interpretations were taken as gospel by some," he notes. "They're just now being questioned, and some of the interpretations from the 1990s are no longer valid—for example, that either a fire or storm event caused many of the animals to orient

continued on page 20

Keeping Ancient Time

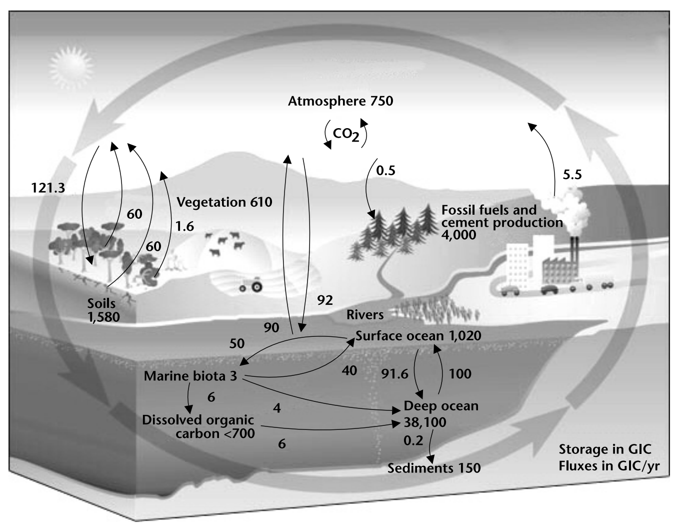
John R. Southon's Contributions to AMS Dating

John R. Southon, AMS pioneer.

JOHN R. SOUTHON

FEW SCIENTIFIC BREAKTHROUGHS have impacted the field of archaeology as thoroughly as radiocarbon dating (RCD), which came into common use about 50 years ago. Before RCD, it could be annoyingly difficult to determine the age of an archaeological find; now it's a piece of cake, so long as there's associated organic material present. That's not to say the method is perfect; it has experienced a few rough spots in its developmental history, but over the decades a legion of patient researchers have smoothed kinks in the process, and they have achieved great success in narrowing the gap between the radiocarbon record and other ways of measuring the past. One of the most active and influential of these researchers is John R. Southon, of the Earth System Science Laboratory at the University of California, Irvine.

A physicist by training, Dr. Southon probes the past using an exotic method known as accelerator mass spectrometry (AMS), which yields accurate counts of the elemental compositions of very small samples. In the course of his research, he's dated everything from seafloor cores to spines from sea urchins; and in so doing, he's contributed significantly to refining AMS techniques and to such disparate fields as archaeology, biology and fisheries, and paleogeology.



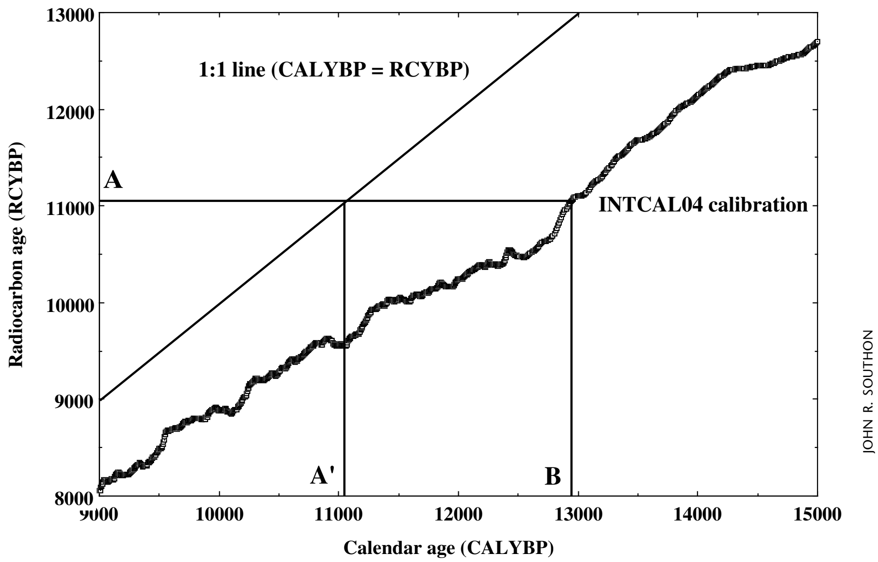
AFTER WIKIPEDIA

The carbon cycle, displaying the exchange and storage of carbon (in gigatons) in Earth's atmosphere, hydrosphere, and geosphere. Humans contribute more than five gigatons of CO_2 to the atmosphere every year.

What radiocarbon is, and why it's important

Most elements come in several different forms, or isotopes, each with a slightly different mass. The number of protons in the atomic nucleus determines the element; the number of neutrons determines the isotope. Some isotopes are radioactive; that is, they eventually decay to a more stable form by emitting radiation. Physicists measure the decay rate by the element's half-life, the time it takes for half the atoms in a sample to decay into something else. It's relatively simple, using physical and chemical methods, to determine how much of a particular radioactive isotope remains in a sample and, therefore, to determine approximately much time has passed since the sample was formed. Half-life measurement is the basis for a variety of dating methods, including RCD.

The radioactive form of carbon, Carbon-14 (^{14}C), contains six protons and eight neutrons. It emits an electron to form the stable Nitrogen-14 (^{14}N), which has seven protons and seven neutrons. The half-life of ^{14}C, 5730 ± 40 years, is very predictable, and the RCD method measures the amount of ^{14}C remaining in a once-living sample. Since an organism stops accumulating carbon when it dies, this dating method is an excellent way of telling how long it's been since death occurred. The process works extremely well for samples that are relatively "young" (in the geological sense), but becomes less precise the further back in time you go. Moreover, the process becomes increasingly difficult the smaller the sample size. In many cases, RCD gives an age range rather than a specific age for a sample: for example, 10,520 ± 150 years before present (yr B.P.), rather than a more precise 10,487 or 10,640 yr B.P. The variability (the number following "±") is generally one standard deviation from a statistical mean.



The radiocarbon calibration curve corrects for the difference between the number of years calculated to have elapsed since radioactive carbon in the material began to decay (called radiocarbon years, based on the half-life of Carbon-14 of 5,730 years), and the actual age of the sample in calendar (365-day) years. For example, sample A, collagen from two bone tools found at the Anzick site in Montana, was dated by AMS ^{14}C analysis to 11,040 ± 35 RCYBP. Aberrations in the radiocarbon record, however, introduce a disparity between the apparent age A′ and the actual (calibrated) age B, 12,940 CALYBP. Southon's research is determining accurate values for the calibration, which varies unpredictably over the centuries and millennia.

We know some effects that skew radiocarbon ages, resulting in a significant difference between radiocarbon yr B.P. (RCYBP) and calendar yr B.P. (CALYBP). For example, an enrichment of radiocarbon in the atmosphere during the last Ice Age (more on this below) yields dates for that period that are significantly younger than they should be. Then there's us humans. We've contributed a great deal of both radioactive and nonradioactive carbon to the atmosphere in the past few centuries. Our burning fossil fuels has diluted the natural levels of radiocarbon in the atmosphere (a process called the Seuss effect), while our detonating thermonuclear weapons in the atmosphere since 1950 has *increased* the atmospheric levels of ^{14}C (the Libby effect). Both effects can introduce errors into measurements of young radiocarbon dates, which is why intrepid scientists like Southon have spent large chunks of their careers in calibrating this most useful dating method. AMS in particular has played a huge role in refining the radiocarbon record.

Pure science

The traditional RCD method counts the decay rate of existing radiocarbon atoms in a sample; for a modern sample, that's about 14 per minute per gram. AMS dating, on the other hand, measures the actual number of ^{14}C atoms. Charged ions are accelerated to high kinetic energies, and the isotopes are sorted based on their different atomic masses (^{14}C is a tad heavier than ordinary ^{12}C).

Like many pioneers in AMS dating, John Southon got his start in low-energy nuclear physics, the precursor to radiocarbon-dating technology. "The first experiments on detecting radiocarbon with tandem accelerators were done in mid to late 1977," Southon recalls. "The first groups developing this method, I think, bootlegged most of the experiments—they were done at nuclear physics labs on a shoestring. After a couple of years, the people developing this technology started to get some funding coming in and started looking around for post-docs. I was part of the second wave that was hired a year or two after the first experiments were done. I got in because it looked like a neat application of something I knew something about, and because the first experimenters were looking for people who had a background in low-energy nuclear physics technology."

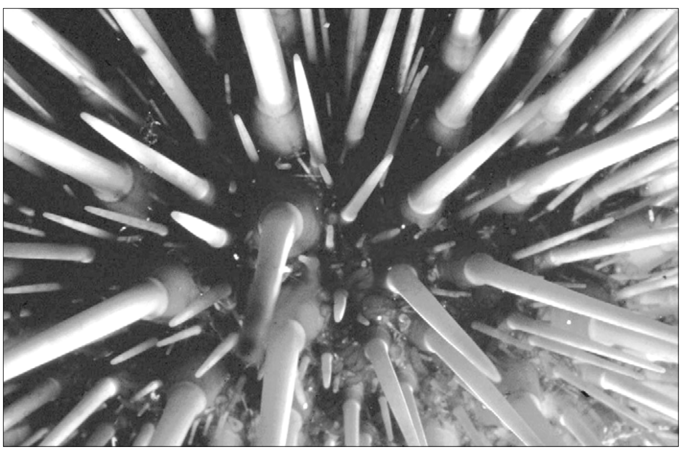
Over the next 30 years, Southon made significant contributions to the technical end of AMS, fine-tuning the technology and furthering our understanding of how extraneous factors affect AMS readings. That's what he considers one of his two greatest contributions to the field: the process of making the technique itself more reliable. Much of Southon's nontechnical research has focused on developing a better understanding of the radiocarbon calibration curve, which reconciles the radiocarbon record with other well-dated events in order to refine its accuracy. Because of various effects and localized conditions, the radiocarbon and calendar ages of a sample might disagree by several hundred years, sometimes even more.

That's where Southon's other most significant contribution comes in. He's done a great deal of work with other scientists on radiocarbon calibration back to 50,000 years ago, based on seafloor cores from the Cariaco Basin off the coast of Venezuela. The basin experiences a very high sedimentation rate, and because the sediments contain little or no oxygen, there's very little animal activity to disturb them. "The way this works," he explains, "is that climate proxies in the sedimentary record can be tied to other paleoclimatic records that can be independently dated—such as Greenland ice cores." All the sharp climate transitions of the last 50,000 years are recorded in Greenland's ice, and you can get independent chronologies using other dating methods as well, even on the Cariaco cores themselves. Part of the Cariaco sedimentary record takes the form of varves—laminated sediments produced on an annual basis, like clockwork—so that's another independent time scale right there.

Even as Southon and his colleagues calibrate the radiocarbon curve, they're able to corroborate it using other dating methods and to refine those as well. Varves and tree rings, which are also accrued annually, are useful for assigning dates to events in the immediate past. Southon explains that there are two basic types of methods that can date events earlier than can be calculated from tree rings and varves: the radiocarbon method, which dates organic (carbon-bearing) materials, and dating methods that depend on other half-life decay rates. One of these is the uranium-thorium method, typically used to date rocks and corals. Although the results of these dating methods don't always agree point-by-point, Southon and his colleagues are working to reduce the discrepancies, with encouraging progress. Over the last few years, those discrepancies have been reduced by a factor of three or four. "In the past, we had huge discrepancies in these records," says Southon, "but these were mostly problems with the independent timescales, not with the radiocarbon data. Those discrepancies are getting much smaller—they're still there, but they seem to be converging."

Carbon through the ages

In recent years, Southon has also helped establish UCI's Keck Carbon Cycle AMS Laboratory, which studies the Earth's carbon cycle—that is, the way carbon cycles through the atmosphere, hydrosphere, geosphere, and biosphere. In fact, his interest in understanding the carbon cycle is what sparked his interest in refining the radiocarbon calibration curve in the first place. Now the prize may be in sight, for if the calibration curve can be refined to a low margin of error for a time span extending back 20,000 to 30,000 years, we will finally have a means of accurately tracing the carbon cycle. "The reason why convergence of calibration records is important is that for the first time, we're getting something we can really use for that purpose," he points out. "If we can get a handle of how the carbon cycle behaved under conditions very different from today, we have a good test of existing carbon-cycle models. If a model works, we have a good predictor of what will happen in the future."



Close-up of a red sea urchin, courtesy of the Gulf of the Farallons National Marine Sanctuary in California. Southon's work proved that these animals can live at least 100 years.

One problem with the existing radiocarbon record is that during the last glacial period, there was an unusually high level of ^{14}C in the atmosphere, while carbon dioxide levels were oddly low. Southon believes that the high ^{14}C and low CO_2 levels are interrelated, because a large volume of the ocean (and all the carbon in it) was isolated from the atmosphere. Today there's convection within the ocean from bottom to top, but during the last Ice Age much of that vertical circulation was cut off in the Southern Hemisphere, owing to the presence of sea ice and the stratification of freshwater over saltwater from that ice melting in the summer. As a result, large segments of the deep-water ocean didn't come into contact with the atmosphere for thousands of years. The deep sea received biomass carbon from the surface layer, and that carbon was sequestered there, drawing down the CO_2 level in the atmosphere. Meanwhile, this isolated piece of the ocean received little new ^{14}C, because it was cut off from CO_2 exchange. It grew very old from a radiocarbon perspective, while the rest of the carbon involved in the cycle became very young, since newly produced ^{14}C was cycling through a smaller total carbon mass.

According to Southon, radiocarbon age differences between skeletons of coeval surface- and bottom-dwelling plankton in marine cores from several ocean basins are starting to make sense in light of the "cutoff ocean" hypothesis, though not all the data are consistent. In turn, this suggests that that hypothesis is part of the answer to what's skewing the radiocarbon curve.

Playing in other people's backyards

If you think the AMS field might be rather dry, without much excitement and variation to hold your interest, that's certainly not been the case for John Southon. He has, in fact, guest-starred in many fields only marginally related to his area of expertise. In one case, he helped prove that red sea urchins mature very slowly (to the chagrin of many in the West Coast sea urchin fishery). Many of his collaborations, however, have been with archaeologists. For example, he contributed to a recent research product that proved that the Pleistocene megafauna died out in two distinct pulses in North America (**MT 21-4,** "Earlier Than You Think: The Timing Of Megafaunal Extinctions In North America"), though he insists his role was minor. "I enjoy working with archaeologists," he says. "It's not what I do, but it's fun to have a kind of backstage pass in someone else's field of science, so that I get to hang around with some smart people in fields that aren't mine.

"That's one of the joys with an instrumental technique—you get to interact with a lot of different people in different fields. You have a lot of fun doing your own science, and a lot of fun helping other people's science as well."

–Floyd Largent

How to contact the principal of this article:
John R. Southon, Researcher
Earth System Science
School of Physical Sciences
University of California, Irvine
226 Rowland Hall
Irvine, CA 92697
jsouthon@uci.edu

Clovis Dethroned

continued from page 3

records, like Virginia's Cactus Hill and Topper in South Carolina, seem to have pre-Clovis lithic horizons, some of them very old indeed. And then there's Monte Verde, the Chilean site long since determined, at 12,500 RCYBP, to be considerably older than Clovis. Other examples of purported pre-Clovis sites abound in the literature, some with compelling evidence for great age. *End of Part 1.*

–Floyd Largent

How to contact the principals of this article:

Michael R. Waters, Director
Center for the Study of the First Americans
Texas A&M University
College Station, TX 77843-4352
e-mail: mwaters@tamu.edu

Thomas Stafford, President
Stafford Research Laboratories, Inc.
200 Acadia Avenue
Lafayette, CO 80026
e-mail: twstafford@stafford-research.com

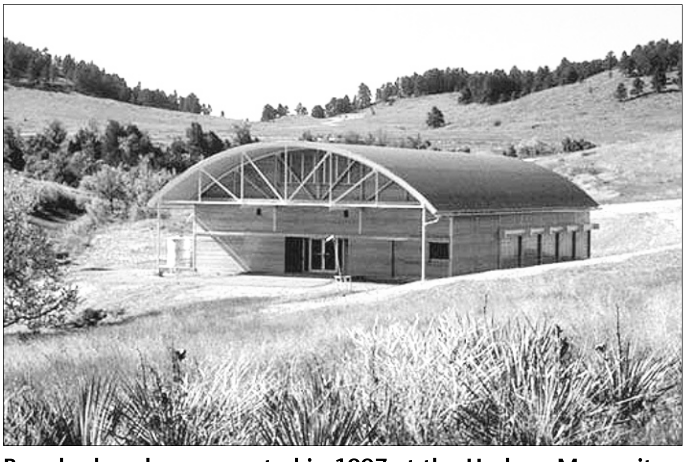
Is It or Isn't It?

continued from page 16

themselves in a similar direction. The examination of the maps, from both the 1970s and the 1990s, reveals a random scatter of orientations."

An abiding mystery

At this late date, the only thing that can settle the debate is further research, which got underway in 2006. "New research and researchers are investigating the Hudson-Meng site," Agenbroad says. "The site will ultimately confirm its origin. The site has a unique story to tell, a story based on valid excavation and interpretation. Let the site reveal its own information. Don't force it into the mold of a newly devised 'formational model' of examination and interpretation."



LARRY TODD

Bonebed enclosure erected in 1997 at the Hudson-Meng site.

Todd, on the other hand, believes that multiple interpretations are necessary, at least for the time being. "There are a number of other somewhat plausible ideas, but they're really difficult to evaluate," he asserts. "I believe the nature of the mortality event at Hudson-Meng is a key research question that I'd hate to see dismissed by a 'what-else-could-it-be' argument."

As Rapson puts it, "If we were to use an analogy to modern courtroom arguments, in the closing stage as the defense lawyers we would conclude that the Alberta people have been accused of killing the bison without sufficient evidence. We've established reasonable doubt."

Agenbroad disagrees. From a legal standpoint, he says, "the best evidence rules the conclusion, whatever the volume of contrary evidence. I think the spearpoints in, under, beside, and penetrating the bison bones fall into the 'best evidence' category." To stretch the legal analogy a bit further, it's safe to say that the jury's still out on the origin of the Hudson-Meng site.

–Floyd Largent

How to contact the principals of this article:

Larry Agenbroad
Director, The Mammoth Site
1800 West Hwy 18 Bypass
Hot Springs, SD 57747
605-745-6017
e-mail: larry4mammoth@mammothsite.com

Professor Emeritus
Department of Geology
Northern Arizona University
P.O. Box 4099
Flagstaff, AZ 86011-4099
e-mail: Larry.Agenbroad@nau.edu

David J. Rapson, Adjunct Affiliate Professor
Department of Anthropology
Iowa State University, Ames
324 Curtiss Hall
Ames, IA 50011-1050
e-mail: drapson@iastate.edu

Lawrence Todd, Professor
Department of Anthropology
Colorado State University
C-207 Andrew G. Clark Bldg.
Fort Collins, CO 80523-1787
e-mail: Lawrence.Todd@ColoState.edu