MAMMOTH TRUMPET

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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

A Deadly Dance

Paleoamerican hunters harass an enraged giant ground sloth in this drama told by footprints found at White Sands National Monument in New Mexico. Research team leader Matthew Bennett of Bournemouth University, U.K., dates the footprints to the terminal Pleistocene. Let your imagination determine the outcome of this encounter. See our lead story on **page 1.**

Image: Alex McClelland, Bournemouth University

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Ghost Fossils

MATTHEW BENNETT

Human footprint superimposed upon a giant sloth print at the Lake Otero site.

A Pleistocene Trackway and Possible Kill Site at White Sands, New Mexico

ASIDE FROM POTHUNTERS, wind and water can be the archaeologist's worst enemy, as natural forces blindly chew their way through and destroy valuable evidence about prehistoric lifeways. On the other hand, if it weren't for erosion, many of the world's most important sites would never have been found. That's certainly true for what may be the most significant prehistoric site to date at White Sands National Monument (WHSA) in New Mexico.

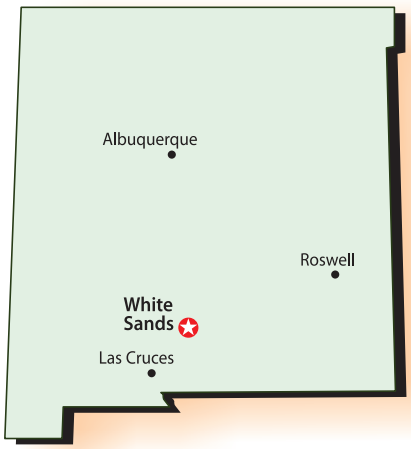
While we suspect that the First Americans preyed on a wide variety of big game, we have confirmed kill sites for only seven general types: bison, camelids, horses, giant ground sloths, gomphotheres, mammoths, and mastodons. Some of this evidence, especially for sloths, is meager (**MT 28-1,** "Pre-Clovis butchered ground sloth in Ohio"). But at WHSA, we have indirect but compelling evidence that very early humans may have hunted giant ground sloths in New Mexico. This consists of a site where rare conditions

INSIDE

preserved over a hundred sloth tracks closely associated with a similar number of human footprints. Numerous arc-shaped indentations found among the tracks in multiple locations, caused by the animal's immense foreclaws pressing into the sediments, suggest it violently whirled around to face its tormentors more than once.

Not an animal to be messed with

Though no sloth bones or stone tools have been found at the site, the team that reported on the trackway in the 5 May 2018 issue of *Science Advances* strongly suspect it represents a kill site. Why else would anyone get so close to a hulking monster with sharp, inches-long claws? It would be like taunting a combination of bison and tiger. The ground sloths of Pleistocene New Mexico weren't the pokey little Zootopian grinners that



modern sloths have become. They measured 9–10 ft tall, and along with the claws, one species had hides studded with bony formations called dermal ossicles.

They clearly weren't pushovers. These huge, bulky herbivores were possibly quite agile when angered and well equipped to take care of themselves. Herbivory does not a meek mammal make, as anyone who's ever been chased by an angry bull can attest.

An earthshaking discovery

WHSA, home to Alamogordo, is best known as a site for earthshaking activity in the 1940s, when the U.S. government tested nuclear weapons there in hopes of putting a final end to World War II. Tests continued into the 1950s. But the fine, pale gypsum sands for which the White Sands National Monument was named were hiding at least one much earlier suspected act of violence, likely associated with a more primal human need: day-to-day survival.

The only known remaining evidence of this long-ago event is a multispecies animal trackway originally discovered by park naturalist David Bustos in the shoreline deposits of former Lake Otero, located on the west side of Alkali Flats in the Tularosa Basin. Initially identified in 2007 after winds shifted the local sand dunes, it's one of a number of intriguing trackways discovered in WHSA since 1932. WHSA boasts the highest concentration of Ice Age human and animal prints in the Americas—and it's likely there are more to be found. Some of the known trackways contain

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Michael R. Waters	Director and General Editor e-mail: mwaters@tamu.edu
Ted Goebel	Associate Director and Editor, **PaleoAmerica** e-mail: goebel@tamu.edu
James M. Chandler	Editor, **Mammoth Trumpet** e-mail: wordsmiths@trueband.com
Christel Cooper	Office Manager e-mail: csfa@tamu.edu
C&C Wordsmiths	Layout and Design
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–Michael R. Waters, Director

hundreds of fossilized tracks. Unfortunately, these "ghost fossils" (as WHSA researchers call them) are fragile and can erode quickly if not stabilized.

"The work at White Sands goes back a while," says Matthew Bennett of Bournemouth University in the U.K., the research leader of the team that excavated and studied the Lake Otero trackway. "I was first approached in the summer of 2016 and attended a workshop in January 2017 with a number of colleagues. The view of the tracks and their dating was mixed at this meeting, but I was impressed by their potential and the dedication of the park staff, especially David Bustos."

The Lake Otero trackway lies adjacent to an escarpment rising 5 m above a playa basin. Most of the tracks are visible only under certain moisture conditions, which may be why they weren't discovered sooner. Using excavation and various advanced methods, including geophysical and aerial surveys, the researchers identified a wide variety of intact and recognizable animal prints, including ground sloth, mammoth, bison, dire wolf, camel, and possibly big cat; the American lion and *Smilodon* both frequented the area. The tracks were impressed into thin beds of muds and sands with high gypsum and silica content, which hardened like concrete and were soon infilled and covered by the shifting dunes, which preserved them for the ages.

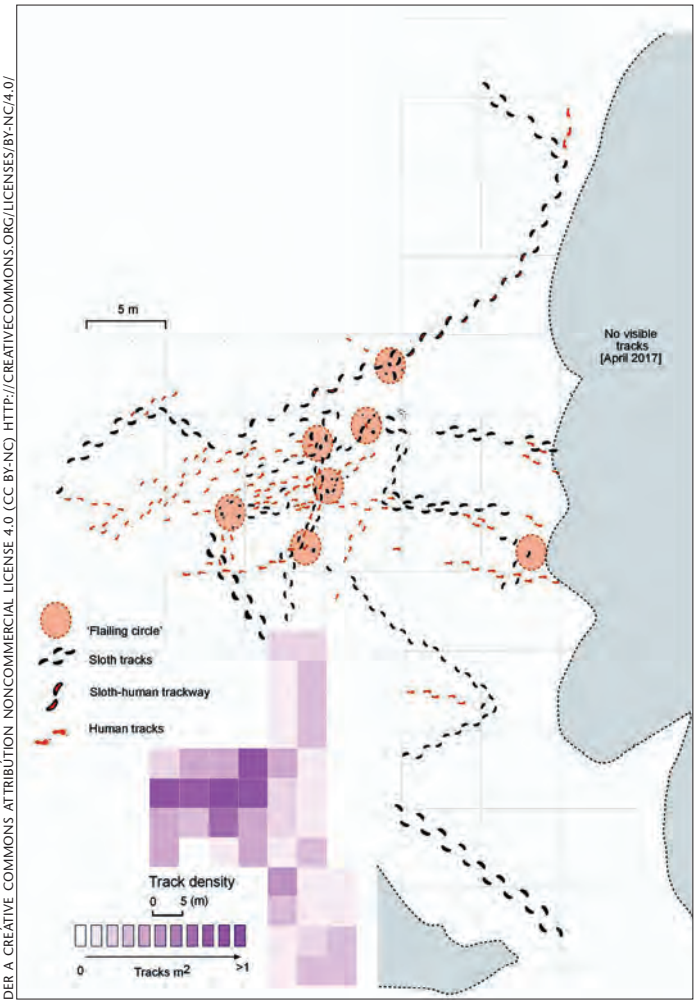
Bennett made a commitment to go back to the site, mostly to study the sloth tracks. "In April 2017 I did just that," he reports. " I have been back five times since, and continue to work there, with the next trip planned for January 2019. It is an amazing place, and the track assemblages are second to none in the world."

It was during that first visit in April 2017 that Bennett made a discovery that could have earthshaking effects in First Americans studies. Upon excavating the barely visible sloth prints, Bennett realized the trackway also included unshod human footprints, both inside and outside the giant sloth tracks. They were clearly laid down at the same time. Repeatedly, when the human and sloth tracks intersect, the sloth tracks abruptly turn in a different direction and the human footprints follow. That the sloth suddenly whirled around and stood its ground multiple times is unmistakable.

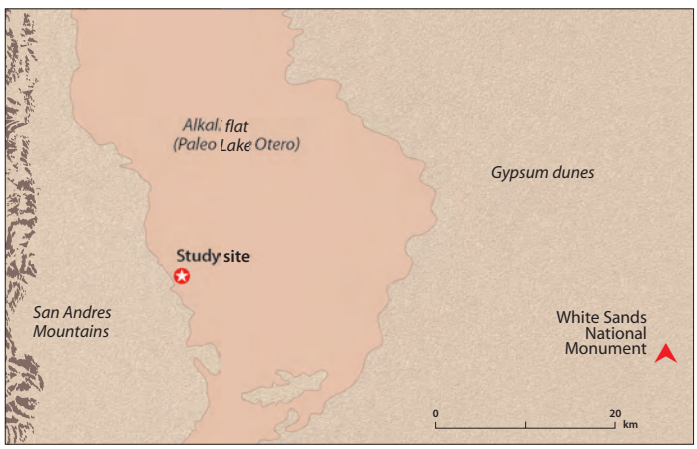
It's hard to miss the implications that a band of human hunters tried to run a now-extinct megaherbivore to ground sometime in the late Pleistocene. Whether they killed it remains unknown.

The trackway including the sloth/human interactions was already noteworthy for being one of the largest concentrations of vertebrate footprints on the continent, and Bennett's find has considerably enhanced its fame. The WHSA trackway represents the world's only known evidence for potential human predation from fossil tracks. Any vertebrate trackways are rare, and those indicating predation are almost unheard of. But this trackway is unique, for the predators were us.

If the massive animal fell that day, it would have provided a small band of humans enough food for weeks if properly preserved. The sloth's hide, claws, and bones would also have served them well as tools.



Map of the sloth/human trackway at the Lake Otero site, showing the hundreds of excavated footprints, the sloth's tortuous path after the human tracks joined the trackway, and seven flailing circles.



Stepping out for the ages

Remains like the Lake Otero trackway are rare because

it takes very specific conditions to preserve even one animal track for thousands of years, let alone hundreds. But geology has laid down enough pages of Earth's history that such trackways aren't unknown, and some have become famous. The dinosaur tracks at Dinosaur Valley State Park near Glen Rose, Texas, formed about 100 million years ago during the Cretaceous era, are possibly America's best known example. Other examples include the human trackway in Laetoli, Africa, which proved that early Australopithecines were fully bipedal, and another multi-species Pleistocene trackway at Wally's Beach in Canada.

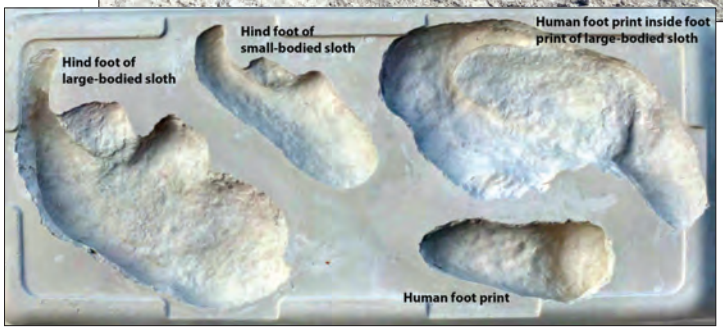
Research team leader Bennet at WHSA.

ALL PHOTOS: DAVID BUSTOS UNLESS OTHERWISE NOTED

While some of the trackways at WHSA have been dated to as early as 30,000 RCYBP, the Otero Lake find is about half that age. The sediments beneath the tracks have yielded radiocarbon ages of about 15,560 RCYBP, though Bennett and his colleagues caution that the tracks were certainly made at some yet-unknown point after that. "We actually just say that the tracks are terminal Pleistocene," Bennett notes. "We date via a form of biostratigraphy. The track-forming window must be in the overlap between the extinction of sloth and mammoth and the colonization by humans."

General view of a concentration of excavated "ghost fossil" tracks (both human and sloth) at the Lake Otero site.

MATTHEW BENNETT



Composite cast of giant sloth and human footprints from the Lake Otero site.

For those worried that the nuclear testing might have affected the local radiocarbon record, Bennett says that's not really relevant. "The dating we have is good and consistent. More to the point, our dating does not rely on C-14." The ghost fossils must be at least 11,700 years old, since we know from the fossil record that giant sloths were locally extinct by then, so their potential age range, while neatly bracketed, covers millennia. This includes the age range of the Clovis culture, which dates as early as 11,050 RCYBP, or 13,000 CALYBP. It's possible the tracks are pre-Clovis, though this is by no means certain. We do know for certain that there were people in North America at least as early as 15,000 RCYBP, so we can't just ascribe the kill trackway to Clovis. Lithic finds known for the area date to the Folsom era and later, but by that time, the giant sloths were long gone.

A dance of death with a formidable partner

The species of sloth involved was either the Harlan's ground sloth, which stood about 3 m tall upright and has been described as resembling a giant hamster, or the slimmer Shasta ground sloth. The latter more closely resembled modern sloths, but on a much larger scale. An adult Harlan's sloth could easily weigh more than a ton. The Shasta, a still-impressive one-quarter of that weight, was almost the same length. Both species bore long, sharp claws on their forepaws. Given the size of the tracks at Lake Otero, the sloth was probably a Harlan's.

Superimposed on the sloth tracks were more than 10 human tracks made by multiple individuals of indeterminate age and sex. Clear impressions in the mud of the sloth's claw or "manus" as it spun around suddenly, in what the researchers call a "flailing circle," suggest someone was following it, and it wasn't happy about that. This occurred seven times in the series of sloth prints, and all seven instances are associated with human footprints 15.2–29 cm long, comparable in size to the feet of modern humans. The smaller prints suggest it was a tribal affair: Women and children may have been involved in the chase, and concentrations of other fossil footprints farther away, on the margin of the trackway, suggest a crowd was watching the hunt.

It's clear the sloth was familiar enough with human predation

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Footprints on the Sands of Time

A TEAM OF ARCHAEOLOGISTS digging off the coast of Calvert Island in British Columbia in 2014 discovered a single footprint pressed into clay. Further excavations revealed 28 additional footprints. And what footprints! They are believed to be the oldest human tracks ever found in North America.

"We archaeologists get really excited about things like stone tools, but it doesn't strike the public in the same way," says Duncan McLaren, University of Victoria archaeologist working with the Hakai Institute. "These footprints really caught people's imaginations in a different way."

The media storm came in two waves. First, news leaked out after the team found the initial footprint. Then major news outlets like the *New York Times* and *Scientific American* contacted the team after their findings were published in *PLOS One*. "There's a sort of mythology amongst the population in North America about how people arrived here after the LGM [Last Glacial Maximum]," McLaren explains. "That's slowly changing. The more we look at the coast, the more variable the story of the Ice Age than we ever imagined. The change in ideology along with finding scientific evidence for the coastal hypothesis caught the attention of these media outlets."

McLaren has pursued multidisciplinary research since graduate school, when he focused on aspects of archaeology, geography, biology, and Earth sciences. Today he works with the Hakai Institute, which conducts long-term scientific research at remote locations on the coastal margin of British Columbia. He explains, "I've been looking at the environmental histories of places, how areas of the coast were deglaciated, where different sea levels were at different times. I'm trying to find archaeological sites along old shorelines." In short, his work is driven by looking at long-term histories of local habitations.

A peculiar environmental history

Around 13,000 years ago, sea level was about 120–130 m lower worldwide. McLaren's team was working on an area on Calvert Island that behaved eccentrically. The weight of glacial ice pushed down on the Earth's mantle, a phenomenon known as isostatic depression, with the result that sea level wasn't 120 m lower there, but pretty close to what it is today. As the ice melted, global sea levels rose about 120 m. And so did Calvert Island. It rebounded. As McLaren describes it, "The land rose up with the water levels here."

Farther inland, the opposite was happening; the terrain was depressed even further by overlying ice, which meant the sea level there was about 200 m higher than it is today. "You get this discrepancy," McLaren tells us. "Closer to

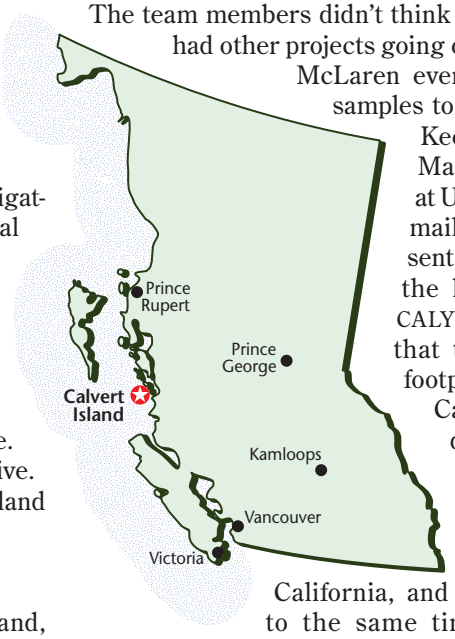
JIM STAFFORD

◀ View across the beach at site EjTa-4 on Calvert Island. In the background is Hecate Island.

◀ Aerial photograph showing the location of the excavation unit with footprints. Imagery courtesy of the Hakai Institute. The shell-midden boundary is based on information provided by Farid Rahemtulla.

the shore, sea level is up to 200 meters higher, but offshore it's 130 meters lower. And we are looking at something in the middle called a 'sea-level hinge.'" That "something in the middle" was a large, protected beach, which likely attracted maritime-adapted people for several millennia.

The hinge feature is a boon for archaeologists investigating the intertidal environment. At most sites on the coastal margin, archaeologists have to contend with the tide (**MT 30-4,** "Looking for sites at the water's edge"). McLaren explains the difficulty: "Twice a day the tide comes in, so you're battling the water. I shy away from underwater archaeology. It's expensive, you have to go deep, and often you return with minimal results. So we're targeting places like Calvert Island, where there's a sea-level hinge. We can access the ancient shoreline without having to dive. As far as we know, Calvert Island would have been an island 13,000 years ago as well."



Lo, footprints!

Calvert Island lies just a few miles south of Triquet Island, home to one of the oldest known North American settlements, a 14,000-year-old site where archaeologists recently uncovered fishhooks, stone tools, a hearth, and relics. "Information on the early occupation at Triquet Island has not yet been published," McLaren frankly admits. "We are still working on verifying our initial results there."

McLaren's team was excavating small units into beach sediments on Calvert Island one day in 2014 when his colleague stumbled upon something unusual. "My friend and colleague Darryl Fedje hit a grayish brown clay—quite a different kind of sediment," McLaren recalls, "He cleared up all that gravel and said, 'Hey, it looks like there's a footprint at the bottom of this test.' He cleaned up the footprint with his trowel, which essentially meant removing all the black sandy gravel, but unfortunately that also seemed to remove the print. So I didn't get a photo of it the first time. Darryl had taken a couple of samples of organic matter, then closed up the hole."

View of the 4-by-2-m excavation unit. The 2-by-2-m square at center was dug in 2015 to Stratum XII. The 2-by-1-m units on either side of this were dug to Stratum VII in 2016.

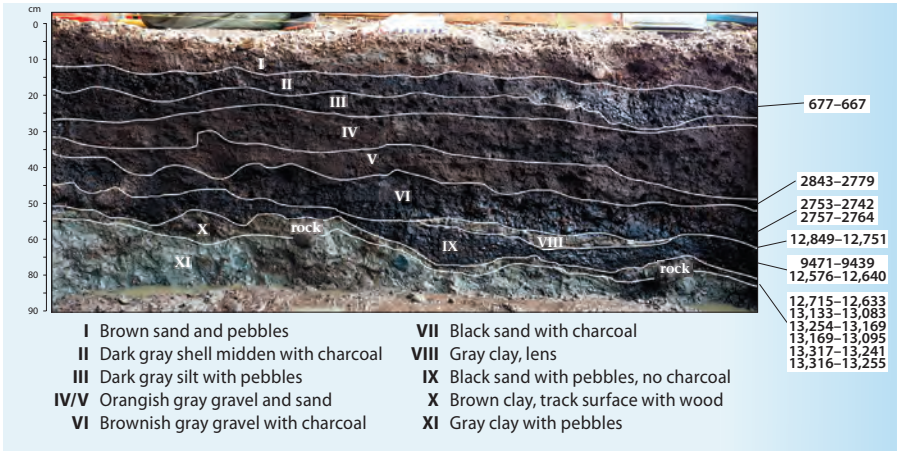
The team members didn't think much about it because they had other projects going on.

McLaren eventually sent one of Fedje's samples to John Southon at the W. M. Keck Carbon Cycle Accelerator Mass Spectrometry Laboratory at UC Irvine, but it got lost in the mail. Six months later, McLaren sent off a second sample, which the lab dated to about 13,200 CALYBP. McLaren remembered that this date belonged to the footprint Fedje had uncovered on Calvert Island, beneath beach deposits in front of the Meay Channel I archaeology site.

Soon afterward, the sample that McLaren had originally sent arrived in California, and the lab dated that sample to the same time. Radiocarbon ages on wood samples, identified as lodgepole pine (*Pinus contorta*), taken from the surface and bottom of the track impressions consistently dated to 13,320–12,630 RCYBP. The team returned in 2015 and 2016 to excavate a larger area where the footprint had been discovered and eventually found another 28 footprints. "We had to excavate very carefully and slowly, which was hard since we had to race the tide," McLaren says. A total of 29 human footprints were revealed in a 4-by-2-m area. Many more footprints were present, but couldn't be accurately measured, having been distorted by over-trampling.

Becoming a footprint sleuth

The footprints are varied in preservation. Some are quite distinct, others have toe-drag marks, which make them more obscure," "I didn't know much about footprints before this," McLaren admits, "and had to do a lot of research. When I was writing this publication, I was on a beach resort in Mexico in winter. I was spending a lot of time just studying people's footprints on the beach." Footprints, he found, reveal more than people's travel across the landscape. They also give clues to their mobility and the way they congregate in a particular area. Studying footprints, he says, "really conjures up people's



View of the east wall of the 4-by-2-m excavation unit shown on page 6, showing strata and associated calibrated radiocarbon ages (CALYBP). Only dates on identified plant remains and charcoal have been included.

imaginations. You imagine these people moving through the landscape."

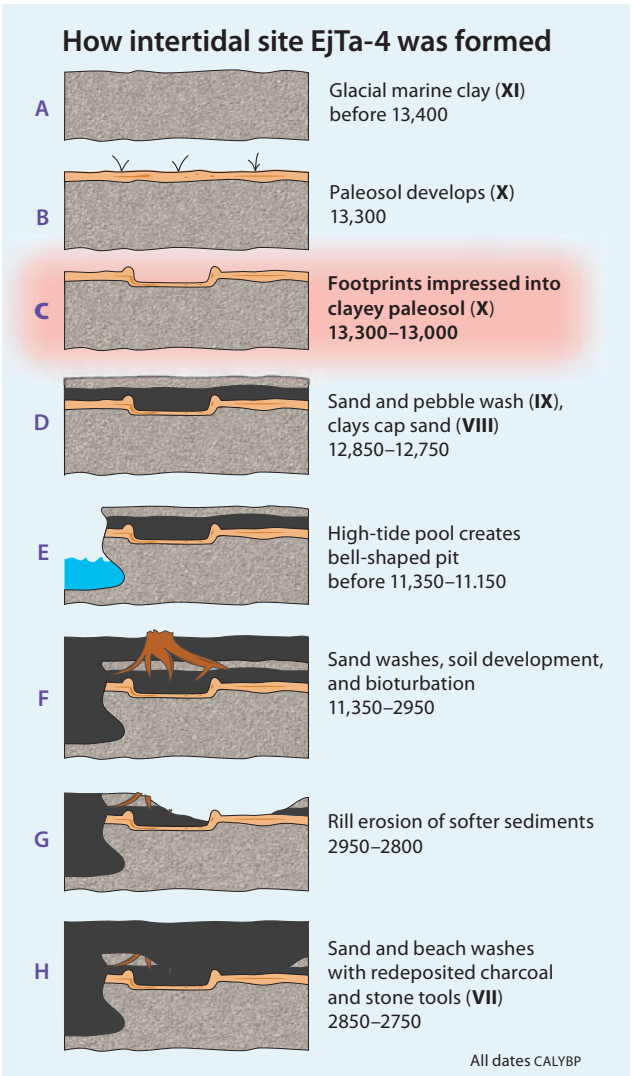
McLaren knows of only three other instances of human footprints dating to the Pleistocene/Holocene transition discovered in the Americas: human tracks found on sandstone platforms in the intertidal zone at the Pehuen Co site in Buenos Aires Province, Argentina; three footprints found at the Monte Verde site in Chile, which dates to 14,600 CALYBP (**MT 33-3,** Tom Dillehay, the Clovis-First iconoclast"); and two human prints left in tuff at the Cuatrociénegas site in Mexico, dated to 10,700 and 7200 CALYBP. Ancient footprints are usually exposed in coastal areas by erosion, thus making the Calvert Island footprints exceptional for their discovery far below the surface and, moreover, in an area where researchers hoped to find archaeological remains associated with Ice Age sediments.

Fitting for shoes

The 29 footprints uncovered on Calvert Island were made by at least three persons. Right and left feet are apparently those of two adults and a child, possibly a nuclear family. The footprint measurements correspond to modern-day U.S. shoe sizes of junior size 8, women's size 3, and men's size 7–8.

All three sets of footprints were facing the same direction, indicating travel in a northwest direction. McLaren isn't sure what to deduce from this. "It was a mucky area they would have been in,"' he tells us, "so I imagine they were getting out of a boat at high tide and walking towards the shoreline, moving from the beach into a drier area. This was a place where people were hanging out a bit more." Some famous footprint sites are trackways, linear paths of consecutive footprints. The assemblage of footprints from Calvert Island, on the other hand, is nonlinear; they likely represent foot traffic at a congregation site, where people conduct their activities in an area centered upon a central attraction or feature.

Although McLaren's team believe there may be more footprints in the area, they elected to stop excavating because they couldn't prevent waves from destroying exposed sediments. It was better, they decided, to defer further investigating to a future scientist with a method for controlling the tide.



Help from all quarters, including First Nations

McLaren boasts that the project, from its inception, has been collaborative in nature. He describes the nurturing environment at the Hakai Institute and University of Victoria: "We have a close cohort of scientists, some of whom are students. So we often work on each other's projects. We have feedback loops. Many people who worked in the field with us also contributed to analyzing and writing the article in *PLOS One*." Before the paper was written, a preliminary version was presented at the May 2017 Prehistoric Human Tracks conference at the University of Cologne and Neanderthal Museum of Germany. Archaeologists, ethnographers, and trackers who attended contributed insights and feedback to the project.

Perhaps the most noteworthy contributions came not from

Footprints miscellany

BOTH: JOANNE MCSPORRAN

Footprints showing unsteady footing. A, heel slip: Track #26 with an elongated heel as a result of foot slipping forward while walking in the clayey substrate. B, toe drag: Track #4 with discernible toe-drag marks. This track was later pedestaled and removed to the lab.

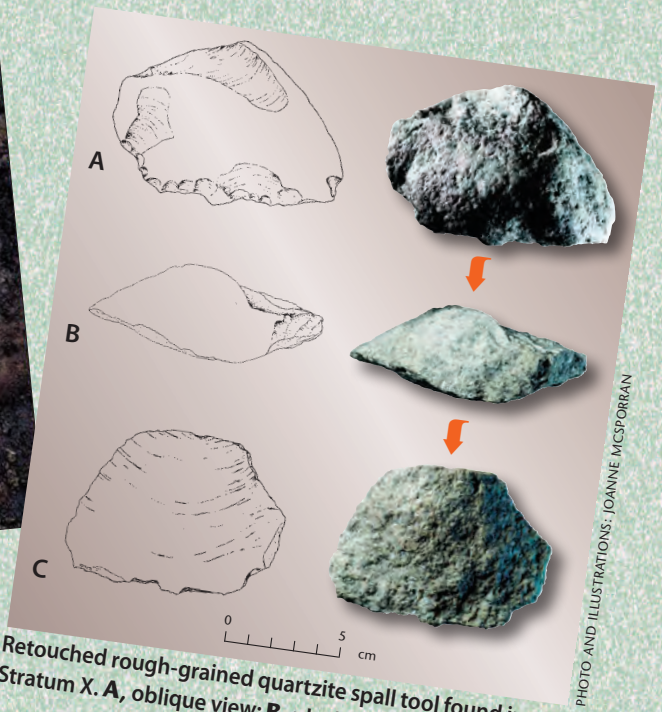
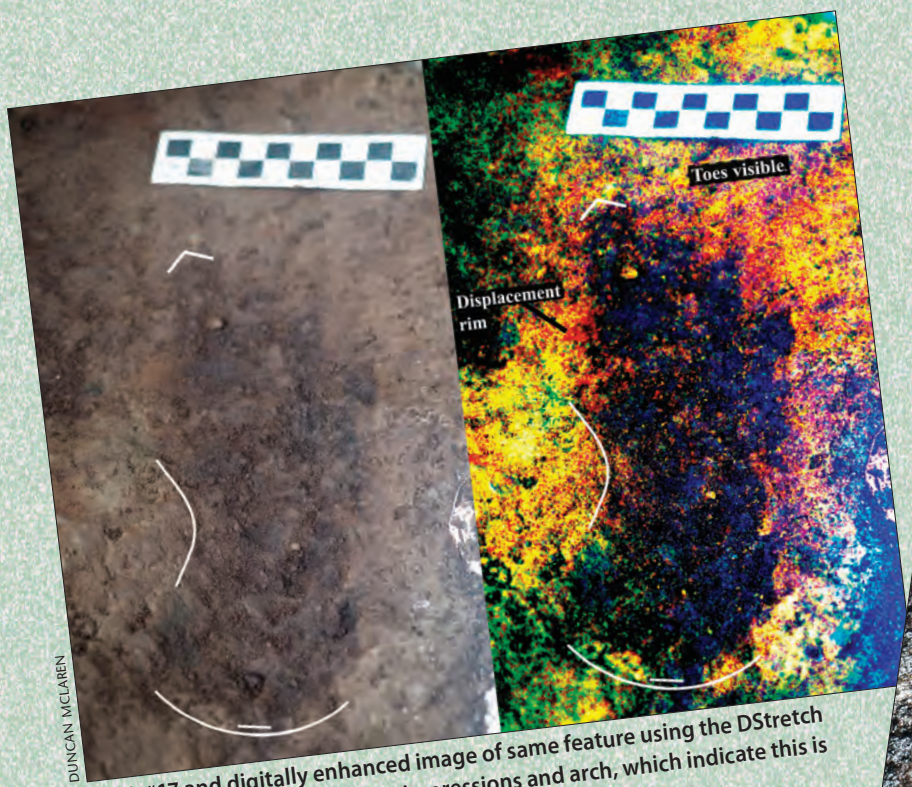


PHOTO AND ILLUSTRATIONS: JOANNE MCSPORRAN

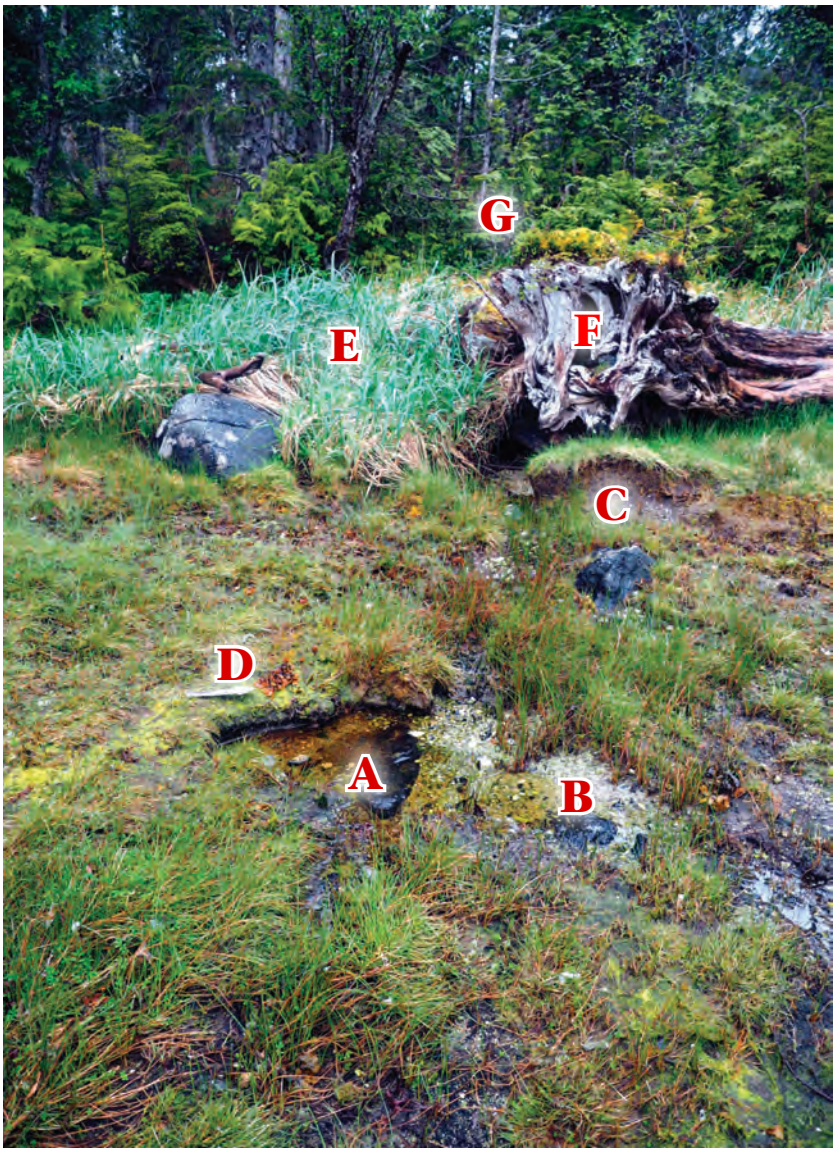
Retouched rough-grained quartzite spall tool found in Stratum X. A, oblique view; B, platform view, C, ventral view.



DUNCAN MCLAREN

Track #17 and digitally enhanced image of same feature using the DStretch plugin for ImageJ. Note the toe impressions and arch, which indicate this is a right footprint.

Twig of lodgepole pine (*Pinus contorta*) sampled from the base of Stratum IX sediment, which overlies the track surface. This wood was dated to 12,640–12,576 CALYBP. The underlying light brown clay is the track surface (Stratum X); under that is gray clay (Stratum XI).



DUNCAN MCLAREN

High intertidal pool near EjTa-4 and present-day features of the upper intertidal zone analogous to those described in the site formation processes for Strata IX–VI. A, upper intertidal bell-shaped pool; B, rill erosion caused by run-off; C, steeply eroded interrill; D, 20-cm scale; E, dunegrass on top of high-tide beach berm; F, driftwood rootball; G, western redcedar (*Thuja plicata*) forest.

seasoned professionals but from local communities, a happy circumstance that British Columbia archaeologists prize. The local communities include members from two First Nations groups, the Heiltsuk First Nation and Wuikinuxv First Nation. McLaren notes that when conversing with some First Nations members, certain topics are unpopular—the hypothesized coastal-entry route of the First Americans, for example, because it denies their belief in their supernatural origins.

Members of the tribes were nevertheless eager to assist and involve themselves in all aspects of the project, from research design to publication. In fact, the publication in *PLOS One* was vetted by both First Nations. McLaren feels strongly that Native people have much to contribute. "There are First Nations members in BC," he emphasizes, "who aren't necessarily formally trained in archaeology but who have way more experience than many M.A. students."

Especially helpful to McLaren's team was the First Nations members' intimate knowledge of the landscape and its wildlife inhabitants, which became invaluable in answering an important question: Were the footprints those of humans? Of the large mammals that populate the area today, only the hind paws of black bears and grizzly bears leave prints similar to human footprints. "We're very attuned to bear footprints. They have a more triangular shape. The heel falls more in line with the middle and front parts of the foot," McLaren says. Workers certainly had intimate knowledge of bears. "One of the people who worked with us at the site was from the Wuikinuxv First Nation," McLaren remembers. "Five years before, he'd been mauled by a bear and severely injured." To ensure worker safety, other field crew members had been trained to recognize bear footprints.

Based on the clear arch and toe and heel impressions of the tracks found by McLaren's team, he is certain they were the footprints of human feet.

Adding to a growing body of evidence

Paleoenvironmental studies reveal that glacial refugia capable of supporting large mammals and plants existed along the outer Pacific coast of Canada and southeastern Alaska 20,000 to 13,000 years ago. What has been lacking is archaeological evidence for human occupation from the same period and geographic region. The footprints discovered on Calvert Island are a solid link to an important subset of First Americans, those who valued the ocean as a bountiful provider and a means of transportation. For McLaren, they confirm that "people were using watercraft, and thriving and exploring coastal environments very early on." MT

–Katy Dycus

How to contact the principal of this article:
Duncan McLaren
Hakai Institute, University of Victoria
Department of Anthropology
Office: COR B336
Victoria, BC V8P 5C2 Canada
e-mail: dsmclaren@gmail.com
The Hakai Institute website http://hakai.org/

Suggested Readings

McLaren, D., et al. 2018 Terminal Pleistocene epoch human footprints from the Pacific coast of Canada. *PLoS ONE* 13(3): e0193522. https://doi.org/10.1371/journal.pone.0193522

Remembering

DENNIS J. STANFORD
1943–2019

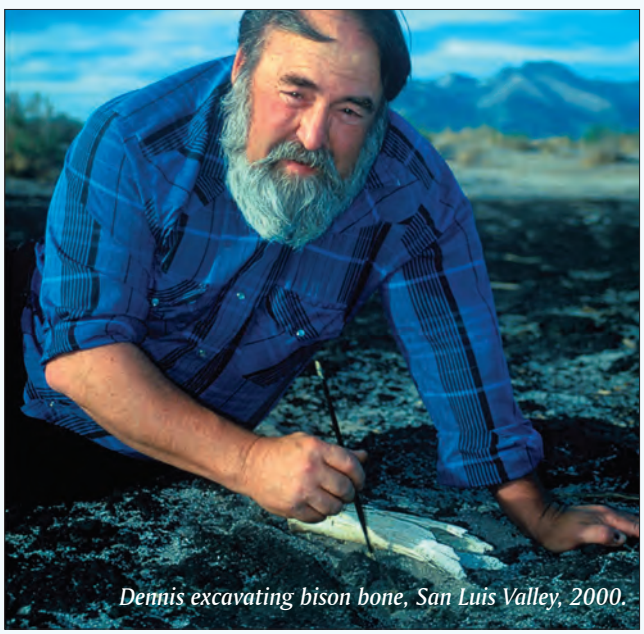
DENNIS STANFORD, Curator of North American Archaeology and Director of the Paleoindian Program at the Smithsonian Institution's National Museum of Natural History, died 24 April 2019, in Georgetown Hospital in Washington, DC. In his final days he received many heart-felt visits from his colleagues, family, and friends. Over his long career, Dennis worked throughout North America, where he was best known for his work in Alaska and the American Plains. His dissertation research in Alaska put him in direct contact with Eskimo groups, and these experiences seem to have shaped his appreciation of human adaptive responses to the environment and his interest in experimental archaeology. Dennis's extensive knowledge of hunter-gatherers, lithic technology, and experimental archaeology earned him the respect of colleagues around the world. During his time as curator, he traveled to Central and South America, Siberia, and Europe to examine collections and visit colleagues on their excavations.

Dennis was born in Iowa and lived in New Mexico, before spending his formative years in Wyoming. His work in archaeology started early, finding some of his first artifacts at the age of 9. His teenage years in Wyoming cemented his career path as he volunteered at the Union Pacific Mammoth Site and attended the University of Wyoming where he and his older classmate George Frison studied anthropology under Dr. William Mulloy. These experiences led to his eventual enrollment in the Ph.D. program in Anthropology at the University of New Mexico. Dennis completed his Ph.D. in 1972, based on his work at the Walakpa site in Alaska.

Late in graduate school and before the start of his 47-year career at the Smithsonian, Dennis was a ditch-rider in New Mexico. On horseback with dogs and rifle, Dennis rode ditches to ensure no one stole water from ranchers. Dennis often mentioned that his reputation as a ditch rider put him in line for a position as County Sheriff—he turned it down to become Curator at the Smithsonian. While we are glad he did, those of us who knew him well have no trouble imagining him on horseback in his black cowboy hat patrolling the mesas and arroyos of the American Southwest. Dennis became curator at 29 years old and built a strong program in Paleoindian archaeology through excavation, collaborations, and the acquisition of many private collections.

As curator, one of Dennis's first official Smithsonian projects was the excavation of the Jones Miller site in Colorado. This huge undertaking, funded by the National Geographic Society, involved the excavation of a 200-m^2 area of a Hell Gap (ca. 11,000 CALYBP) bison-kill site, in which over 300 butchered bison were recovered. While the size of the excavation was remarkable compared to many Paleoindian sites, it remains one of the most meticulous excavations ever conducted. Not common for the time, Dennis's excavations included three-dimensional mapping, detailed site-level aerial photography of each unit (early photogrammetry), and fine-mesh water screening and floatation of the matrix. It also included careful mapping and collection of microfauna, gastropods, pollen, and phytoliths, which allowed for detailed environmental reconstruction.

Many of Dennis's other projects in the 1970s and early 1980s involved carefully planned experiments which not only informed him and colleagues about the lethality and function of stone tools, but the specific technologies and survival strategies used by early people in North America. With colleague Bruce Bradley, Dennis conducted a series of experiments on projectile-point fracture patterns. These involved both atlatl-thrown points and thrusted projectiles at both animals and inanimate objects. While many of these studies were not published, Dennis's activities were mostly designed for his own education, through which he became one of the foremost experts in understanding Paleoindian technologies, recognizing refurbished artifacts, and interpreting specific patterns of projectile-point use and manufacture. Anyone who worked closely with Dennis witnessed both his near photographic memory when it came to artifacts and his attention to detail. He was gifted in understanding and demonstrating the differences between technological or stylistic choices and unmeaningful variation. One of his strengths as a curator was his ability and willingness to share his knowledge, as he frequently did, with the many researchers that visited the Smithsonian's Paleoindian collection.



Dennis excavating bison bone, San Luis Valley, 2000.

ALL PHOTOGRAPHS COURTESY OF PEGI JODRY

In addition to his flintknapping and lithic experiments, Dennis made continual contributions to the problem of when and from where North America was colonized. Through the 1970s and 1980s Dennis commented on some of the leading claims for a pre-Clovis occupation of North America. Various bone assemblages from contexts pre-dating Clovis had been found on the Great Plains and in Canada. These assemblages contained bones that were interpreted to have been broken or flaked by humans. Two of the sites, Dutton and Selby, were studied by Dennis, and his analyses suggested that some of the bones could have been modified by human activity. Dennis, along with Richard Morlan and Robson Bonnichsen, further evaluated these hypotheses by examining the practicality of flaking proboscidean bone and assessing whether animal bones would have been useful as tools. The Ginsberg experiment, which examined both elephant butchery with stone tools and the flaking and use of bone flakes for cutting, remains one of the more detailed actualistic studies ever conducted on this topic. Stanford and colleagues' 1981 report of this experiment in *Science* raised additional questions about the presence of early bone technology in North America and provided modern analogs for comparison in future studies. These studies and other analyses in which Dennis participated are still relevant today given recent extraordinary claims such as the Cerutti Mastodon in San Diego as well as others.

Dennis in Colorado with his grandson Anthony.

*Dennis (*left*) and Pegi Jodry on landfast ice margin near Barrow, Alaska.*

Throughout his career Dennis was on the forefront of Paleoindian and pre-Clovis studies. Later in life, Dennis became well known for his controversial "Solutrean Hypothesis," where he and colleague Bruce Bradley proposed that the first people to arrive in North America might have come from Europe (Iberia) during the last glacial maximum. While critics of Stanford and Bradley's argument often debate the proposed technological similarities between Solutrean and early Paleoindian technology as well as other aspects, Dennis merely saw his Atlantic Crossing idea as a proposal to be tested. Much of Dennis's impetus for his ideas about a trans-Atlantic crossing came from his vast knowledge of lithic technologies and his appreciation of how arctic people can navigate harsh northern seas. Dennis once said, "I spent over thirty years looking for the origins of Clovis in Alaska and Siberia. . . . I never found it—I had to look elsewhere." Stanford and Bradley's idea has been met with much criticism and is not fully accepted by many professionals. But as Dennis would frequently admit, he never meant his controversial idea (with Bradley) to be a description of New World colonization, instead simply a hypothesis that should continue to be tested. If you look back on his career, with his frequent questions about bone breakage, the interpretation of controversial sites, or the analysis of certain technologies, without question Dennis repeatedly made us reconsider what we thought we knew. If we can agree on nothing else, we now know that the initial colonization process of the New World was more dynamic than previously thought. Right or wrong, Dennis contributed greatly to understanding this process.

Although Dennis is credited with over 150 publications, he leaves beyond a legacy that is much greater than his research. Upon his death the Smithsonian reported that over Dennis's career he brought in over one million objects to the museum, which largely represent the Smithsonian's Paleoindian Collection. These artifacts and the collection that he built will forever remain available for study. Dennis was a gifted scientific communicator, and without his knack for storytelling, his spirit, love for life, and genial personality, far fewer would know what they do about Paleoindians. It was largely this personality that helped him build such a large and diverse Paleoindian collection. Without Dennis, many of the artifacts that we have studied, or still yearn to examine at the Smithsonian, would not be available. In thinking of Dennis's many qualities, to me the one that stands out the most was his willingness to facilitate so many researchers' work. Dennis was very generous with his time, and even if you disagreed with him, he was willing to share his personal knowledge and observations, which he had built up over a very full life. All you had to do was listen, a task he made very easy. Cheers to you, Dennis—ride easy and happy trails!

–Joe Gingerich
Department of Anthropology
Ohio University, Athens, Ohio
e-mail: gingerij@ohio.edu

This remembrance of Dennis Stanford is reprinted with permission from *PaleoAmerica*. Joseph A. M. Gingerich (2019) Dennis J. Stanford (1943–2019), PaleoAmerica, DOI: 10.1080/20555563.2019.1662692.

Digging below the Ash

Discoveries at Fort Rock Cave

STANDING at the water's edge, I wondered how a lake this deep could have formed on the top of a mountain. Geologists believe the story begins long ago when Mount Mazama, a great volcano towering 4,000 masl, formed as part of a chain of volcanoes in the Pacific Northwest that includes Mount Shasta and Mount St. Helens. The peak was built of lava flows, ash, and debris from repeated eruptions. About 7,700 years ago, Mount Mazama erupted in an epochal explosion.

This eruption was 40 times as powerful as the 1980 eruption of Mount St. Helens. After the explosive eruption that removed most of the mountain's peak, Native American legend recalls that what remained of the summit collapsed into the vacated magma chamber with a thunderous roar. A huge smoldering caldera resulted from the geologic event and, over time, filled with water to become Crater Lake, the deepest lake in the U.S.

The explosion pulverized the mountain peak, which released an enormous ash plume, and this is where archaeology comes in. The ash cloud was so intense and sprawling that it covered nearly the entire Pacific Northwest, as far north as Alberta, Canada, and as far east as Nebraska. This ash remains a visible layer of sediment throughout the region, providing archaeologists studying the Northwest a chronological marker for relative dating.

Mazama ash serves as an important stratigraphic marker in central Oregon; its thickness and character make it readily identifiable in the field. When Luther Cressman first excavated Fort Rock Cave in the 1930s, he used the ash layer as a reference to distinguish between assemblages.

Where once stood Mount Mazama, a volcano 4,000 m high, now lies Crater Lake, the deepest (954 m) in the U.S. The feature in the middle of the lake, Wizard Island, was formed by a later, less-severe eruption.

NATIONAL PARK SERVICE

The early days

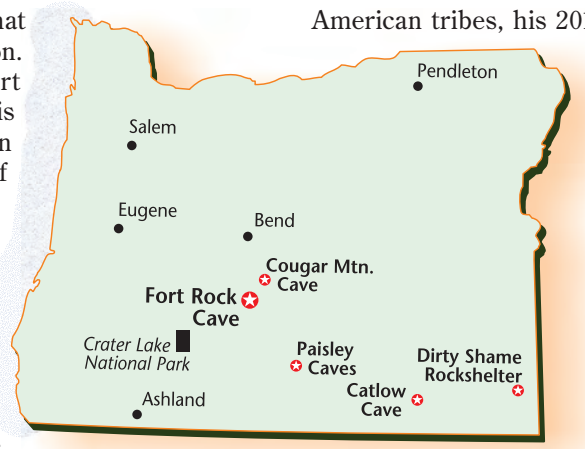
Cressman, having been ordained an Episcopal priest, left the priesthood in 1929, the year he earned his Ph.D. in sociology from Columbia University. His career change proved fortunate for future archaeologists who have built upon his work in the Pacific Northwest. Even his "mistakes" in the field have spurred significant advances in the study of the First Americans.

Cressman, a scientist who refused to run with the pack, argued for very early human presence in the Great Basin. His vision was rewarded in 1938, when his team found several examples of sandals beneath a layer of Mazama ash in Fort Rock Cave. The perfectly preserved sandals, made of shredded sagebrush bark, were later radiocarbon dated to 10,500–9,300 CALYBP, making them the oldest footwear ever discovered in the Americas (**MT 24-3.** "Walking in their shoes"). Now on display at the University of Oregon Museum of Natural and Cultural History in Eugene, the sandals are known for their "Fort Rock style": flat, with closed toes and twined sole. This sandal style has been identified at other sites as well, such as Cougar Mountain and Catlow Caves.

Although Cressman is best known for his discovery of the sandals, Tom Connolly, director of archaeological research at the University of Oregon Museum of Natural and Cultural History, considers at least as important his work at Paisley Caves, where he claimed to have found evidence for humans associated with extinct Pleistocene megafauna. "Although people dismissed this claim," says Connolly, "this possible discovery prompted

the later work at Paisley Caves that essentially verified his interpretation. His claim of great antiquity for Fort Rock Cave was also dismissed by his colleagues, but he was again shown to be correct with the development of radiocarbon dating."

As a result of Cressman's work in the region, Fort Rock Cave was recognized as the site of the earliest evidence for human habitation in Oregon. It retained this distinction for decades, until archaeologists returned to test Cressman's theories and excavated the Paisley Caves (**MT 25-4, 26-1,** "Paisley Caves").



Prehistoric artifacts uncovered by Cressman's team at Fort Rock Cave included basketry and stone tools. Cressman and his colleague Howel Williams, however, didn't describe the stratigraphy of Fort Rock Cave in detail, other than declaring that "like the Paisley Caves, Fort Rock Cave failed to show convincing stratigraphy."

Cressman distinguished only "above pumice" and "below pumice" assemblages. His 1938 catalog lists 541 artifacts, of which 38% appear to be from post-Mazama contexts and 62% from pre-Mazama contexts. "Cressman was dealing with geologic units, not depositional units," says Connolly. "We've since relied on fibers to make sense of stratigraphy."

When Stephen Bedwell returned to Fort Rock Cave in 1966, he failed to identify intact deposits in the interior. He found that Cressman's occupation layer was thin and contained no preserved perishable artifacts. The next year he focused on areas outside the mouth of the cave, and in 1973 claimed to have found evidence for an exceptionally early occupation at Fort Rock Cave. Many researchers dismissed his purported discovery.

CHRIS HAVEL

Connolly addressing reporters in front of Fort Rock Cave.

Learning that the nearby Paisley Caves were first occupied 14,500 CALYBP gave Connolly's team the impetus to revisit Fort Rock Cave and discover whether it might yield evidence for early visitors, perhaps even pre-Clovis.

Return to Fort Rock Cave in the 21st century

"Our primary goal was to assess the integrity of the remaining deposits and to evaluate the context of Bedwell's earliest radiocarbon age," Connolly says. With the support and involvement of the Burns-Paiute, Warm Springs, and Klamath Native American tribes, his 2015–2016 project aimed to "systematically describe the remaining deposits and determine whether intact deposits remained to evaluate the likelihood of the pre-Clovis occupation." His team, following Bedwell's (1970) stratigraphic descriptions as closely as possible, determined that deposits of only two strata defined by Bedwell remained intact within the interior of the cave, gravel layers associated with Pleistocene high stands of pluvial Fort Rock Lake.

The site chronology prior to Connolly's work was based on 7 dates from Cressman's and Bedwell's work, and 12 direct AMS ages on sandals and basketry. Based on a review of Bedwell's and Cressman's field notes, it appeared that at least some of the reported ages were too old. Bedwell's dates, for example, were obtained from the Gakushuin Laboratory in Japan, which became notorious for producing unreliable dates. Except for Cressman's first date reported in 1951, all extant fiber dates that figure in the current site chronology are the result of Connolly's work.

Connolly's team determined several trends in site occupation and artifacts:

- no evidence was found for occupation before 11,000 CALYBP;
- radiocarbon-dated fiber artifacts confirm substantial occupation 10,550–9200 CALYBP.

Considering Cressman's artifacts from post- and pre-Mazama contexts and projectile-point types from the site, Connolly's team concluded that Fort Rock Cave was intermittently occupied during the terminal Pleistocene and early Holocene.

"We recovered a modest sample of lithic artifacts (mostly obsidian)," Connolly tells us, "and a huge volume of animal bones: jackrabbit, marmot, and artiodactyl elements, including some elk-size bones." Although well preserved, most bones are highly fragmented and extensively processed. Edge-modified obsidian flakes are the most common tool type recovered, together with some projectile points and point fragments. Most projectile points are foliate or Western Stemmed types. "We also recovered a Northern Side-notched point base and several Rosegate points," he says. "They show that people used the cave at least intermittently throughout the Holocene." The abundance of woven fiber sandals suggests that Fort Rock Cave provided welcome shelter at least during the cold winter season.

Fort Rock Cave yields to Paisley Caves in antiquity

When Connolly found no evidence that Fort Rock Cave was occupied before 11,000 CALYBP, it became clear that Paisley Caves was the older site.

When Luther Cressman dug below the ash at Paisley Caves, as he did at Fort Rock Cave, he claimed to have found sediments containing a hearth, bones of Pleistocene horse and camel, and artifacts. As in the case of Fort Rock Cave, however, he didn't publish detailed stratigraphic data.

Dennis Jenkins, research archaeologist at the University of Oregon in Eugene, decided in 2002 to test Cressman's claim that humans occupied Paisley Caves when Pleistocene mammals roamed the region. His team unearthed strands of thread made of grass fiber beneath the Mazama deposits of cave 5. These fibers yielded an AMS date of 12,750 RCYBP (about 15,200 CALYBP), making them the earliest example of cordage in the Americas. He also recovered coprolites. Tests for protein residue and reconstitution analysis of the four oldest samples confirmed that the coprolites were, in fact, human.

JACK LIU. COURTESY THE UNIVERSITY OF OREGON MUSEUM OF NATURAL & CULTURAL HISTORY

Fort Rock Cave sandals, made of sagebrush bark with closed twined flat soles and open twined toe covers.

Human DNA from the coprolites radiocarbon dated to 14,300 years ago. The date broke the "Clovis barrier" and made Paisley Caves the best-documented pre-Clovis site in North America. Four years later, aDNA authority Eske Willerslev analyzed the samples. Mass-spectrometry analysis on mitochondrial DNA from coprolites determined that people in haplogroups A2 and B2 lived in south central Oregon 12,300 RCYBP (about 14,200 CALYBP), 1,000 years earlier than the accepted date for the Clovis culture (**MT 29-4,** "Tracking Paleoamerican migrations with mitogenomes"). This new date of earliest human settlement has become accepted by most archaeologists.

TOM CONNOLLY

Excavating exploratory units at Fort Rock Cave in 2015: (*front–rear*) Dennis Jenkins, University of Oregon; Judson Finley, Utah State University; Geoff Smith, University of Nevada, Reno.

Although Jenkins, or "Dr. Poop," as he became known, obtained astonishing early dates and thereby put Paisley Caves on the map of archaeological antiquity, his triumph was hard won. On returning to excavate, he found that Cressman hadn't backfilled the site and it had consequently been heavily looted. The floor was trashed with basalt blocks that had fallen from the roof, silt, organic matter, animal feces, food, and nesting materials. This is the stuff of an archaeologist's nightmare.

Challenges at Fort Rock Cave

Connolly encountered similar challenges when he returned to excavate at Fort Rock Cave in 2015 and 2016. What surprised him most was the extent of destruction inside the site. "The damage to the deposits inside the cave was extensive," he remembers. Some intact deposits may lie outside the cave or buried deep beneath the massive debris pile in front of the cave, but he found no intact deposits inside the cave. Although Pleistocene gravels are preserved, the lake-level history of the pluvial lake at Fort Rock is neither well understood nor well dated. Connolly suspects that the upper lake-deposited gravels were exposed and only partly covered by eolian silt when people first occupied the cave. "Revisiting previously excavated sites is usually a challenging endeavor, especially when they were excavated before modern excavation and reporting standards were developed," Connolly explains.

Since 1989, a team that draws members from University of Oregon Museum of Natural and Cultural History, Bureau of Land Management, University of Nevada, Reno, and the Nevada State Museum has been systematically dating fiber artifacts from northern and western Great Basin sites. The record currently numbers at least 475 radiocarbon dates, the majority being AMS dates with a standard error of less than 100 years. The current chronology of Paisley Caves is based on 275 dates on cultural items—artifacts, charcoal, hearths, butchered bone, hide and fur, and human coprolites and hair ranging from 14,600 CALYBP to modern times.

Granted, the stratigraphy and radiocarbon chronology

of Fort Rock Cave don't contribute to our understanding of the peopling of the Americas. The site nonetheless figures prominently in the cultural history of this region. Connolly admits that "it was frustrating for us not to add anything new to that." He is, however, proud of revisiting the site, reevaluating early dates, and building a bigger, more comprehensive history. "Fort Rock Cave is part of that larger history. The bigger picture is what interests me, it's what's most engaging," he says.

CHRIS HAVEL

Connolly.

Leaving something for later

Fort Rock Cave was declared a National Historic Landmark in 1961 and added to the National Register of Historic Places in 1966. This designation confers a symbolic seal of protection over the site and its materials. Yet over the last 80 years, Fort Rock Cave, once one of the most important archaeological sites in the northern Great Basin, has decayed into a devastated shell. Connolly lays the blame on landowner management and decades of intensive looting. "It's also the product," he says, "of careless archaeology done with little regard for either future work or the conservation ethic."

The materials gathered at Fort Rock Cave are primary resources for understanding and interpreting the past. All archaeological remains, from terrestrial or marine environments, from a variety of inorganic and organic materials including metal, stone, ceramic, bone, wood, plant fiber, and skin—the moment these materials are uncovered, they are at risk of rapid *and irreversible* deterioration.

Connolly speaks for archaeologists when he says, "We hope that old sites like Fort Rock Cave will remain important not only because of what was found but also because of the hard lessons learned regarding site preservation and management." His takeaway message for us: "Preservation ethics must take over. Fort Rock Cave is a good lesson. We must leave something for later." MT

–Katy Dycus

How to contact the principal of this article:
Tom Connolly
Director of Archaeological Research
University of Oregon at Eugene
Oregon State Museum of Anthropology, Bldg 116
Eugene, OR 97403-1224
e-mail: connolly@uoregon.edu

Suggested Readings

Connolly, T. R., et al. 2017 Return to Fort Rock Cave: Assessing the site's potential to contribute to ongoing debates about how and when humans colonized the Great Basin. *American Antiquity* 82.3:558–73.

Ghost Fossils

continued from page 4

to be wary of its attackers. "You can see this in the trackways," notes Bennett. "The trackways become more tortuous when human tracks are present—[with] twists and sudden changes in direction." There are no such patterns in the sloth tracks where human tracks are absent. The patterning of the profuse human footprints, the multiple flailing circles, and the animal's multiple changes of directions indicate the humans were, in fact, harassing the sloth. Why do so unless they were hunting it? Indeed, some footprints indicate a person approached on tiptoe, as if sneaking up on the beast while its back was turned.

Questions seeking answers

There may be more tracks east of the sloth-human trackway area, which measures approximately 30 m EW by 90–100 m NS; if so, they lay beneath the dunes at the time of the investigatory team's work. If they exist, they may include more direct evidence of the sloth's demise—if, in fact, that was what occurred. "We don't actually say it's a kill site, just the scene of an altercation between a sloth and humans," says Bennett. "We believe that the balance lies with hunting, but are careful with our interpretation. The likelihood is that if the sloth was hit by a weapon of some sort, it would have fled and been tracked as it bled to death."

Some observers have suggested the human footprints inside the sloth prints were made in a playful way well after the sloth had passed, like a child might try to walk in an adult's tracks at the beach. The child-sized prints recorded could support that. It's also possible that younger people were testing their courage by harassing the beast. But Bennett is convinced otherwise. The tiptoe prints, the tortuous path of the sloth whenever humans approached, the flailing circles all suggest a deadly serious dance between human and megaherbivore.

Further research to be conducted in 2019 may yet determine the sloth's ultimate fate. Stay tuned.

–Floyd Largent

How to contact the principal of this article:
Matthew Bennett
Professor of Environmental and Geographical Sciences
Institute for Studies in Landscapes and Human Evolution
Bournemouth University
Talbot House, T124
Talbot Campus, Fern Barrow
Poole, BH12 5BB UK
e-mail: MBennett@bournemouth.ac.uk

Getting to the Bottom of Topper

Albert Goodyear

Goodyear in the pre-Clovis excavation at Topper, 2004.

ALL PHOTOS: SEPAS

A NATIVE OF ST. PETERSBURG, Florida, Albert C. Goodyear, currently a semi-retired researcher with the University of South Carolina and Director of the Southeastern Paleoamerican Survey with the University, as a child loved to play cowboys and Indians in his father's restaurant in St. Petersburg. When that phase passed, his interests focused more on Florida Indians such as the Seminole. The gift of a box of arrowheads from his grandmother when he was eight captured his imagination and sparked a serious study of where Florida Indians lived and the artifacts they created.

Early mentors shape his career

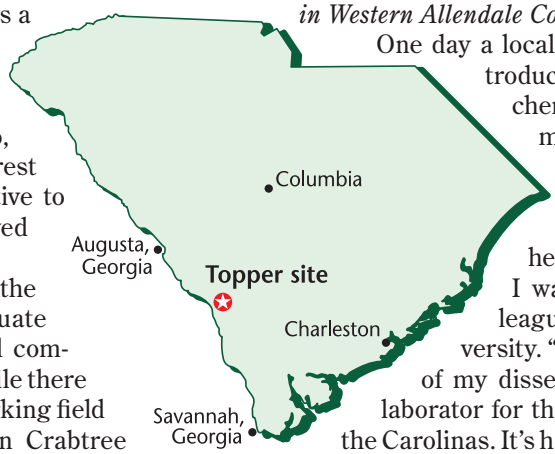
"Starting in high school," Goodyear says, "I began to find mentors who could help me learn more about local archaeology. These included Ripley Bullen of the Florida State Museum, who was willing to work with members of the public who found sites and artifacts." Goodyear's enthusiasm led him to join the Florida Anthropological Society. He devoured every quarterly journal from cover to cover. By searching beaches and dredged-up fills around Tampa Bay and other local sites, he acquired a modest artifact collection. Bullen and Lyman O. Warren encouraged Goodyear to submit articles about his findings to the state journal, where he first became a published writer. From the beginning, chert artifacts from earlier periods like Suwannee and Bolen points fascinated him.

Curious about artifacts that were being pumped onto shore from the bottom of Tampa Bay, Goodyear learned that the finds were associated with deposits of oyster shells used to construct roadbeds. Goodyear and Warren studied the deposits, which were likely prehistoric shell middens submerged by rising sea levels at the end of the last Ice Age.

Goodyear received a bachelor's degree in anthropology from the University of South Florida near his home, together with a letter of recommendation for graduate school—written, fortunately for Goodyear, by a professor possessed of a forgiving nature: His fine leather briefcase bore a puncture from a dart Goodyear once hurled from an atlatl.

After basic training with the Army National Guard in Ft.

Gordon, Georgia (where he found a Dalton point in a tank track while on maneuvers), Goodyear left for graduate school in Arkansas. In 1969 he was accepted as a research assistant with the Arkansas Archaeological Survey, and in 1971 he earned his master's degree. The survey station archaeologist at Jonesboro, Dan F. Morse, shared Goodyear's interest in Dalton points and their dating relative to other early side-notched points. He proved to be an invaluable mentor.



Intrigued with the archaeology of the Southwest, Goodyear attended graduate school at Arizona State University and completed his doctorate studies in 1974. While there he benefited enormously from a flintworking field school, where legendary knapper Don Crabtree gave him invaluable insight into lithic technology by demonstrating how ancient toolmakers transformed stone into tools.

The sheer love of archaeology and curiosity have sustained Al Goodyear from childhood, and he happily infects those around him. "Al has such enthusiasm for archaeology," says CSFA graduate Ashley Smallwood, Assistant Professor at the University of Louisville and one of many young archaeologists Goodyear has mentored. "It's inspiring. I have benefited greatly from our conversations about lithic technology and Paleoindian archaeology."

A new grad makes things happen

Newly minted Dr. Goodyear assumed his first position at the University of South Carolina in 1974 as director of the highway archaeology program. His assistant was a young archaeology student named David G. Anderson (**MT 32-2,** "An organized mind: David Anderson). The high density of lithic artifacts discovered in the area drew Goodyear's attention to the chert sources in Allendale County of South Carolina and Brier Creek in southeast Georgia. A survey of Allendale chert sources therefore topped his list of priorities. Consequently, in 1984 Goodyear and South Carolina archaeologist Tommy Charles published *An Archaeological Survey of Chert Quarries in Western Allendale County South Carolina.*

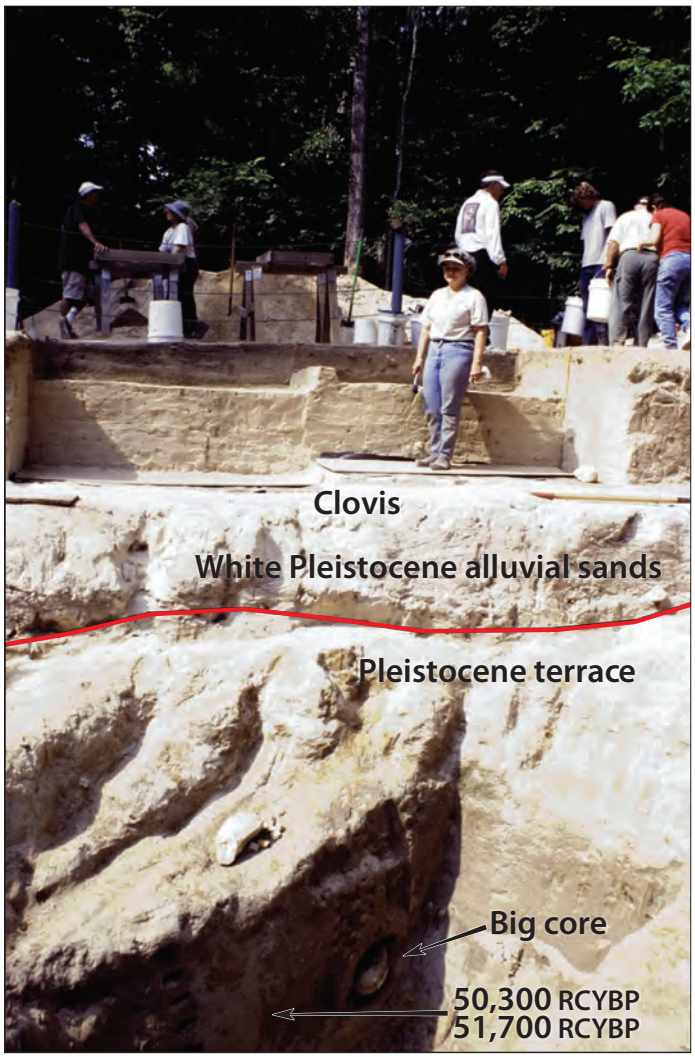
One day a local collector by the name of Topper introduced Goodyear to an Allendale County chert quarry. The site would eventually monopolize his attention and establish his preeminence in Southeastern Paleoamerican archaeology.

"I met Al some 35 years ago when he served as a consultant on a project I was working on in Florida," says colleague Randy Daniel of East Carolina University. "He subsequently served as a member of my dissertation committee and eventual collaborator for the last couple of decades on Clovis in the Carolinas. It's hard to overstate the importance of Al's mentorship on my career. My archaeology and Southeastern archaeology in general have been made better because of him."

Bringing the public to science

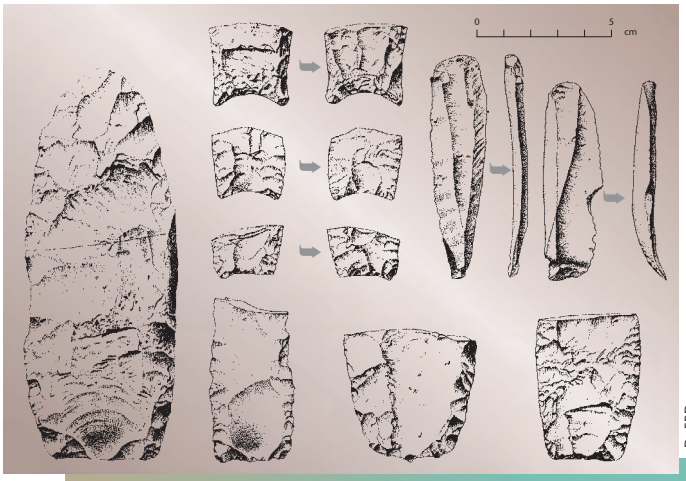
Digging chert quarries with their vast quantity of lithic artifacts turned out to be a gigantic labor-intensive task. What was needed, Goodyear realized, was a program that involved the public. Beginning in 1996 at the Big Pine Tree site (**MT 11-1,** "Site near Savannah River yields clues to Paleoindians") and later at the Charles and Topper sites, he recruited volunteers for the Allendale Paleoindian Expedition. Participants, after making a donation to the university, signed up to work for at least a week at the dig. In 2005 the program was renamed the Southeastern Paleoamerican Survey to emphasize a broader research scope.

Participating in the program wasn't all grunting and sweating under the South Carolina sun. Volunteers received instruction in an archaeologist's basic practices from advisers close at hand. At the end of the work day they were treated to Al Goodyear's famous barbecue, with usual entrées of pork roast and venison burgers and side dishes galore. On many



Volunteers at the Topper site, 2005. "This photo more than any other," says Goodyear, "illustrates the depths of the various artifact-bearing layers at Topper."

evenings Goodyear or a guest speaker treated the volunteers to a presentation that illuminated a particular facet of the science they were participating in. The phenomenal success of the Southeastern Paleoamerican Survey can be measured by the many volunteers who returned year after year. No one can deny that Al Goodyear is unexcelled at selling archaeology. If he weren't already recognized as a top-rank Southeastern Paleoamerican archaeologist, he could certainly claim fame as a supremely successful promoter of his product.



Classic Clovis artifacts from the Topper site. The fractured preform on the far left, which was well on its way to becoming a spearpoint, is called "Alaina's sword" in honor of unit supervisor Alaina Williams.

"Al helped shaped my career in many ways," says University of Tennessee colleague Anderson, "first by steering me to graduate school with his mentor, Dan Morse, and then by being a good research colleague and sounding board in the decades that followed. He has been a lifelong friend, was best man at my wedding to Jenalee, and is someone whose positive attitude and love of archaeology inspire me every day. His work on Paleoindians in South Carolina shows the significant contributions that can come from long-term focused research in a particular region."

Typical flake tools from the pre-Clovis white Pleistocene alluvial sands zone.

Pre-Clovis flake tools found at the top of the Pleistocene terrace.

Clovis at the Topper site

Beginning in 1998, annual excavations at the Topper site yielded a wealth of Clovis artifacts. Goodyear justifiably refers to Topper as "the jewel of Southern quarry-related Clovis sites." It's also the southernmost excavated Clovis site in the Southeast.

The site lies on a terrace and an adjacent hillside that overlooks a spur of the Savannah River. During Clovis times, chert was available in the Savannah River as well as from upland outcrops. Topper chert supplied generations of Pleistocene- and Holocene-age inhabitants with high-quality cryptocrystalline toolstone for manufacturing projectile points and other stone tools. "This chert," Goodyear tells us, "was the primary resource that drew people to the site for several millennia." By mapping the spread of fluted points, Goodyear gauged the spatial dimensions of a huge Clovis settlement area that sprawls across South Carolina and into southeast Georgia. This distribution, merged with the provenance of stone tools found in the Clovis levels of Topper, defines the Allendale–Brier Creek Clovis complex.

The outcrop on the hillside overlooking the terrace was exposed during pre-Clovis times and later, but around 15,000 years ago the river cut into its present channel, exposing river-bottom chert that was used by Clovis and later peoples. The geology team found that the pre-Clovis zone in the terrace was in fact the Ice Age streambed of the Savannah River when it flowed at a higher elevation. In the Ice Age, the Savannah existed in two phases: the upper zone, comprising sands and small gravels characteristic of a braided-stream regime; and a lower phase, characterized by finer-grained sediments, clay, and silt typical of the back swamps of the river today. In other words, the river underwent a meander phase. As the river left its higher elevation, rainfall eroded the surrounding slopes, burying the pre-Clovis zones.

In 2000, Goodyear, with the help of CSFA founder Rob Bonnichsen, assembled an impressive team to help date the stratigraphy at Topper. Geochronologist Tom Stafford of Stafford Research Laboratories came to collect radiocarbon samples.

CSFA Director Mike Waters volunteered his services, as did Steve Forman, an OSL-dating specialist, and John Foss, project soil morphologist from the University of Tennessee. Together, they found clear evidence of river activity in the lower portions of the sands. OSL-dating verified the age of the Clovis occupation at 13,000 yr B.P. (**MT 18-3,** "Luminescence dating of Quaternary sediments: New methods for dating archaeological components"). Goodyear confidently contends that Topper is the oldest radiocarbon-dated site in North America.

Excavating in the pre-Clovis terrace (50k RCYBP zone) under the roofed structure, 2011.

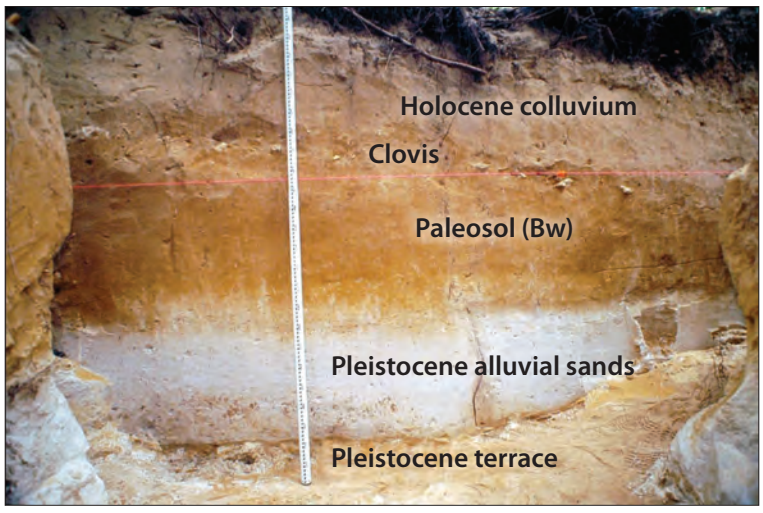
For 35 years, Goodyear has studied sites in the central Savannah River Valley of Allendale County. His research has been funded by grants from the National Park Service, the National Geographic Society, the Archaeological Research Trust, the Elizabeth Stringfellow Endowment Fund, Sandoz Chemical Corporation, and the Clariant Corporation and Archroma, current owners of the Topper property. His explorations of chert quarry sites in the area have yielded countless artifacts from the Paleoamerican through the Archaic periods at Topper and the nearby Big Pine Tree site.

Beyond Clovis at Topper

After about a meter's depth of excavation at the Topper site, Goodyear remembers, "everything went away." As a veteran of classical archaeological training, he assumed he had exhausted evidence for the Clovis occupation. His reasonable attitude was that "you don't look for what you don't expect to find." It didn't occur to him to dig deeper until he read of the Cactus Hill site in Virginia, where stone tools and evidence of another, earlier occupation appeared below the Clovis horizon. That news was reinforced by word of Tom Dillehay's discoveries of a pre-Clovis occupation at Monte Verde in Chile (**MT 33-3,** "Tom Dillehay: The Clovis-First iconoclast"). A flood at the Big Pine Tree site was a convenient excuse for Goodyear to move his 1998 volunteer force to Topper, where he asked the workers to dig deeper. They began with a test square at the base of the hillside. At 30–50 cm below the expected Clovis level they encountered a zone of white Pleistocene alluvial sands which contained small flaked artifacts—side- and endscrapers, spokeshaves, utilized flakes, gravers, prismatic blades, and bend-break tools—and larger artifacts including cores, choppers, and planes (**MT 16-4,** "The Topper site: Beyond Clovis at Allendale"). Goodyear and his team were ecstatic.

At 1.8-m depth they encountered several chert cobbles piled as though by human hands. Around the feature they found several flake tools that didn't resemble typical Clovis artifacts. Many of these were burin-like tools made from the weathered chert cobbles from the hillside by the bend-break technique.

Fortunately for Goodyear, the Topper site lies on property then owned by the Clariant Corporation, a chemical company based in Switzerland, which granted archaeologists unlimited access to the area. Using a backhoe and hand excavation, the team dug about 4 m below ground surface, where they uncovered artifacts simpler and smaller than Clovis specimens from the higher level. A black stain in the sediments surrounding the artifacts supplied charcoal needed for radiocarbon dating. Tom Stafford obtained two radiocarbon dates from humified plant remains of 50,300 and 51,700 years RCYBP. These dates, which suggest a much earlier arrival for humans in the Western Hemisphere than predicted by any currently accepted model, ignited a firestorm of excitement and controversy.



Backhoe Trench 15 reveals the complete stratigraphy of the Topper site, 2002.

Beware of geofacts

The news spread faster than rumors of gold in the Klondike, and reporters swarmed to interview Goodyear and his team. Goodyear was keenly aware that his discovery would be subjected to intense scrutiny by the scientific community. "In identifying early human artifacts, especially in assemblages without highly formalized artifacts such as bifaces and prismatic blades," he explains, "issues concerning the possible role of nature in creating pseudo-artifacts must be considered." A study of 225 cobble- and boulder-size nodules and artifacts from various

depths at Topper found that nearly 90 percent of them had some flake removals. Graduate student Douglas Sain accordingly conducted freezing and thawing experiments and found that such mechanical weathering processes are unlikely to produce detachments with lithic attributes characteristic of conchoidal or bend fractures. More information about the artifacts, stratigraphy, and dating of Topper pre-Clovis can be found in an article by Goodyear and Doug Sain in *Early Human Life on the Southeastern Coastal Plain* (see "Suggested Readings").

Goodyear and his colleagues remain convinced that the simple stone tools found below the Clovis level at Topper are evidence for much earlier peoples who camped at Topper long before the Ice Age ended. For Al Goodyear, these early dates corroborate evidence from early sites in Brazil and Chile that suggests humans were in the Western Hemisphere between 30,000 and 50,000 years ago.

A volunteer excavates the Clovis floor on the hillside at Topper, 2008.

"At present, approximately 130 contiguous square meters have been hand excavated in the pre-Clovis Pleistocene-age sediments," Goodyear says. Since every incident of rainfall interfered with work at the Topper site, in 2006 a permanent covered structure that includes a viewing deck was installed to protect the pre-Clovis excavations on the terrace (**MT 21-4,** "Clovis at Topper"). This pleasant addition encourages visits year-round by scientists, the media, and graduate students working on dissertations and theses.

Retirement . . . sort of

After 40 years, Goodyear in 2014 retired from the University of South Carolina. He was immediately reappointed as an Affiliate of South Carolina Institute of Archaeology and Anthropology. In 2016, Goodyear and colleague Andrew White relocated to spacious new USC facilities at Barnwell College, where many of the Allendale collections now reside.

"Since 2014 I have been working to publish various ongoing studies," Goodyear tells us. "My goals were and continue to be developing SEPAS [The Southeastern Paleoamerican Survey] and hopefully getting the program endowed." He continues to coauthor various journal articles on the Younger Dryas impact hypothesis, including a recent study of a widespread platinum anomaly across North America at the Clovis horizon, along with current studies of the stratigraphy of the Pleistocene-Holocene transition at the famous White Pond site in South Carolina.

As if this weren't enough to keep a scientist busy, he is currently developing a fluted-point database for the state of Florida, which may ultimately be integrated with other databases for Georgia, South Carolina, and North Carolina. "This region of North America should have a high potential for Pleistocene archaeology," Goodyear explains. "With the Topper and Page-Ladson sites, we see strong promise of discoveries yet to come."

"Even after all these years, when Al's doing his thing, he's like a kid in a candy store," says SCIAA colleague Christopher Moore. "His enthusiasm and passion for archaeology is contagious!" MT

–Martha Deeringer

How to contact the principal of this article:
Albert C. Goodyear
SCIAA-USC
1321 Pendleton St.
Columbia, SC. 29208
e-mail: goodyear@mailbox.sc.edu

Suggested Readings

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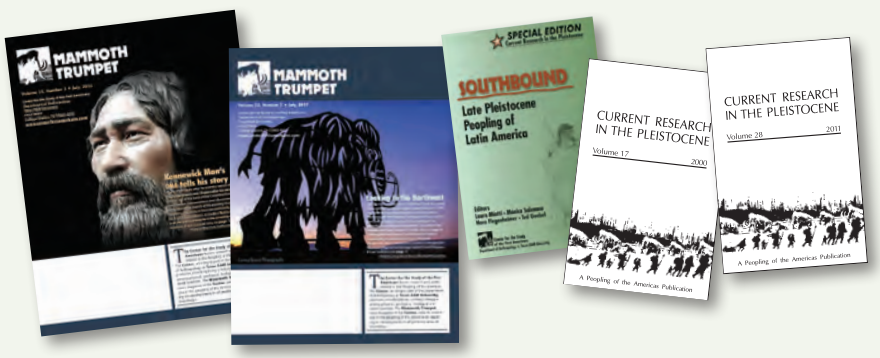

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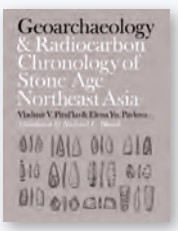

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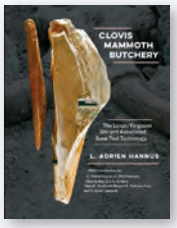

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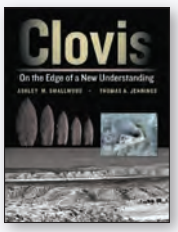

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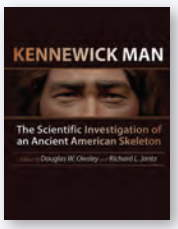

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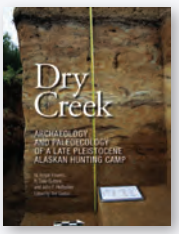

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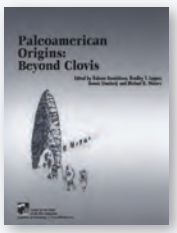

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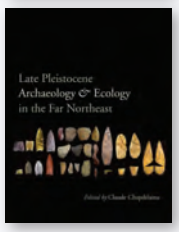

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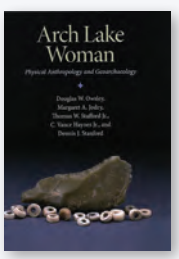

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