MAMMOTH TRUMPET

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Center for the Study of the First Americans
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The Case against Clovis

Yes, Clovis people created lithic masterpieces like these projectile points. But no, argue geoarchaeologist Mike Waters and geochronologist Tom Stafford, they weren't the First Americans. In our lead story on page 1, the second of our two-part report, Drs. Waters and Stafford tell how the evidence led them to their conclusion (which, to no one's surprise, hasn't been universally accepted by the scientific community), and they describe the work that lies ahead of every scientist seeking an intellectually honest answer to the question, Who were the First Americans?

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Clovis Dethroned

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

ALL THINGS CONSIDERED, the idea of a pre-Clovis occupation doesn't seem so preposterous. What's surprising, to some of us at least, is the *way* that the reality of pre-Clovis has been proven. It seemed more likely that the smoking gun would be a clear, unequivocal cultural horizon underlying clear, unequivocal Clovis artifacts; and if there were older radiocarbon dates associated with the stratigraphically older artifacts, then so much the better. But a sudden contraction of the established Clovis date range, based on a reconsideration of the Clovis radiocarbon record—who ordered that?

Cover story

The news of the true age of Clovis was so shocking that it made the cover of the issue of *Science* in which the article appeared, and the shock waves haven't died down yet. Although Waters and Stafford are satisfied with their conclusions, not everyone has accepted the new Clovis ages. As Stafford puts it, "At this moment, I know of no professional scientist who has said, 'I was wrong, the new data convince me to change my mind, and there must be a shift in the way we all view the peopling of the New World.'

Tools of the trade: Clovis artifacts in situ at the Gault site in east-central Texas.

INSIDE

I feel the greatest impact has been to students and the nonacademic (avocational) archaeological community. The future advancements will be made largely by people still in school, and those who have the curiosity to look beyond safe, decades-old explanations."

While the data are hard to deny, some skeptics are still holding out for older Clovis sites. But at the moment, there aren't any other Clovis sites to date, though Waters and Stafford make it clear they're eager to date any that might turn up. Says Stafford, "We need 20 times more Clovis sites, and we need scores, if not hundreds, more radiocarbon and other radiometric dates before we can consider our hypotheses adequately tested. New data might lead to entirely new hypotheses that are totally different than our present ones. What I hope happens is that our research encourages people to test our hypotheses by making new discoveries. New field and laboratory research, not ruminating over old data, is what will test our interpretations."

Whence Clovis?

Clovis tools have been found at sites scattered over most of North America. This begs a question: How did the Clovis culture manage to spread into and dominate an area of tens of millions of square kilometers in just a few hundred years? There are two possibilities: Either it was the people who spread, supplanting or absorbing the original populations; or their lithic products were so superior to existing toolkits that the new technology diffused across the continent, hopping from culture to culture. According to Waters, "Either hypothesis is possible and testable. We need to examine the technology of Clovis at the sites of known age, and see if the tools are made in the same way. If so, then it might argue more for migration than diffusion. If significant variation is found within the technologies, then perhaps diffusion is more plausible. Also, we need to gather much more data about the pre-Clovis occupants of the Americas."

Stafford, for his part, is convinced that Clovis was a set of ideas rather than a particular group of people. "Wherever Clovis technology was invented," he says, "it was obviously so effective that it was copied rapidly, and it replaced previous technologies that could have been based on bone, wood, or small lithics, or some combination of each. These are artifacts that are either extremely perishable or not in the search image of those excavating vertebrate fossil remains that are 12,000 years old or older." He emphasizes that vertebrate fossil sites older than 11,500 RCYBP need to be excavated as archaeological rather than paleontological sites. Only then, he believes, will we find more evidence of pre-Clovis occupations. "Field scientists perform an unfortunate triage that precludes ever answering the question of pre-Clovis presence. Once faunal remains or a stratum are determined to be older than 11,500 RCYBP, excavations either cease or are relegated to vertebrate paleontologists because 'humans were not present before Clovis, and therefore there's no reason to look at the deposits as an archaeological resource.'" In such a situation, he says, "The

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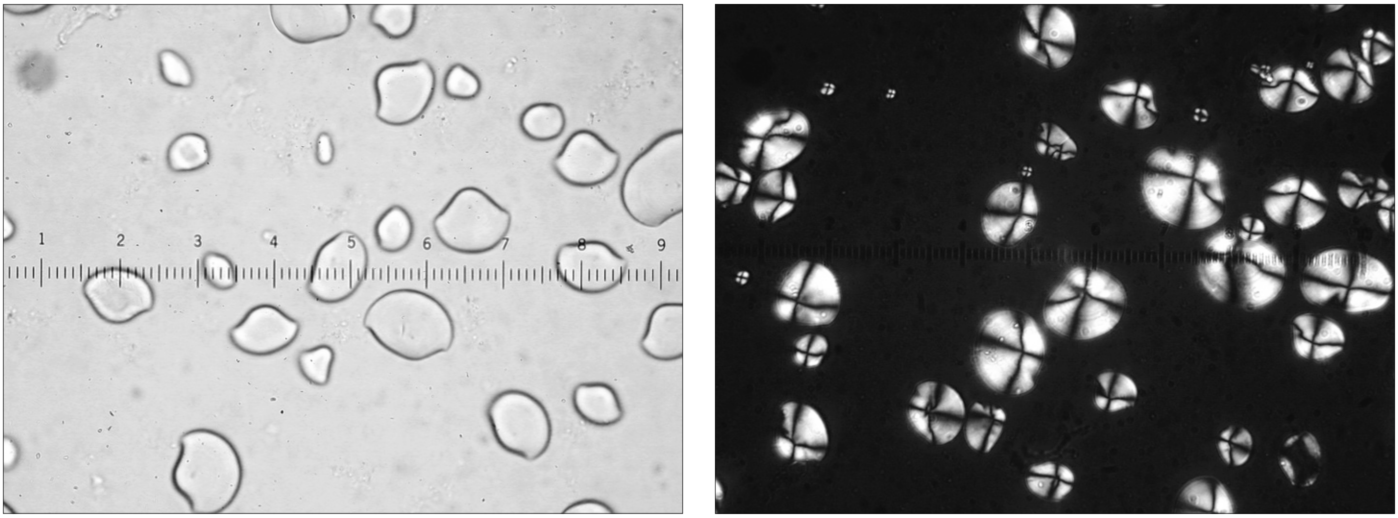
–Michael R. Waters, Director



BOTH: MASAHIRO KAMIYA

False garlic starch grains viewed in a microscope under normal light (*left*) and polarized light (*right*). The "cross" is a characteristic of most starch grains; its shape and appearance help distinguish the starch of one species from another. Each tick of the scale equals 2.5 microns (25 microns between numbers).

Little Things Mean a Lot:

The Search for Starch Grains at Archaeological Sites

by Vaughn M. Bryant

BY TRAINING AND HABIT, archaeologists searching for traces of the First Americans gather the visible remains found at sites. The analyses of animal and human bones, broken rocks and chipped stone, charcoal from fire hearths, remains in storage pits, worked flint and bone, and all the other visible artifacts are what fill the pages of site reports. But what about microscopic evidence? Did anyone search for it? Granted, some early American sites have been tested for fossil pollen and even phytolith (plant crystals) remains, but rarely have searches for these types of evidence been fruitful. A few of the stone artifacts from some of these sites have been sampled for animal or human blood; even fewer of the residues are being tested for DNA.

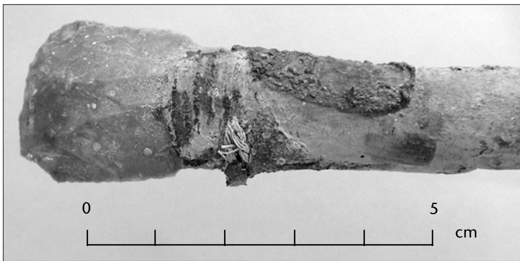
So why do I think that most archaeologists searching for the First Americans are missing the boat? Because they haven't been searching for the remains of starch grains.

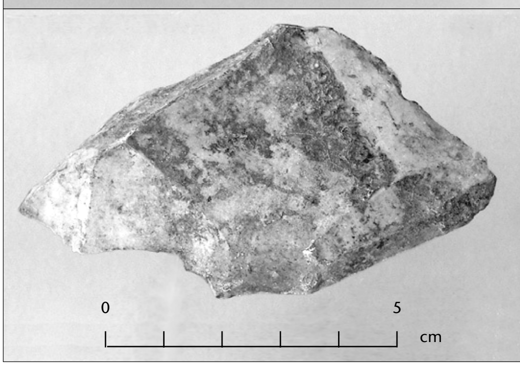
Testing for animal *and* plant matter

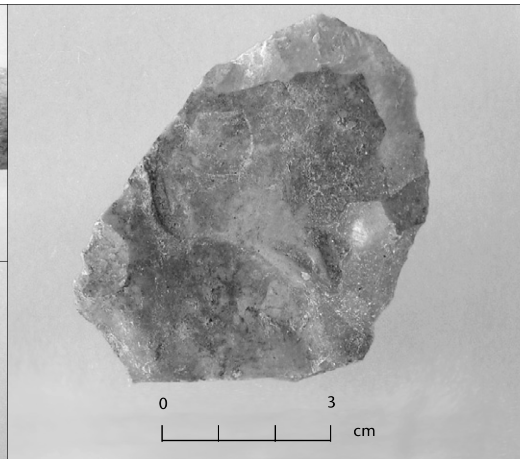
During the mid 1990s, Bonnie Williamson of the University of Witwatersrand, South Africa, was a graduate student working at the nearby Rose Cottage Cave site, where she was asked to examine the surfaces of hundreds of stone tools for attached residues. Archaeologists hoped that some of those Middle and Late Stone Age tools might still have residues stuck to their cutting edges that could be tested for traces of animal blood, amino acids, and maybe even DNA. Because of the age of the site and prevailing assumptions about our ancient ancestors, most believed the stone tools would reveal that these early cultures primarily hunted and butchered a variety of large game animals. But when the tests were completed, the researchers were shocked. Williamson found that just over 50 percent of all the residues on the stone tools came from plants, not animals. There were some plant fibers in the residues, but the strongest cases for plant usage came from preserved starch grains in the residues that were still attached along the cutting and grinding edges. Yes, there were some blood residues on the stone tools, but these were few in comparison to the overwhelming evidence of plant usage. Her study confirmed the important role women must have played in early cultures. And her study also showed that some tools were multipurpose because they had both starch and blood residues on them.

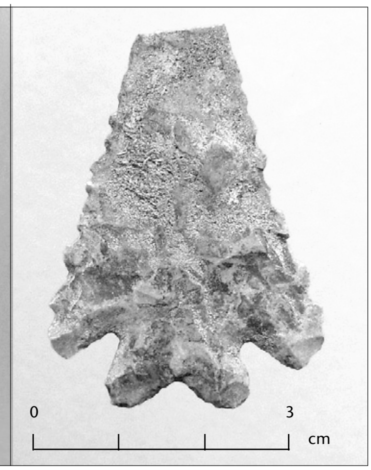
A decade later Dr. Williamson teamed up with paleoethnobotanist Dr. Lyn Wadley to examine the botanical remains and stone tools from the Middle to Late Stone Age (61,500–26,000 yr B.P.) site of Sibudu Cave, located on a cliff overlooking the Tongati River in KwaZulu-Natal, South Africa. Using cross-polarized light microscopy and birefringence tests, Williamson found that of the 412 stone tools she examined, 36 percent still had starch grains attached to their cutting surfaces. She also found that 23 percent of the stone tools had cooked starch residues attached to their surfaces, suggesting that the subsistence of these Middle and Early Late Stone Age cultures, like those of the Rose Cottage Cave site, relied heavily on plant foods and products.

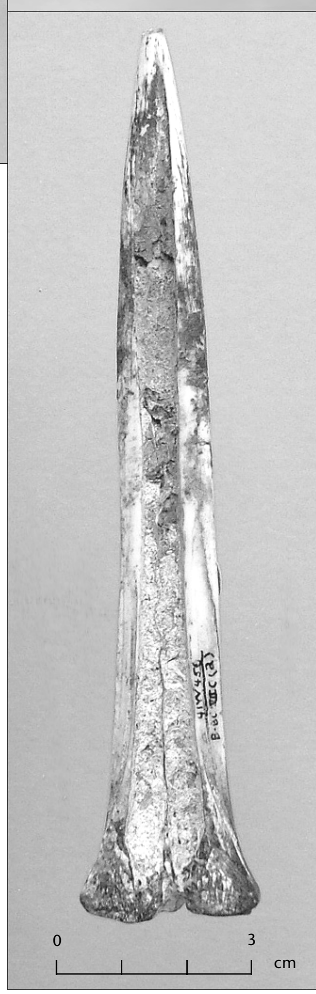
Even though many archaeologists were shocked to learn these South African sites contained 60,000-year-old starch grains that could still be identified to genus, sometimes even to species, those studies weren't the oldest. That record belongs to Dr. Philip van Peer and his team of archaeologists from Belgium. During the late 1990s and early 2000s they excavated Site 8-B-11, located in northern Sudan on Sai Island in the Nile River, a site chosen because of its long archaeological record extending from the Early to Middle Stone Age. Among the many stone tools and artifacts they found in the Lower Sangoan levels (200,000–180,000 yr B.P.) were two sandstone slabs with cut-out depressions and nearby a number of imported quartzite cobbles showing wear surfaces. When the worn surfaces of those











ALL: TEXAS A&M UNIVERSITY ANTHROPOLOGY REPOSITORY—PHOTOGRAPHIC ARCHIVES

Artifacts like these, with areas of coloration and evidence of accretions, are prime candidates for residue analysis. The tool at upper left comes from a late-Archaic site in Mexico; all the others come from the Hinds Cave in west Texas, from levels dating from the early to late Archaic. Bryant says that residue "can be found on many artifacts . . . *if you look for it!*"

cobbles were cleaned in a sonic bath, plant phytoliths and starch grains found in the loosened residue suggested the cobbles had been used to pound or grind starchy plant tissues, possibly including grass seeds.

Finding starch grains on old stone tools isn't all that new, nor has it been limited to South Africa. After receiving a B.S. in geology in 1964, then studying at Alaska Methodist University in Anchorage, Thomas Loy worked as a Canadian archaeologist in British Columbia. During the early 1980s he began noticing that many stone artifacts from Canadian sites still had what he thought was blood residue stuck to their cutting edges. After carefully examining 104 stone tools collected from four separate archaeological sites, each located in a very different ecological region of Canada, he shocked archaeologists by reporting that 86 percent of the tools had dried animal blood residues on their cutting edges that could be identified with more than a half-dozen animals ranging from sea lions to snowshoe rabbits. Using a variety of forensic techniques, Loy continued his pioneering research on identifying both plant and animal residues on stone tools. After working in the Arctic, Loy moved his study to Oceania, where in 1992 he reported finding taro (*Colocasia esculenta*) starch grains attached to 28,000-year-old stone tools from archaeological sites in the Solomon Islands. He was recognized as the world's leading authority on plant and animal residues, and at his untimely death in 2005 he was developing new ways to recover tiny traces of DNA on the surfaces of stone tools.

Finding starch at archaeological sites

Finding starch grains isn't as difficult as you might think, but you have to look for them. Surprisingly, as early as 1905 the German botanist L. Wittmack suggested that recovering and identifying ancient starch grains might prove to be a valuable resource tool for archaeologists. However, his suggestion was virtually ignored for over half a century. Today we realize that Wittmack's suggestion was insightful and that starch grains can be recovered from a wide variety of archaeological sites occupied over vast periods of time. Starch grains preserve remarkably well not only in arid regions such as deserts and semi-deserts, but also in hot and humid semitropical and tropical regions where most other forms of organic remains decay and are destroyed. Starch grains can be recovered from wet or dry soils—some have been dated as old as 2 million years. Starch grains have also been recovered from a vast array of stone cutting and grinding tools. They have been found attached to pottery fragments and preserved basketry, and in human coprolites (ancient feces). What's amazing is that the vast majority of ancient starch grains found in archaeological sites are intact and appear unaltered

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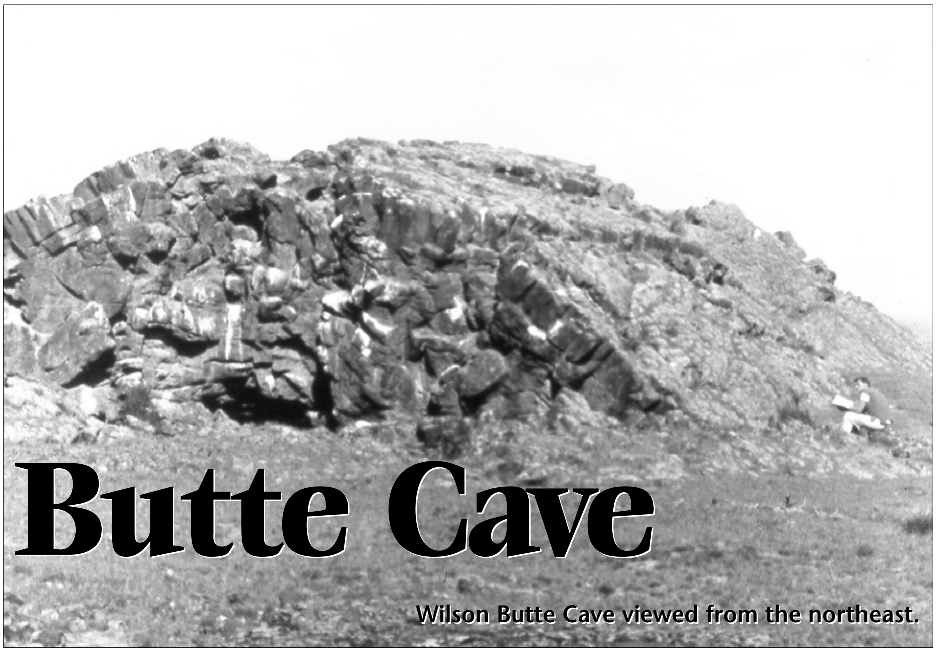
An Enduring Investigation

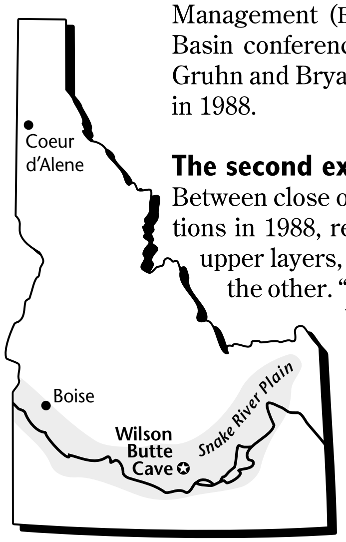
Wilson Butte Cave


Wilson Butte Cave viewed from the northeast.
ALAN BRYAN

WILSON BUTTE CAVE is a controversial site for many archaeologists. Formed of an expanded gas pocket within an old lava flow in the Snake River Plain of south-central Idaho, the cave yields evidence of pre-Clovis habitation in an area that was previously thought to have been settled no earlier than 12,000 yr B.P. Despite destruction of the uppermost levels of the cave by relic hunters, Ruth Gruhn, professor emerita of Anthropology at the University of Alberta, working with two excavation teams at an interval of 30 years, has reconstructed the cave's early paleoenvironment and recovered hundreds of artifacts.

In addition to the pre-Clovis evidence at the cave, in the uppermost stratum arrowpoint styles, bone gaming pieces, pottery sherds, a fragment of coiled basketry, and distinctive moccasin styles all contribute strong evidence of a Fremont presence in southern Idaho during the late prehistoric Dietrich phase (500–1500 yr B.P.), adding fuel to the Fremont debate.

Dr. Gruhn's report on her 1959–60 excavations as well as the final report on the second excavations in 1988–89 have been published, and both are now available. They are sure to excite controversy in the archaeological community.



The first excavations

In 1959 Gruhn, a graduate student at the time, worked with a crew of students at the cave. Evidence of extinct fauna told Gruhn the earliest occupation in the cave was probably terminal Pleistocene. Her interest piqued, she returned for a second season in 1960. Her dissertation, published in 1961 by the Idaho State College Museum as Occasional Paper #6, has been reprinted and is available again, along with the 2006 report *New Excavations at Wilson Butte Cave, South Central Idaho* (Occasional Papers of the Idaho Museum of Natural History #38), which covers the second excavations conducted at the cave.

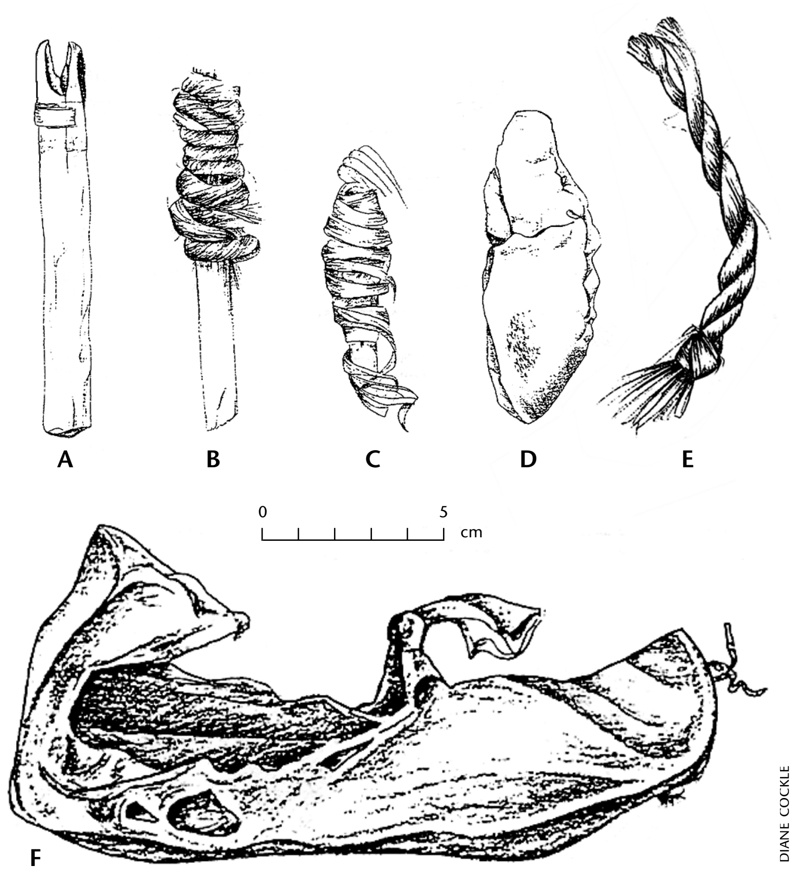
Despite a tight budget, charcoal and bone samples from the 1959–60 excavations were submitted to the University of Michigan lab for radiocarbon dating. The results derived from two bone samples, made available in 1965, surprisingly dated the earliest deposits to a pre-Clovis age. The artifacts found with these early-dated materials gave Gruhn good reason to return to the cave in the late 1980s.

In the interval between the two Wilson Butte Cave excavations, Gruhn and her husband, Dr. Alan Bryan, excavated early sites in Guatemala, Venezuela, Brazil, Nevada, and other places in Idaho. The idea to go back to Wilson Butte Cave arose in 1987 in a discussion with John Lytle, the Bureau of Land Management (BLM) archaeologist for the district at a Great Basin conference. Funding by the BLM made it possible for Gruhn and Bryan and a small team of volunteers to set to work in 1988.

The second excavation

Between close of excavations in 1960 and beginning of excavations in 1988, relic hunters destroyed the stratigraphy of the upper layers, shoveling the dirt from one side of the cave to the other. "By the time we got back in '88," Gruhn remembers mournfully, "strata A and B were completely gone." Salvaging evidence of early occupations was Gruhn's first concern, and they set to work with the hypothesis that the earliest levels might still remain undisturbed. Test excavations confirmed that there were substantial undisturbed deposits in the lower levels of the cave. "On that basis," Gruhn recalls, "we were able to get a regular research grant from the Social Sciences and Humanities Council of Canada, and go back to the cave with a fair-sized student crew in 1989."

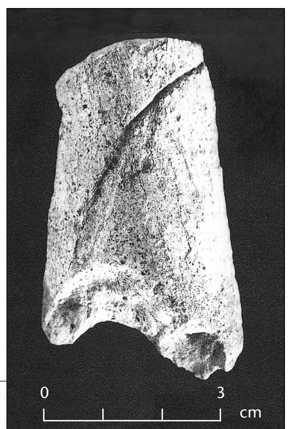
Artifacts of the Fremont tradition found at Wilson Butte Cave. A, knife handle; B, fire bundle; C, wrapped bundle; D, leather pouch; E, knotted cordage; F, moccasin.



The interior of the cave is about 30 m in diameter; and the sediment fill is about 3 m deep at maximum, near the cave mouth. The two lowest major strata, E and C, are waterlaid sediments derived from outside the cave. Stratum E, yellow-brown clay, directly overlies the bedrock floor of the cave; and Stratum C is a thick deposit of gray-brown sand that overlies Stratum E. The matrix of the upper strata, B and A, was windblown silt. Although after 1960 these two upper strata were thoroughly churned by relic hunters, many artifacts were recovered from the disturbed deposits in the 1988–89 excavations and are described in the 2006 report.

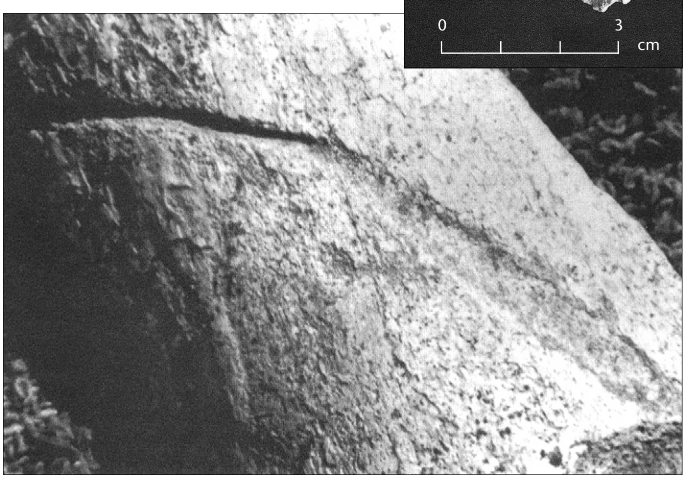
Reading the record

There was little fossil pollen found in the cave sediments, so other means were used to reconstruct the paleoenvironment. One of the clues the team relied on to infer the environmental setting through time was the large collection of bones of small mammals and birds recovered throughout the deposits in 1959–60. Birds of prey, especially owls, regurgitate the bones and hide of their victims as a raptor pellet, which resembles a cat hairball. The cave, a perfect roost for owls, produced the remains of many raptor pellets. Owing to the relatively restricted environmental range of the small mammals and birds that were the owls' diet, expert zoologists were able to identify the species of the prey and thereby infer the approximate environment around the cave at intervals during the past. Raptor pellets recovered from earlier stratigraphic levels reveal species of small rodents that live in relatively cool, moist environments. About 7000–8000 years ago, the owl prey shifted to hares and rabbits, signaling a trend to the semiarid conditions of southern Idaho today. These data are reported in appendices in the 1961 volume.



Modified fragment of thick mammalian long bone recovered in Stratum E. ▶

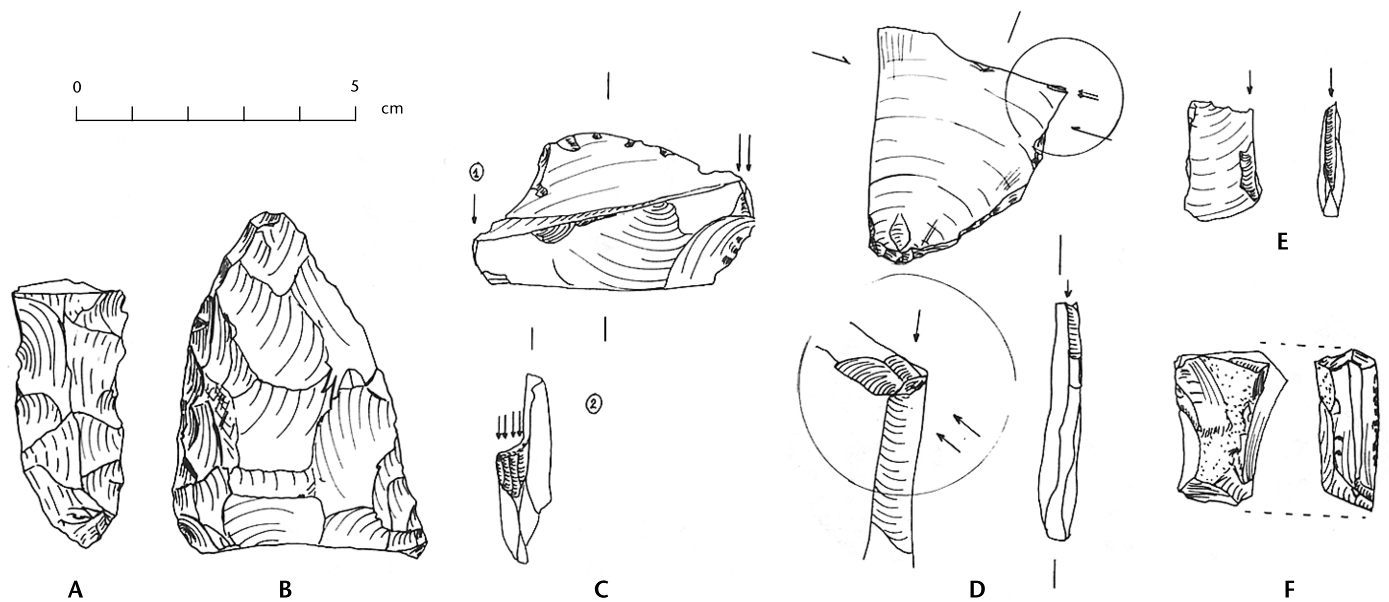
Close-up of incision. ▼



Bones of now-extinct megafauna, principally horse and camelid, were recovered from Stratum E and the lower levels of Stratum C. A bone fragment with an apparent cut mark and a few stone flakes, all recovered from Stratum E, may indicate early sporadic use of the cave by ca. 16,000 RCYBP. Stone artifacts were numerous although scattered within the sand in the lower levels of Stratum C, which may date back to 11,000 RCYBP and possibly older. Most prominent were Great Basin Stemmed points assignable to the Haskett type, and there were also some large shouldered points similar to Plano types.

New analyses

When a site has undergone repeated investigations over an extended period of time, scientific advancements will likely invite reevaluating earlier findings. That was the case with Wilson Butte Cave. Obsidian hydration (OH) analysis is a technology that is utilized in Gruhn's new report but was not available in the 1960s. OH analysis uses the results of X-ray fluorescence (XRF) analysis of volcanic glass artifacts, along with other data, to estimate the age of an artifact. XRF, a time-tested technique that dates back to the 1920s, bombards a mineral sample with X-rays and detects the energy levels of

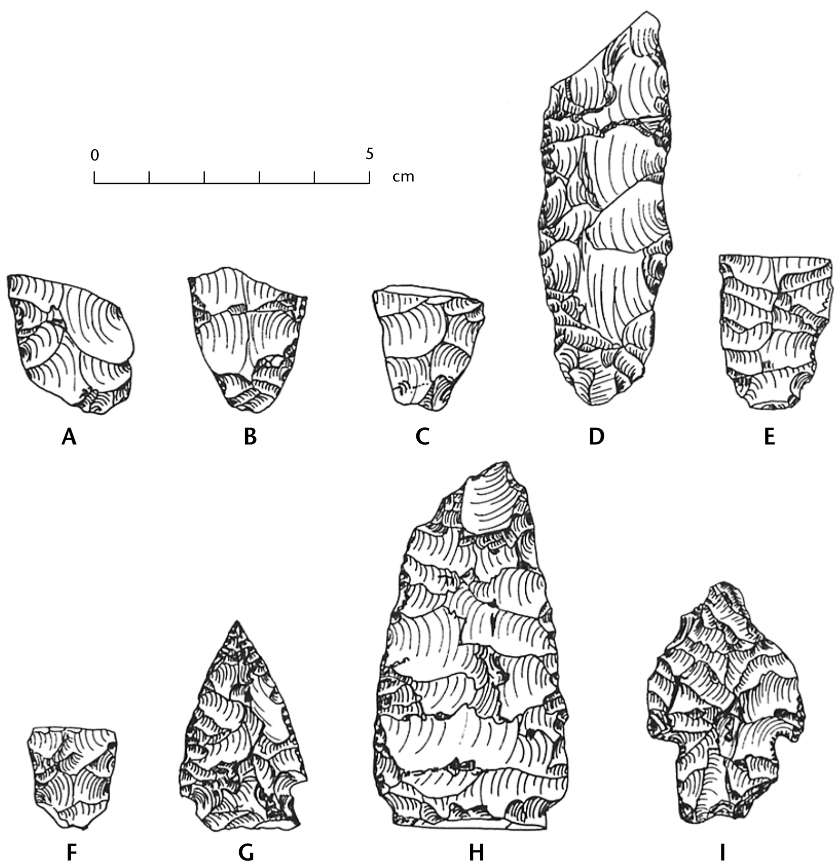


Artifacts from Stratum C, facies C4, basal gray sand. **A**, stemmed point base; **B**, biface; **C–D**, burins; **E**, burinated flake geometric; **F**, spokeshave.

secondary emissions; since every element has a unique emission signature, XRF reveals the precise constituents of the sample, and each geological source of volcanic glass can be distinguished. Thus, given an artifact's XRF signature, an analyst can frequently identify the volcanic formation where the toolstone was quarried. OH analysis can then be used to date the artifact. By measuring the depth of the weathered rind on flaked obsidian and correlating the result with such variables as source material, temperature, and moisture, OH analysis gives a fair approximation of the time elapsed since the item was flaked. For the Wilson Butte Cave collection, Jeff Bailey located and sampled the major geological sources of volcanic glass in southern Idaho, and used XRF to determine the emission signatures of these samples and to identify the geological sources of artifacts from the cave. The OH analyses of Wilson Butte Cave artifacts were subsequently carried out by Christopher Stevenson.

Although results of OH dating aren't universally accepted by the scientific community, it's encouraging that the OH dates of late-prehistoric artifacts from Wilson Butte Cave agree quite closely with dates obtained by conventional techniques on similar artifact types at other archaeological sites. It's interesting, then, that OH analysis of two Great Basin Stemmed point bases from Stratum C produced dates earlier than 13,000 CALYBP, equivalent to calibrated radiocarbon dates for Clovis. With an eye to the future, Stevenson lists in the appendix of the 2006 report the rind measurements of artifacts in case new advances in OH dating call for recalculation.

Technology isn't all that changed in the 45 years that separate Gruhn's reports on Wilson Butte Cave. Since 1961, new terms have been introduced for point types of the region; and the chronology of major climatic phases has been



Stemmed or shouldered projectile points from Stratum C, facies C1, gray/brown sand. **A–C**, small basal fragments of stemmed points; **D**, stemmed point base; **E–F**, stemmed point bases yielding early OH dates; **G–I**, fragmentary large shouldered points.

revised. Moreover, cultural identification of the late-prehistoric Dietrich phase (500–1500 yr B.P.) has become controversial with the identification of artifacts as Fremont.

Fremont peoples in Idaho during the late prehistoric?

The collections of 1950s relic hunters and in particular sherds of pottery recovered from Stratum A during the 1959–60 excavations reveal a surprising Fremont presence at the cave in late prehistoric times. We know that the Fremont people thrived farther south in Utah and western Colorado, where they formed villages, cultivated corn, and made pottery. Archaeologists had long considered the possibility of the Fremont tradition as far north as Idaho; their suspicion seems to be confirmed by recognition of particular projectile point styles and bone gaming pieces, as well as perishable artifacts including a "dewclaw" moccasin, a fragment of a coiled basket, and sherds of pottery, all diagnostic of the Fremont tradition, in the Wilson Butte Cave collections.

Excavations in progress on the north side of the cave in 1989.

ROY CARLSON

In Utah, the Fremont culture disappeared about 800 years ago; and by historic times Utah and southern Idaho were occupied by Numa peoples, the Shoshone. The reason for this culture change is one of the great debates in American archaeology. In chapter 10 of *New excavations at Wilson Butte Cave*, Diane Cockle, who focused her master's thesis on the relic hunters' collections from the site, illustrates and describes in detail artifacts dating to the late-prehistoric phase, and discusses implications of a probable Fremont occupation at Wilson Butte Cave. Gruhn, in her summary chapter, addresses the Fremont controversy in considerable detail.

Evidence for pre-Clovis occupation

The pre-Clovis date of 14,000 RCYBP returned on a bone sample from the lower level of Stratum C submitted to the University of Michigan radiocarbon-dating lab after the 1959–60 season continues to excite Gruhn. Imperfect stratigraphic conditions, however—waterlaid sand deposits, scattered artifacts, and absence of a living floor—in Stratum C have given Clovis-First proponents cause to question whether the artifacts are definitely associated with that dated material. Gruhn discusses the dating of the lower part of Stratum C at some length in her concluding chapter of the 2006 report. As for the underlying Stratum E, all the evidence suggests that people occupied Wilson Butte Cave only sporadically before 10,000 RCYBP because conditions inside the cave were unfavorable. "Based on the nature of the sediment," she points out, "the environment inside the cave was cold and damp. No one is sure how large the opening of the cave was at 10,000–15,000 RCYBP. It may have been unattractive to people and used only occasionally during a storm. Its occupation could have been very ephemeral if the cave was not that habitable."

The answer to whether pre-Clovis humans occupied Wilson Butte Cave during the period of deposition of stratum E remains elusive. Perhaps in the future new methods of testing will tell us conclusively when the cave's earliest occupants arrived. Regardless of who the first occupants turn out to be, the cave has already given us a wealth of information about early Idaho.

–Dale Graham

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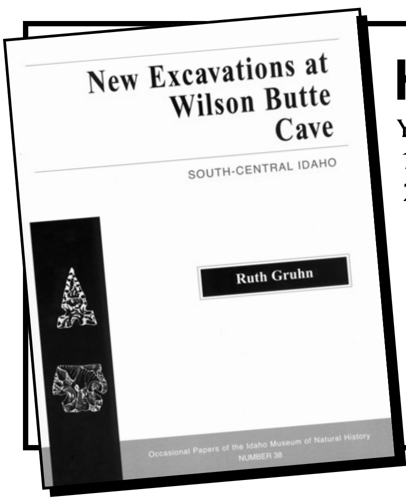

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You can order a copy of the reprint of the 1961 report (Occasional Paper #6) or the 2006 report (Occasional Paper #38) for $40 each plus S&H, or the set for $75. Order from:

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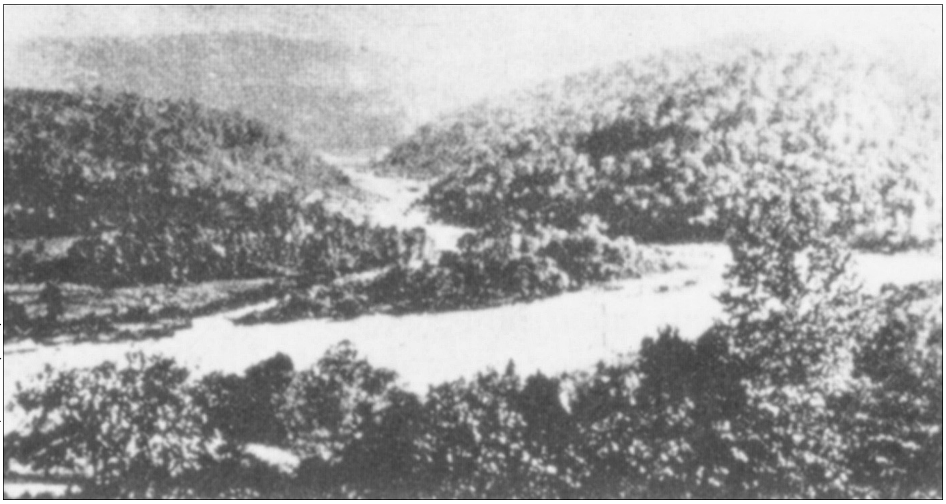
The Hardaway Site



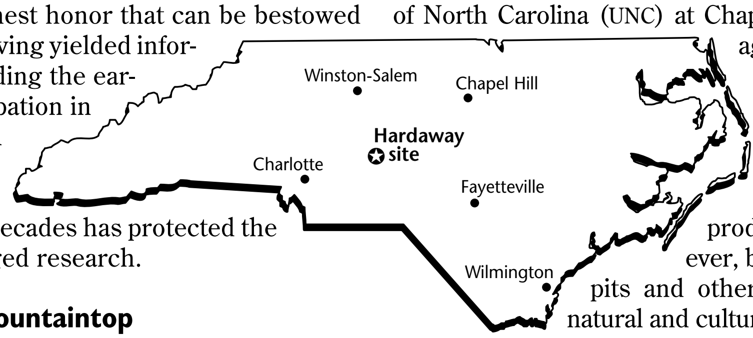
A Treasure Preserved

The Narrows of the Yadkin River, about 1890. The Hardaway site lies at the top of the hill to the right. Most of the area seen in this photograph became submerged after the Narrows Dam was built, forming Badin Lake.

by Mark R. Barnes,
Senior Archeologist, National Park Service (retired)

EARLY AMERICANS saw something to distinguish the Hardaway site from the surrounding terrain in the North Carolina Piedmont, for they started visiting this rocky ridge, perched nearly 300 ft above the Yadkin River, as early as 12,000 years ago to refurbish their toolkits and hunt local game. Successive occupations continued until historic times.

Research at this enormously rich site has so expanded our knowledge of Paleo-Indian and early-Archaic artifact typologies and occupation chronology that in 1990 the federal government designated the Hardaway site (31St4) a National Historic Landmark, the highest honor that can be bestowed on a cultural property, for having yielded information crucial to understanding the earliest periods of human occupation in the eastern United States. A large part of the credit goes to ALCOA, Aluminum Company of America, which for decades has protected the Hardaway site and encouraged research.



A lithic workshop on a mountaintop

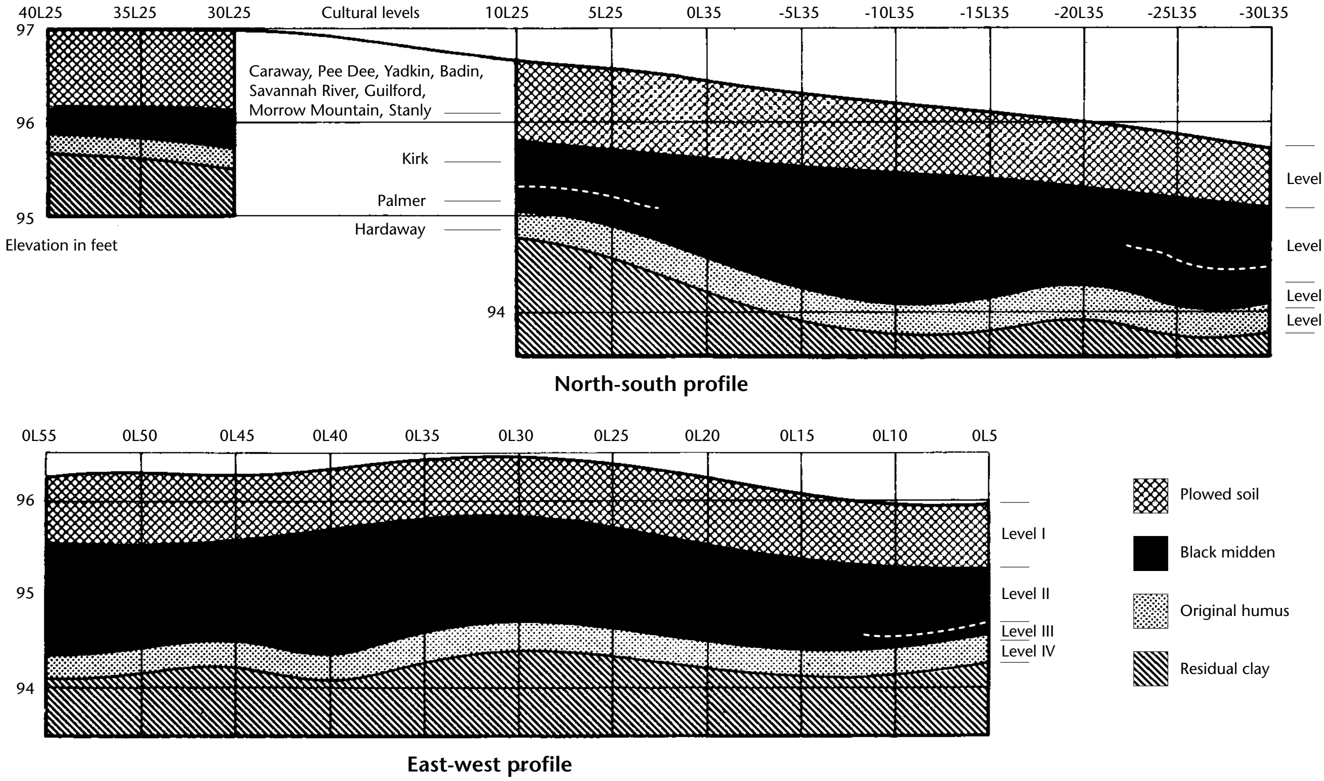
The Hardaway site lies 140 ft above the west bank of Badin Lake, a reservoir created when the Narrows Dam was constructed early in the 20th century. Before then, the site lay approximately 280 ft above the Yadkin River. The site sits at the northern end of a ridge, referred to as Hardaway Point, on a relatively level area capped by two knolls. Separating the two knolls is a low saddle, which is believed to contain an old springhead and today tends to be wet and muddy much of the year. Local tradition holds that the saddle was once a small pond that was graded and filled to create a railroad bed by the Hardaway Construction Company, for whom the site is named.

The ridge on which the Hardaway site is located is part of the Uwharrie Mountains, and lies within the Slate Belt of central North Carolina that was formed by extensive volcanic uplifting of the slate beds. The rocks of the slate belt are of volcanic and sedimentary origin, and include slate, shale, mudstone, argillite, greywacke, conglomerate, siltstone, and sandstone.

The first archaeological investigations

H. M. Doerschuk, an amateur archaeologist, first brought the Hardaway site to the attention of Joffre L. Coe of the University of North Carolina (UNC) at Chapel Hill in 1937. In 1948, and again in 1951, Doerschuk, Paul Strieff, and Coe and his students sank a single 5-by-5-ft square, which they excavated in arbitrary 6-inch levels. These first excavations produced meager results, however, because intrusive features and pits and other complications masked the natural and cultural stratigraphy.

In 1954, UNC obtained a lease from the Carolina Aluminum Company, forerunner of ALCOA, to conduct additional excavations at the Hardaway site. In the course of systematic excavations begun in 1955, cultural stratigraphy was identified by excavating "natural" layers. Coe noted a 28-in-thick "midden" (later identified as stratigraphic Zones II and III) overlying a 2-ft-thick layer of original topsoil. Lithic toolmaking debris constituted about 40 percent of the volume of the midden zone. The results of the first phase of excavations (1954–1958) formed the basis of Coe's dissertation, which was published in 1964 by the American Philo-



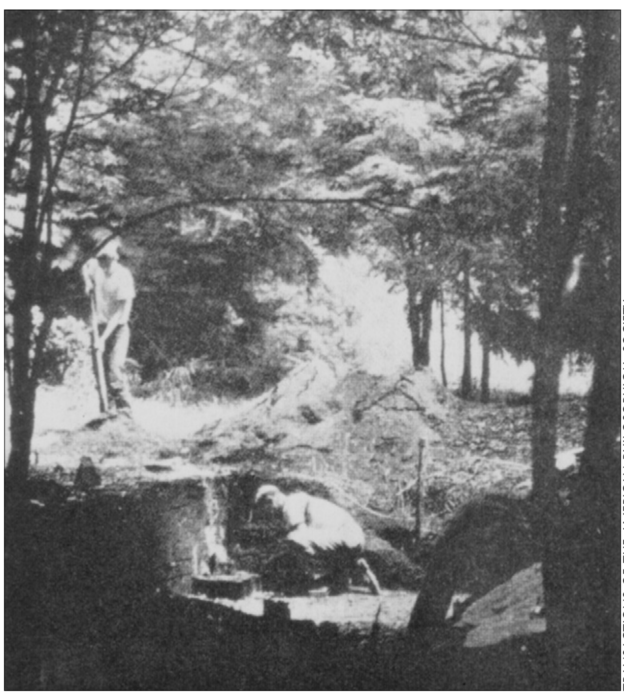
AFTER FIG. 49, TRANSACTIONS OF THE AMERICAN PHILOSOPHICAL SOCIETY, VOLUME 54, PART 5 (1964). REPRODUCED BY PERMISSION.

Stratigraphic profiles of the Hardaway site.

sophical Society as *The Formative Cultures of the Carolina Piedmont.*

Together with co-investigator H. Trawick Ward of UNC–Chapel Hill, Coe undertook a second phase of excavations from 1975 to 1980 in an area of the site south of the previous work. The research objectives, according to Dr. Ward, consisted of "defining the limits of the occupation, obtaining subsistence data, and collecting radiocarbon samples." Although their investigations weren't thoroughly analyzed at the time, they did show that the occupation area of the Hardaway site covers the entirety of Hardaway Point. (Archaeologist I. Randolph Daniel, Jr. of East Carolina University analyzed the excavated data as his own doctoral dissertation, later published in 1998 as *Hardaway Revisited: Early Archaic Settlement in the Southeast.*)

To date, 143 5-ft squares have been excavated at the Hardaway site, removing over 8,300 ft^3 of soil. In addition, test excavations have been dug at various locations along the ridge, including 3 5-ft squares on the northern end of Hardaway Point. By the end of the 1980 field season, over 7 metric tons of cultural materials had been recovered from the site, including more than 3,000 projectile points, 5,000 scrapers, and other types of tools.



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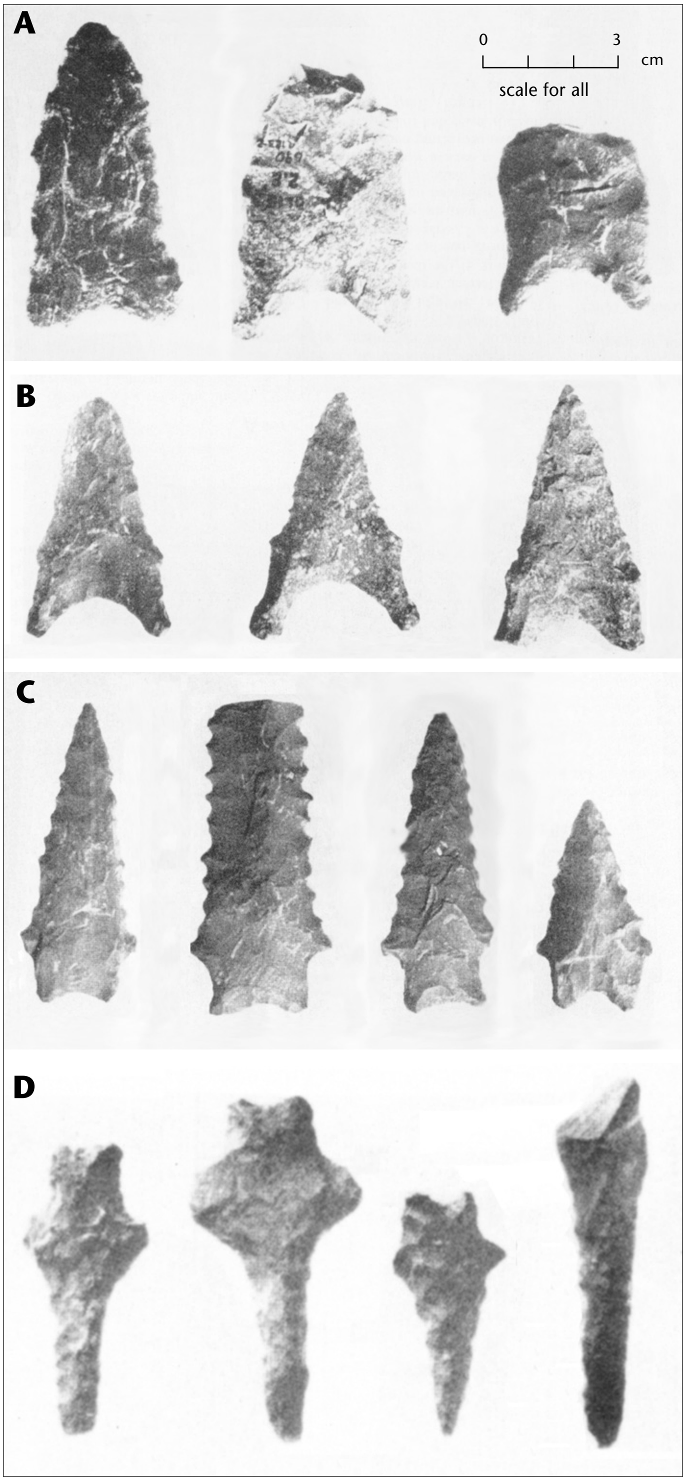
A worker clears a Hardaway hearth in the 1958 season. Soil Zones I through IV appear on the profile above the hearth.

Site and stratigraphic analysis

Work at the Hardaway site has confirmed five stratigraphic zones, of which four contain cultural material. The oldest of these zones is Zone V, a red clay cap 2 to 10 ft thick. Except for a few artifacts in the uppermost portion, which possibly became embedded when the exposed clay dried and cracked, this zone is culturally sterile and predates human occupation at the site.

Zone IV is a thin (2–3 in) layer of ancient humus, now an orange-red clay. Identified by Coe as the earliest human occupation level at the Hardaway site, this layer contains evidence of what Coe called the Hardaway cultural complex. Ward believed the Hardaway cultural complex existed during the earlier part of the Paleo-Indian pe-



Lithic artifacts from the Hardaway site. A, examples of the Hardaway Blade projectile point type recovered from Zone IV; the two specimens on the right are considered "typical Quad" points. B, Hardaway-Dalton points from Zone IV. C, Kirk Serrated points. The fractured point is from Zone III; all the others were recovered from disturbed soil. D, chipped-stone drills. The leftmost three are Kirk drills from Zone II and disturbed soil; the rightmost is a Hardaway drill from Zone IV.

riod in North Carolina; he estimated the date at 14,000–12,000 yr B.P. Subsequent comparison of Hardaway materials with those from other sites, however, and reanalysis of the original data have identified the Hardaway complex as a manifestation of the early-Archaic period, rather than a definite Paleo-Indian occupation. Excavations of the Hardaway Zone IV revealed stone-lined hearths and recovered projectile points, blades, drills, end- and sidescrapers, and large quantities of primary and secondary debitage.

Zone III is a 5- to 6-in-thick layer of brown clayey loam containing materials associated with the Palmer cultural complex, named after Palmer Mountain, located a short distance to the north of Hardaway Point. Dating to an early part of the Archaic period (ca. 10,000 yr B.P.), the Palmer occupation at the Hardaway site accumulated more cultural debris than the earlier occupation in Zone IV. This suggests either that larger groups were occupying the site, or that the site was being occupied more frequently or for longer periods than during the Hardaway occupation. In Zone III stone-lined hearths have been found and large quantities of Palmer-type projectile points and other tools have been recovered, along with substantial primary and secondary debitage.

Zone II is associated with the Kirk complex (named after the nearby colonial Kirk homestead). The Kirk Zone II, a dark brown clayey loam matrix 1–1.5 ft thick, is so rich in cultural debris that Coe in 1983 estimated that the volume of artifacts is greater than the volume of soil! The types of stone tools recovered are consistent with those found in Zones III and IV; moreover, the Kirk occupation appears also to have engaged in intensive biface production, resulting in a thick deposit of accumulated lithic debitage. Based on comparable sites in Alabama, Virginia, Tennessee, and West Virginia, the early-Archaic Kirk occupation at Hardaway appears to date to 10,000–8000 yr B.P.

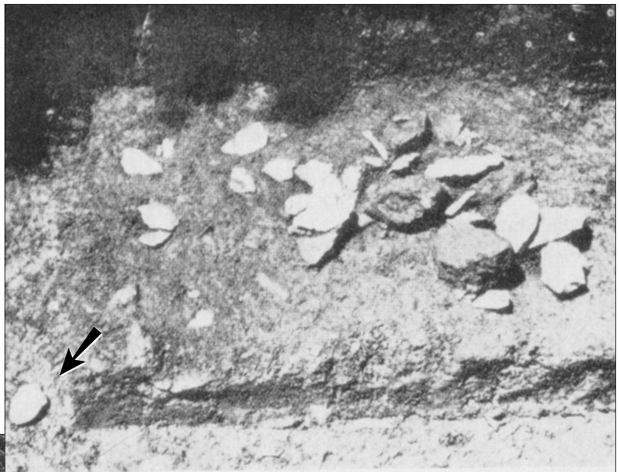
The uppermost Zone I is an 8- to 10-in-thick plow zone containing cultural materials whose provenance ranges from the middle Archaic (ca. 8000 yr B.P.) to historic Caraway Indian occupations of the early 18th century. Successive occupations by cultural groups that visited the Hardaway Point area to make tools from native stone may have produced layered deposits similar to those of occupations in Zones II to IV. Historic farming activities, unfortunately, have completely intermixed all these materials.

Sharpening archaeological method and theory

Coe's definitive work published in 1964 resolved ambiguity about the relative dating of such early-Archaic projectile point styles as Hardaway, Palmer, and Kirk. His definitions of these tools have since been used to date archaeological sites throughout the eastern U.S. that yielded similar points.

It's difficult to overstate the debt American archaeology owes to the Hardaway site for its role in advancing our understanding of the sequential development of prehistoric cultures in the eastern U.S. Today the Paleo-Indian and early-Archaic sequences from the site remain largely unchanged and are still used to date sites in much of the eastern U.S. occupied between 12,000 and 8000 yr B.P.

Relative chronology established at the Hardaway site was particularly important because, as Bruce Trigger notes, "A major problem that confronted archaeologists in eastern North America before radiocarbon dates became available in the 1950's was the establishment of a reliable calendrical chronology. . . . On the basis of guesswork, a very rough chronology was adopted to which Late Archaic cultures that are now dated around 2500 B.C. were placed no earlier than A.D. 300." The initial excavations at the Hardaway site pushed Southeastern prehistory back to at least 10,000 yr B.P. After recently analyzing fluted points from the Hardaway site, Daniel is now confident that the earliest occupation dates as early as 12,000 yr B.P.



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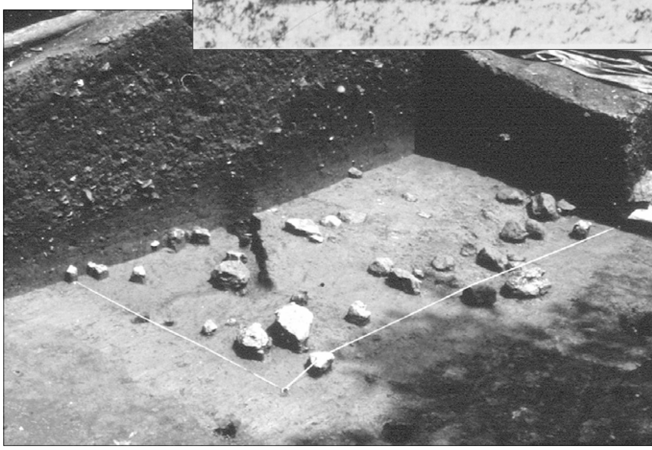
A classic Kirk hearth at the Hardaway ▶ site, consisting of a cluster of rocks surrounded by flakes, blades, scrapers, projectile points, bone fragments, and flakes of charcoal. The sidescraper (*arrow*) lies in the Hardaway zone.

A living floor at the Hardaway site.▼

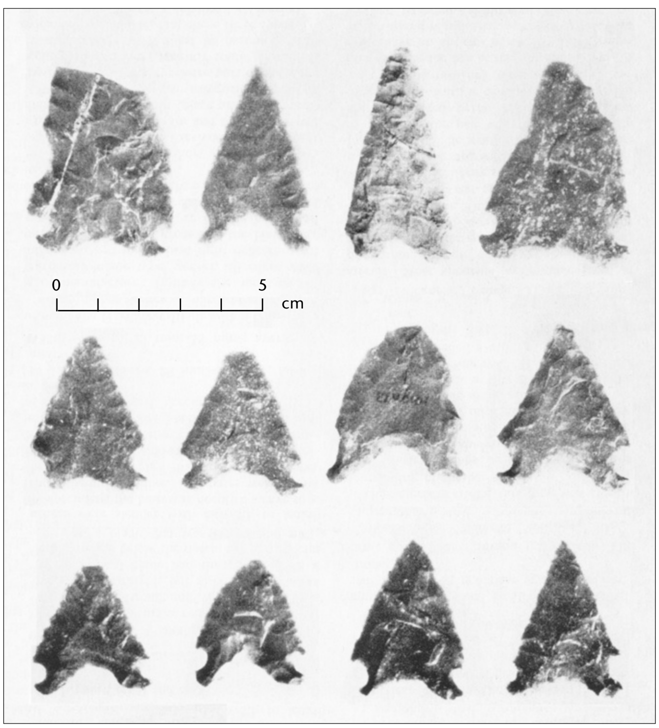


STEPHEN R. CLAGGETT

Prior to research at the Hardaway site, little accurate information was available on the Paleo-Indian and early-Archaic periods of prehistory in the Eastern U.S. In the 1930s archaeologists attempting to understand cultural variation in prehistoric times used what was called the Midwestern Taxonomic Method (MTM). By this rule of thumb, the contents of individual sites or components were catalogued according to trait lists; neighboring sites that shared an overwhelming number of traits were grouped to form foci, equivalent to an ethnological tribe.

Using the MTM analytic technique resulted in interpretations of archaeological sites that were often grossly inaccurate. Extensive erosion throughout much of the Southeast resulted in the deflation of archaeological sites and their contents, which meant that artifacts that may originally have been stratigraphically separated by inches or feet of culturally sterile soil might be found immediately next to each other within the same soil zone. Using the MTM, or trait-list approach, the archaeologist assumed that all artifacts within the same soil zone were related and thus belonged to the same "ethnological tribe." In reality, artifacts might be separated from each other by thousands of years.

His work at the Hardaway site convinced Coe of the fallacy of this MTM technique. He noted that "recurring complexes of traits were in reality the remains of recurring occupations . . . by the same sequence of people." By isolating stratigraphically distinct layers of cultural deposits, he found it was possible to define artifact assemblages characteristic of the Hardaway, Palmer, and Kirk cultural periods. The principles of archaeological observation and analysis that Coe pioneered prevail today.



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Hardaway Side-Notched points, all from Zone IV.

Preserving the site

Coe estimated that 50 to 65 percent of artifact-rich Zone IV remained at the Hardaway site in the 1970s, from which substantial information could be extracted. Sadly, much of that material was lost to relic hunters in the 1980s.

Since 1983 ALCOA, the site owner, empowered by the North Carolina Department of Cultural Resources (DCR), has restricted access to the site, enforced protection under the State Archaeological Resources Protection Act, and maintained the site as a mowed field to forestall erosion. In 2005 ALCOA agreed to transfer collections recovered from past archaeological investigations to UNC–Chapel Hill. Most recently, Alcoa Power Generating, Inc. in 2007 entered into an agreement with North Carolina State Parks to purchase and donate 1,400 acres of land along the Yadkin River—including the Hardaway site—as part of the Yadkin Hydropower licensing agreement with the Federal Energy Regulatory Commission. Specific management details for Hardaway and other sites contained in the tract will be mapped out between DCR's Office of State Archaeology and the North Carolina Division of Parks and Recreation.


MARK BARNES

The author (*left*) congratulates Joffre Coe at the ceremony designating the Hardaway site a National Historic Landmark held November 1990 in Badin, North Carolina.

The significance of the Hardaway site in American archaeology becomes even more pronounced as we approach the century mark in serious Paleo research. Today the site enjoys protection by virtue of its dual status as a National Historic Landmark and as a historic site under the care of the State of North Carolina. Work now in progress is further refining the dating of material recovered from this site and other classic sites that are the foundation of our studies of the peopling of America. Without the protection of cultural resource management, this critical reexamination wouldn't be possible. At the very least, we can expect that the future promises even greater research opportunities at this classic early American site.

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Clovis Dethroned

continued from page 2

non-discovery of pre-Clovis peoples is virtually guaranteed."

Where do we go from here?

As with most startling discoveries, researchers are likely to spend several decades testing the Waters/Stafford findings and filling in the details. Stafford's hope is that their work encourages people "to get out of their chairs, get out of their offices, and do field work and make discoveries. It's fine to write theoretical treatises and teach what has been known for decades, but we need new sites, new analyses, and new ideas."

Waters adds to the list of tasks to be done. "We need to explain the unprecedented rapid spread of Clovis technology over North America. How could this have happened? In the coming years, we need to work towards a model that combines genetic data, geological evidence, and archaeological data into a new and coherent model of the First Americans. This model must be built on empirical data—artifact assemblages from securely dated geological contexts. As we develop a new model, we need to stop thinking about the peopling of the Americas as a single colonizing event. . . . Instead, we need to start thinking of it as a process, with people arriving at different times, taking different routes, and coming from different places.

"The way to get the answers," says Mike Waters, "is to keep digging holes and getting dates."

–Floyd Largent

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Genetic Discovery Refines Our View of the Peopling of the Americas

BOTH: T. G. SCHURR

Two Siberian women belonging to populations sampled in the study, a Northern Altaian from east-central Asia (*top*) and a Chukchi from western Beringia. The 9RA is present in the Chukchi, but was not observed in the Altaians.

A TEAM OF RESEARCHERS, representing institutions from across the United States and in Russia, have made a key discovery in the genetic code of Native Americans and eastern Siberians that sheds light on the origins of the First Americans. Published in the journal *Biology Letters*, the results suggest that nearly all Native Americans are descended from a relatively small founding population that originated, relatively recently, in western Beringia.

The three-wave model

The generally accepted model of the peopling of the Americas postulates at least three waves of migration. The earliest is thought to be the so-called Amerind language group, which basically encompasses all the indigenous peoples of South America and most groups of North America south of Canada.

The second supposed wave of migration was the Na-Dene language group, which used to be referred to as the Athapascans. This includes the native peoples of western Canada and the interior and Pacific coast of Alaska, as well as the Navajo and Apache of the southwestern United States.

The final wave was the Eskimo and Aleut peoples, often referred to collectively as the Eskaleut language group, who most closely physically resemble Asians and are regarded as the most recent immigrants to Native America.

Some genetic studies theorize a slightly simpler model of two major expansions, the earliest being the "Amerind" populations, followed by the more recent circumarctic expansion of Na-Dene and Eskaleut founder populations.

Critics of this three-wave model generally have argued that it is too simplistic and underestimates the number of migrations. Discoveries such as Kennewick Man suggest to some that there was more diversity in ancient Americans than the simple three-wave model could accommodate (**MT 8-3,** "Team Traces Four Trails from Asia"). Analyses of Paleoindian stone-tool technology have even been used to argue that there had been migrations of some European groups to Ice Age America (**MT 17-1,** "Immigrants from the *Other* Side?"). The discovery announced in February is compelling evidence that the traditional, three-wave model isn't too simplistic—it's too complicated.

A "private allele"?

In 2003, a separate team of researchers, which included one of the members of the team that made the discovery in 2007, described an allele, or a variant of a gene, that was present at high frequencies in all the Amerind groups sampled, but completely absent from 47 populations representing the rest of the world. This finding suggested that the variant might be a "private allele." A private allele is a mutated form of a gene that is peculiar to a particular population, or to a set of related populations. It indicates two things. First, the members of the population share a common ancestor. Second, the population in which the private allele is present branched off from neighboring groups and was thereafter mostly genetically isolated from those other groups. The newly discovered putative "private allele" is called "9RA" for "9-Repeat Allele," because it consists of a segment of DNA code that is repeated nine times.

The implications of this discovery were provocative, but the initial study didn't go far enough. The sample of groups didn't include the Na-Dene Indians or Eskimo-Aleuts, nor did it extensively sample those groups from eastern and central Asia generally thought to be ancestral to Native Americans.

The new research team, led by Kari Schroeder and Dr. David Smith of the University of California at Davis, built on the earlier research by posing the following questions. First, did the Na-Dene and Eskimo-Aleut share this special allele with the Amerinds? If they did, then they could be shown to share a relatively recent common ancestry. Second, if the allele was not found in a larger sample of groups from eastern and central Asia, then it could be concluded that modern Native Americans, including the Eskimo-Aleut, were more closely related to each other than to any contemporary Asian population.

To test these hypotheses, the team looked for the "9-Repeat Allele" in two Eskimo-Aleut groups, two Na-Dene groups, nine additional Amerind groups, and two groups from northeastern Siberia. In addition, since other genetic evidence has shown a close relationship between Native Americans and groups from the Altai region of east central Siberia, the team sampled five populations from this area.

LOUKAS BARTON

Kari Schroeder

Corroborating the previous study, the team found 9RA in all North and South American populations that they sampled at an average frequency of about 33 percent. They also observed it, at somewhat lower frequencies, in the easternmost Siberian populations living within a region that corresponds with western Beringia, the Asian side of the Bering Land Bridge. They did not, however, find 9RA in any groups from the Altai region.

Schroeder and her coauthors observed that "the remarkable distribution of 9RA severely constrains the possible evolutionary histories of modern Native American populations." They conclude that the "simplest explanation" for these data is that "the Americas were settled by a single founding population in which 9RA was present and from which all modern Native American populations descend."

ADRIAN COAKLEY, NATIONAL GEOGRAPHIC

Tad Schurr

Other explanations

There are alternative explanations, to be sure. It's possible that 9RA conferred some special benefit in the New World and that natural selection accounts for its relatively high frequency in Native American populations. As Schroeder and her coauthors point out, however, a consequence is that all individuals who possessed the 9RA mutation would have benefited equally in all environments of North and South America, from tundra to tropical rain forest. It's difficult, however, to imagine how this could have been the case, since traits that confer an advantage in one environment, such as dark skin pigmentation in equatorial zones, usually are not equally beneficial in other environments.

Another possible explanation for the modern distribution of 9RA is that the mutation appeared among the Amerinds and spread through gene flow, that is, by migration and the exchange of mates, to the Na-Dene, Eskimo-Aleut, and eventually to the eastern Siberian groups. This suggestion also is implausible. According to Schroeder and her colleagues, the frequencies of 9RA in the Na-Dene, Eskimo-Aleut, and eastern Siberian groups are much too high to be the result of gene flow.

As for why 9RA isn't found in Asia, apart from the populations at the very doorstep of America, there are several possible explanations. First, the 9RA mutation may have appeared so recently in the Americas that there hasn't been time for it to spread deep into Asia via gene flow. Second, the mutation could have been present at low frequencies among Asian groups, some of whose members migrated to the Americas, but was subsequently lost in these Asian groups owing to genetic drift, the process whereby traits that occur at low frequencies in small populations can be lost more or less by chance. Finally, it's possible that 9RA first appeared in an Asian source population, but that population simply has yet to be identified and sampled by geneticists, possibly because it went extinct.

The simplest and best explanation for the modern distribution of 9RA is that nearly all modern Native Americans descend from a common founding population. Ultimately, that founding population had its roots in Asia, but it appears to have been isolated for a time in Beringia, where unique mutations like 9RA appeared and accumulated.

Not surprisingly, the complete story is a bit more complicated than this relatively simple scenario might suggest. Other lines of genetic evidence, including studies of DNA from the mitochondria (**MT 7-1,** "Paleoindians *and* DNA: A Review"; **MT 12-3,** "Reconstructing Human Societies with Molecules Ancient & Modern"; **MT 13-4,** "New World Migration Research Paints Increasingly Complex Picture") and the Y-chromosome,

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indicate that there were a few additional minor pulses of Asian groups into North America. Nevertheless, the implications of the frequency and distribution of 9RA are compelling.

Clovis-First after all?

One of the most surprising implications of the discovery of the 9RA private allele is that it appears to support a model of the peopling of the Americas that many experts regard as outmoded, if not falsified by accumulating archaeological data. The "Clovis-First" model proposed that a small founding population of Beringian big-game hunters entered America about 13,000 years ago and rapidly migrated throughout the Americas. This wave of immigration is represented archaeologically by the widespread and nearly simultaneous appearance of Clovis fluted spear points across much of North American and extending into the northernmost parts of South America.

Discoveries at sites such as Monte Verde in Chile (**MT 13-3,** "The Americas after Monte Verde"), Meadowcroft Rockshelter in Pennsylvania, and Cactus Hill in Virginia (**MT 11-4,** "Simple Tools, Hearth Found beneath Clovis Horizon") demonstrate that people were in the Americas prior to the appearance of the Clovis culture. As a result, some archaeologists, carried away by the excitement of slipping the Clovis leash, have made claims for the presence of people in the New World tens of thousands of years before Clovis.

The discovery of 9RA, however, throws a bucket of cold water on such claims. If all modern Native American populations share relatively high frequencies of this private allele, then they also share a relatively recent common ancestor. Although there is no way to determine precisely just when this common ancestor appeared based on the genetic data alone, it couldn't have been too long ago or there would be more diversification in the frequencies of 9RA throughout the hemisphere.

Theodore Schurr, a molecular anthropologist at the University of Pennsylvania and a coauthor of the *Biology Letters* paper, doesn't think the 9RA data directly support the Clovis-First model. He states in a personal communication that "the older pre-Clovis sites in different parts of the Americas refute this model, in my view, as do the coalescence times for the mtDNA and Y-chromosome lineages in Native Americans—14,000–17,000 years before present on average." Dr. Schurr estimates that the 9RA mutation appeared about 15,000 years ago, which is consistent with a conservative interpretation of the best archaeological evidence.

So, while it is premature to assert that the earliest immigrant groups who carried the 9RA mutation in their genomes also tipped their spears with Clovis points, important elements of the Clovis-First model are consistent with these genetic data. Schroeder and her colleagues point out that their data "do not exclude the possibility of small genetic contributions from other populations." But if there were earlier waves of migration, then either they became extinct prior to the appearance of 9RA, or they were so small in number that they became absorbed by the newcomers who brought 9RA to America.

The question of the ultimate antiquity of humans in America is still open. Fundamentally, it can be answered only by archaeological data. Yet, genetic data can play a vital role in helping to frame the debate. Thanks to the work of Schroeder, Schurr, and their colleagues, we can now be fairly certain that if any colonizers made it to the Americas before about 15,000 years ago, their contribution to the gene pool of modern Native Americans was minimal. The discovery of 9RA has clarified our understanding of the process of the peopling of the Americas. Instead of elaborate models to accommodate evermore waves of migration from increasingly far-flung regions of the globe, the focus is now on one main migration from the eastern fringes of Asia.

–Bradley T. Lepper

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The Search for Starch Grains

continued from page 4

by time. Many examples, even those thousands of years old, still look identical to recently prepared modern reference collections of starch.

Some conditions can influence what types of starch grains will be preserved and how well they will be preserved. Under certain conditions, microbes (bacteria and fungi) can rapidly decompose most organic matter and some types of starch; these conditions include soils that are highly heterogeneous, moist, highly oxygenated, and have a pH between 4.8 and 6.5. Nevertheless, even under these special conditions some forms of starch remain unaffected by microbes.

There doesn't seem to be a direct correlation between soil moisture and starch preservation or destruction. Well-preserved starch grains have been recovered in soils and on stone tools buried in extremely dry caves and in open sites in deserts. Likewise, starch grains have been found on tools and in the soils of caves in tropical regions, as well as on stone tools in open sites in both arid and tropical regions. Unfortunately, there hasn't been enough research conducted to predict the likelihood of starch preservation with varying temperatures. When some starchy plants are cooked in water at temperatures above 50°C, their starch grains gelatinize and may not survive; but moderately high temperature alone, in the absence of moisture, doesn't seem to affect starch. Even starch in baked bread and in starchy foods cooked on heated coals often remains preserved. Our knowledge about the effect of pH on starch preservation is also spotty. Studies of artifacts from the Peztkes Cave site in New South Wales, Australia, indicate that starch grains will survive in the residues of stone tools found in soils with a pH as low as 3.0 and as high as 9.0.

Starch preservation seems to be influenced by the artifacts they become attached to and by the types of foods they come from. A number of archaeologists have noted that starch grains trapped in the cracks and crevices of artifacts seem to escape the weathering effects of microbes or soil environments. Similarly, starch grains on artifacts seem to resist decay if buried in soils rich in aluminum or copper ions, or in sediments composed of various types of clays, hydroxides, oxides, and humic substances. Bulk also appears to enhance preservation: If large plant fragments containing starches (whole seeds, whole fruits, nuts, etc.) are buried, the bulky nature of the plant fragments seems to shield the starch from total decomposition. Many types of starch also survive passage through the human digestive system and remain preserved in human coprolites.

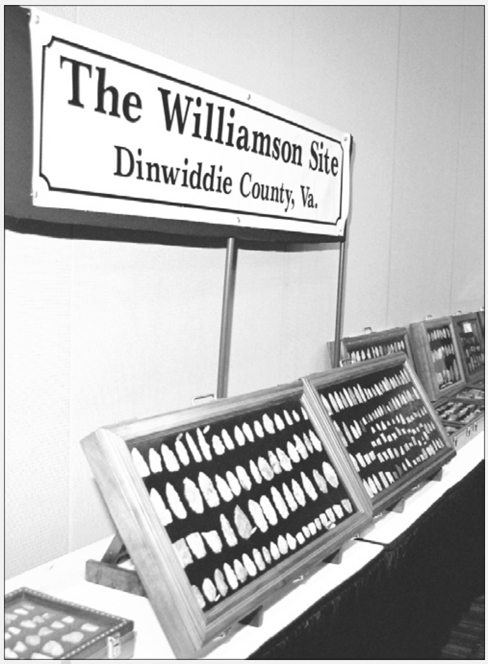
How to collect samples for starch analyses

Soils at a site are a good place to begin the search for starch grains. If starchy foods were used or processed in certain areas of a site, probably some starch grains remain in the soils at those locations. Soil samples for starch analysis should be collected from storage pits, burial features, floor surfaces, and hearths, and from cultural levels exposed during excavations. You must collect soil samples using sterile tools that have been washed and cleaned with deionized water, then dried. Always wear a clean pair of sterile latex gloves (be sure they aren't powdered in starch!) during each sampling to prevent possible contamination. Individual soil samples don't need to be larger than about 20 grams. Seal each sample in a sterile plastic Ziploc bag or in a sterile plastic or glass container that can be tightly sealed. Be sure not to use metal tools to collect samples or allow samples to come in contact with metal; metallic residues can be accidentally transferred to the sample and complicate later interpretations.

If you intend to test stone artifacts for starch residues, it's wiser to remove them in situ using sterile latex gloves rather than wait to recover them after screening. Use plastic tweezers to remove in situ flakes, points, and other small artifacts for starch testing. Wet screening makes stone artifacts much less valuable for starch studies than dry screening.

Even when the search for ancient starch grains at archaeological sites is confined only to analyzing residues on the cutting and grinding surfaces of stone tools, it's still important to take representative soil samples from cultural levels associated with the stone tools to verify that loose starch grains aren't contained in the site's soils. Starch grains found trapped in the residues of stone tools or on the surface of grinding stones present a strong case for the functional use of those tools, but only if starch grains aren't present in the soil matrix surrounding the tools. This dual-component evidence confirms that residual starch came from actual tool use and not from accidental attachment of loose starch in the soils after the artifact was buried.

CLOVIS GALORE!



DARYL P. MILLER SEPAC, USC

Clovis points, courtesy of Rodney Peck of Kannapolis, North Carolina, on display at the Clovis in the Southeast Conference held October 2005 in Columbia, South Carolina.

Why search for starch at First American sites?

I've been mostly unsuccessful in searching for fossil pollen at sites associated with the First Americans (**MT 18-2,** "Pollen and the First Americans," and **MT 18-3,** "The Elusive Pollen Grain"). Others have experienced similar disappointments when searching for fossil pollen and plant macrofossils at many early sites. Occasionally we get lucky at such sites as Monte Verde in southern Chile, where favorable soil conditions ensured that pollen, plant macrofossils, and starch grains survived to be analyzed, but these types of sites are few.

We still know so little about our earliest Americans. What if we were to search for starch and other plant residues on stone tools at First American sites? What if that search proved they processed a variety of plants for foods or medicinal purposes? We might also discover they used stone tools to modify plant materials for use as digging sticks or for hunting implements. Maybe they used stone tools to modify plant stalks and fibers to make sandals and clothing, or used plant materials to weave ropes and baskets.

Just think of all we could learn about our ancient relatives if only we believed that little things can mean a lot! MT

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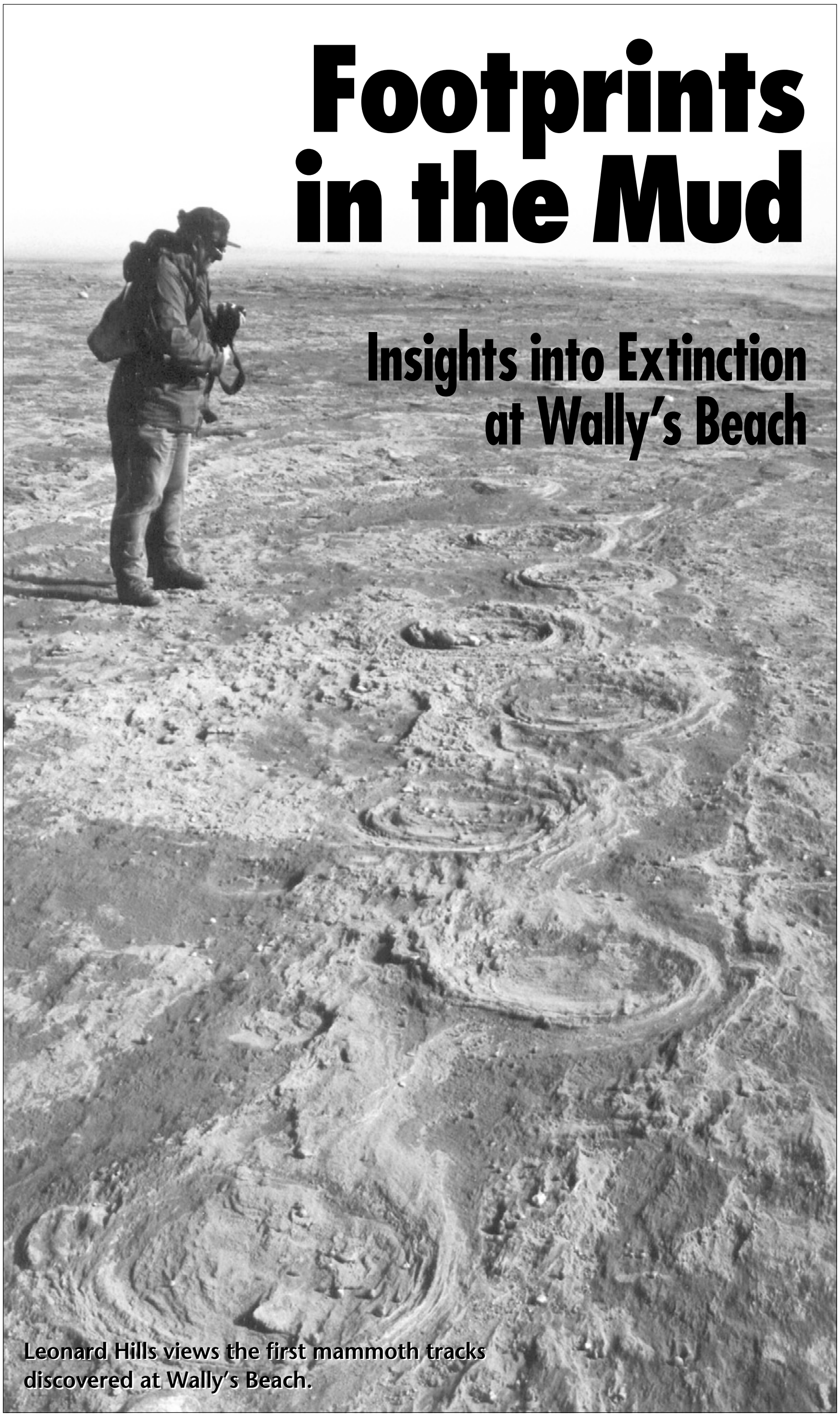
Footprints in the Mud

Insights into Extinction at Wally's Beach



Leonard Hills views the first mammoth tracks discovered at Wally's Beach.

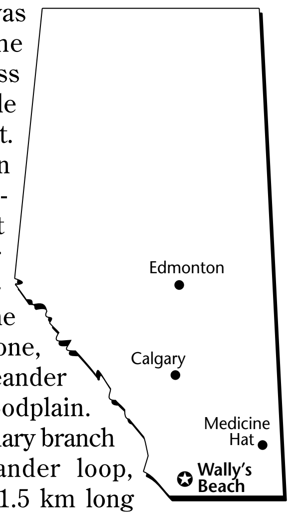
PAUL MCNEIL

THOSE OF US whose bailiwick is prehistory don't often have a lot to work with, but given some time and ingenuity, it's surprising what we can do with what we've got. Archaeologists, paleontologists, and geologists are scientific detectives, working on the iciest of cold cases, frequently with almost no clues at all. But when we pool our resources and compare our data with existing models, we can learn an astonishing amount—sometimes enough to make the past come alive. Take the Case of the Mammoth Footprints, for example. At Wally's Beach in Alberta, Canada, Pleistocene mammoths left trails of footprints that were preserved untouched until Mother Nature decided to clear away the overlying sediments in 1997, revealing them to human eyes for the first time in 13,000 years.

At first glance, a discovery like this one might not have much more than your basic "gee-whiz" factor going for it. Sure, you're seeing a rare reminder of an ancient species that died out before human civilization, but what can you *really* determine just by looking at a few circular impressions in hardened mud? A surprising amount, as it turns out.

Beachfront property

Wally's Beach (site DgPg-8) lies just northeast of Cardston, Alberta, on the bed of a dried-up reservoir. Until about 12,500 years ago, the region was sealed beneath the mile-high thickness of the continent-wide Laurentide ice sheet. As the ice melted in the terminal Pleistocene, the nascent St. Mary's River eroded existing sediments down to the underlying sandstone, then began to meander across its new floodplain. Eventually, a secondary branch cut across a meander loop, forming an island 1.5 km long by 0.5 km wide. Gentle slopes down to the channels gave animals easy access to water and consequently made it an ideal hunting spot for local predators. Among them were a few johnnie-come-latelies that we call humans.



In its heyday, Wally's Beach hosted a simple grass-shrub "mammoth steppe" vegetation. Mammoths, bison, helmeted musk oxen, caribou, camels, horses, and humans regularly visited Wally's Beach, leaving behind copious evidence of their presence. Fortunately for modern forensic scientists, the local soil consisted of fine- to medium-grained windblown sediments that formed dunes at the west end of the island, with layers of silt, sand, and clay stretching behind the dunes. When wet, this material took footprints easily and retained them for a day or two at most. New material blown in constantly covered and entombed the tracks, leaving smooth new surfaces to take even more tracks.

Repeated episodes of track formation and burial ceased only when the new river breached the local sandstone, leaving the island out of reach of new sediments. More substantial vegetation became established, curbing erosion. The buried animal tracks remained safely sealed away until modern times. For several decades they abided quietly beneath the waves of St. Mary's Reservoir, which inundated the island in the 1950s. In the mid-1990s, vast tracts of the lake bottom were exposed when the water level was lowered to allow new spillway construction. The wind quickly removed 1½ to 2 m of the loose sediments covering the relict island, sometimes as much as 10 cm overnight, exposing a treasure trove of paleontological and archaeological remains in the process.

Local resident Shayne Tolman and his children first ran across Wally's Beach in 1997, when they were picnicking. Tolman was so fascinated by the discovery that he eventually went back to school to get his master's degree in geology — but not before he brought the site to the attention of researchers at the University of Calgary. Tolman, archaeologist Brian Kooyman, geologist Leonard Hills, and paleontology grad student Paul McNeil have spent the last decade doing extensive research at Wally's Beach, studying the wide variety of trackways, human artifacts, and faunal remains the wind has exposed.

A suite of radiocarbon dates has bracketed the site's age between about 11,000 and 11,350 RCYBP. Among the most exciting discoveries at Wally's Beach have been several Clovis projectile points, along with the remains of several horses that were apparently butchered by Clovis hunters. Since evidence of Pleistocene horse predation is exceedingly rare, this discovery is particularly significant—it was the subject of a recent *Mammoth Trumpet* article (**MT 21-3,** "Wally's Beach: New Evidence for Pleistocene Horse Hunting in Canada").

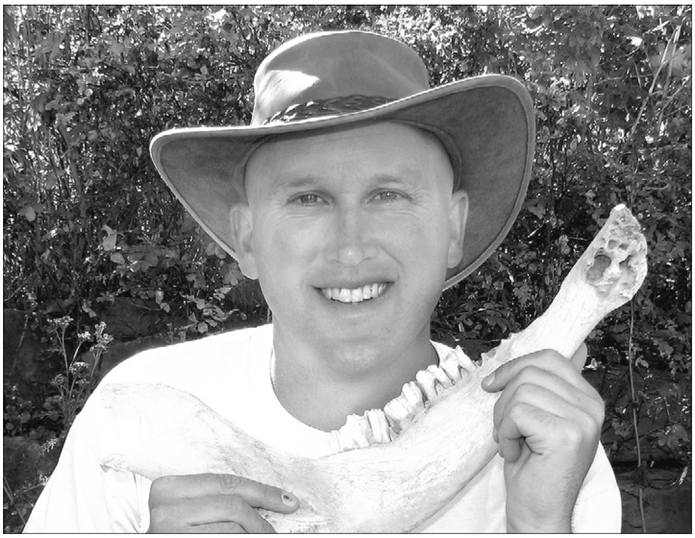
But no evidence at a site like this can be overlooked, and in fact the discovery of intact trackways of both locally and globally extinct animals was a coup. Here was a way for researchers to reconstruct information about species that, in some cases, haven't walked the Earth for thousands of years. By using statistical and analytical methods to squeeze out the last scintilla of data, Paul McNeil did just that. After studying the footprint evidence, he determined that the St. Mary's mammoth population was in significant decline at the end of the Pleistocene. This should come as no surprise, considering that the species was clearly on its way out by then, but it's the *nature* of the decline that's of particular interest.

You see, it appears that humans were to blame.

Serendipity 101

Tolman accidentally discovered the first Wally's Beach mammoth tracks shortly after systematic investigations began. McNeil got involved when Dr. Hills came into his office one day, talking about the mammoth tracks they'd found. "I was skeptical and asked if he had any pictures of them," McNeil recalls. "He said he'd taken some—however, the film was blurry and hadn't turned out. This was starting to sound like a Bigfoot story to me, but I agreed to go down to the site and look. Upon arriving at the site and seeing circular tracks the size of manhole covers dotted in a regular pattern across the landscape, it took me about two seconds to conclude 'Holy @#&%, we've got mammoth tracks!' The most famous picture of Len with the mammoth tracks was taken only moments later."

Data recovery was undertaken with the help of a dedicated group of volunteers from the University of Calgary and the Archaeological Society of Alberta. Using funding provided by the Alberta Historical Resources Foundation, the Alberta Ministry of Environment, the National Research Council, and Westwind School Division, they were eventually able to identify and record over 500 mammoth tracks on numerous trackways. And 51 footprints were clear enough to provide information on precise foot diameters and, in some cases, foot structure. Although no mammoth bones have been found at Wally's Beach, McNeil et al. have provisionally designated as the track-maker the woolly mammoth (*Mammuthus primigenius*), since it was the most common mammoth species living in southwestern Alberta in postglacial times.



PAUL MCNEIL

Paul McNeil with bison jaw.

Gleaning meaning from footprints

When a species is extinct, it can be difficult to extract useful information from raw data, especially from something as basic as their footprints. Oh, you can document metrics like length, width, depth, dermal ridges, number of toes and the like—but how do you assemble and interpret the total evidence without a living example to use as a model? Fortunately, we have the next best thing: the African elephant (*Loxodonta africana*), the closest living relative to the mammoths.

While McNeil had some "very limited reservations" about comparing his mammoth tracks with those of existing elephants, he points out that adults of both species are of roughly the same size and morphology, and that proboscideans in general are conservative in their growth and development. This means you can expect mammoths to pass through the same developmental milestones as elephants. "This evidence is supported by the frozen mammoths that have been discovered, primarily in Russia," McNeil says, "which allows the size compared to the age of mammoths to be compared to African elephants. In addition to the skeletal evidence, there's evidence to support [the argument] that mammoths and elephants had similar social structures as well."

With those considerations in mind, McNeil broke down the 51 clear tracks and trackways into 4 age classes based on size. Given the close similarity of the two species, he assumed the same basic life stages observed in *L. africana*: immature (age 0–12 years), subadult/early mature (13–24), mature (25–36), and mature to old (31–60). The totals for each category worked out to 31.37, 33.33, 17.65, and 17.65 percent, respectively. As expected, the Wally's Beach mammoth population was skewed toward younger animals; however, in healthy proboscidean populations the numbers of young animals are generally much higher. *L. africana* herds usually consist of 50 to 60 percent immature individuals, with subadults making up another 20 to 30 percent. Only in declining elephant populations do the members fall into age categories in a manner similar to that suggested by the Wally's Beach mammoth tracks. Plotted on a histogram, the Wally's Beach mammoth population resembles a modern elephant population undergoing significant predation—by humans.

Breakdown by age of the St. Mary's mammoth population, inferred from 51 clear foot impressions.

Damning evidence

With evidence like this, it's hard to escape the conclusion that people had a hand in killing off the St. Mary's mammoth population, which disappeared for good shortly after these trackways were laid down. Despite the growing controversy about whether humans had anything at all to do with megafaunal extinctions that took place at the end of the Pleistocene (see **MT 21-4,** "Earlier Than You Think: The Timing of Megafaunal Extinctions in North America," and **MT 22-3,** "Megafaunal Extinctions Revisited"), humans were definitely present at Wally's Beach. Plenty of cultural material has been recovered, and the evidence that humans hunted and slaughtered horses at the site is overwhelming—though admittedly no evidence of mammoth predation has yet been discovered here.

In defense of those First Americans, the mammoths of North America were probably already in a bad way by the time of the terminal Pleistocene. The mammoth steppe that supported these massive animals was fragmenting as the ice sheets receded, which severely reduced suitable habitat; adult mammoths required 200 kg of fodder every day to survive, but there was little vegetation available in the moraine along the edges of the glaciers and lush vegetation was confined to smaller areas. The mammoth population was also suffering from predation, probably by carnivores like the American lion, the short-faced bear, and wolf packs. In any case, the added stressors of increased predation most likely contributed to the extinction of the St. Mary's herd.

That said, woolly mammoths had managed to survive the advance and retreat of the ice sheets at least seven times over the previous million years. Then why did they disappear at the end of the last glaciation? The only real difference this time was the presence of a new predator species: humans. It wasn't just that humans were one more predator species added to the mix: humans were a new *kind* of predator. While most predators might take the juveniles of a species as large as the mammoth on a regular basis, only humans were capable of systematically killing adult members of the herd. Taken with the footprint evidence, this strongly suggests that humans contributed, at the very least, to the decline of the St. Mary's mammoth population. Whether this conclusion can be generalized to the rest of North America remains to be seen.

Meanwhile, the Wally's Beach mammoth tracks are steadily wearing away into oblivion. The Royal Alberta Museum in Edmonton made a latex cast of one trackway, and McNeil's group was able to remove a single track in a 600-pound block of sand, burlap, and plaster. Otherwise, except for extensive photographs and metrics collected during the project, not much is left of them today.

The wind is relentless, and erosion never stops. That, perhaps, is the ultimate irony of this case. McNeil says of these tracks in time, "The wind that created a clean slate on which they were first imprinted, that buried them to preserve them, that carefully excavated them to reveal them after 11,000 years, will finally destroy them."

–Floyd Largent

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