# MAMMOTH TRUMPET

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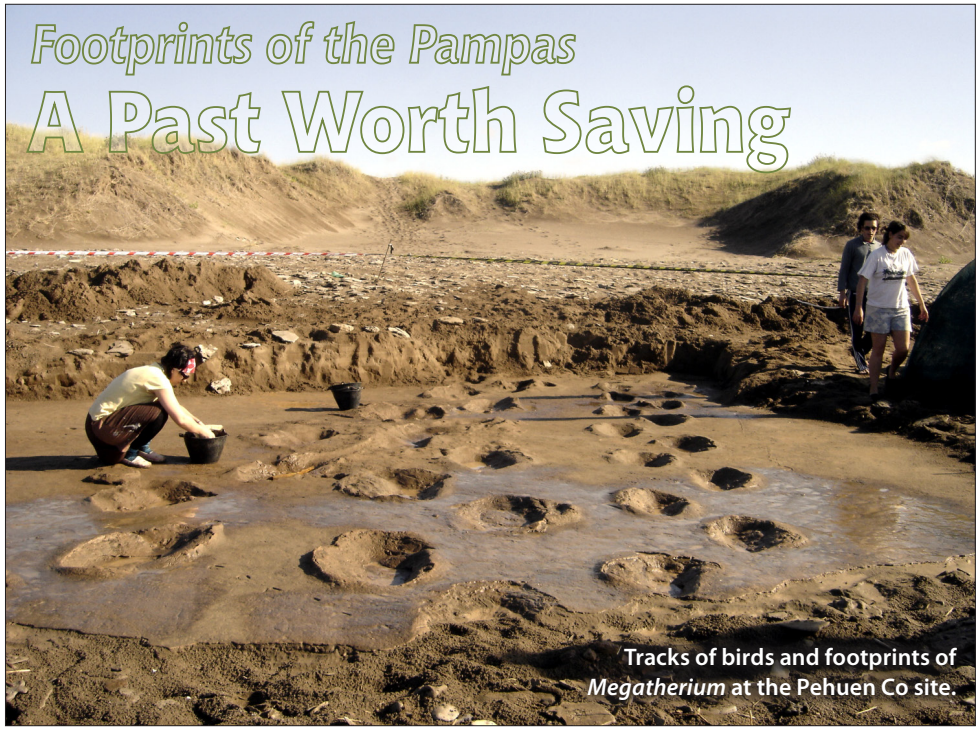
## Footprints of the Pampas
# A Past Worth Saving



TERESA MANERA

Tracks of birds and footprints of *Megatherium* at the Pehuen Co site.



**BLESSED WITH FERTILE SOIL** and lush grasses, the Pampas of Argentina is perhaps best known for its cattle that supply beef to markets all over the globe. The Pampas grasslands roll southward from the Rio de la Plata to the banks of the Rio Negro, westward toward the Andes, and northward to the southern parts of Córdoba and Santa Fe provinces, embracing the entire Buenos Aires and La Pampa provinces. For many millennia before man and cattle arrived, the Pampas was the habitat for myriad herbivores great and small, most of them now extinct and known to us only by their fossils. At the southern extremity of the Argentinean Pampas plain lies a 30-km sector of the Atlantic coast whose soils have yielded an extraordinary assemblage of fossils that give us a snapshot of the changing paleoenvironment at four significant moments over the past 5 million years, from the upper Tertiary through the arrival of the first humans.

And not only the skeletal remains of extinct fauna are present. We also have their footprints, fossilized and safe from harm . . . until now. The rush to preserve these footprints adds a note of urgency to this story.

### A famous visitor

In 1832 Charles Darwin came here to investigate the legendary Monte Hermoso cliffs, whose sediments contain fossil remains of autochthonous South American fauna. His visit is recalled by Teresa Manera, professor at the National University of the South in Bahía Blanca and honorary director of the Charles Darwin Municipal Natural Science Museum. "Darwin went to Monte Hermoso with Captain Robert FitzRoy to survey the area," Dr. Manera tells us. "There, he found some rodent bones that were important in the development

of his thought on the evolution of life." The bones, fossil remains of an extinct member of the cavy family, gave Darwin tangible evidence of an extinct ancestor of a species living today. Here we witness the first stirrings of his volcanic theory of evolution. "After Darwin," Manera continues, "many scientists performed research at Monte Hermoso cliffs—archaeologists, paleontologists, and geologists, which eventually led to an outcrop of sediments spanning from the Pliocene to Holocene," says Manera.

As a geologist working in paleontology, Manera studies vertebrate taphonomy at the Monte Hermoso site. Working with a Ph.D. student, she has found Pliocene vertebrate bones (fishes, amphibians, reptiles, birds, and mammals) and some sloth footprints. "This work was important because it allowed us to define in a better way the stratigraphy of the Pliocene formation (Monte Hermoso Formation), which was very controversial."

## A wealth of material for paleontologists

You would be hard pressed to name another area anywhere in the world so rich in evidence of past life as Monte Hermoso and other sites in the vicinity of Bahía Blanca. Just to the north within a radius of 300 km lie such archaeological sites as Arroyo Seco, El Guanaco, Paso Otero, Cerro La China, Cerro El Sombrero, sites that today are creating immense excitement—and great controversy—by demonstrating that humans occupied the South American continent far earlier than was previously thought (**MT 25-4,** "Paleo South America: Long Time, No See").

Clustered in the immediate vicinity of Bahía Blanca are a suite of sites that span many geological ages. Cristina Bayón, together with Silvia Aramayo, Manera, and Gustavo Politis, professor of archaeology at the Universidad Nacional del Centro in Buenos Aires, describes how stratified sediments formed the sites. The setting originated, they explain, as a plain lying between the hills of the Ventania range and the sea. Fine sediments were laid down in a fluvial environment by meandering rivers laden with silt. Over many millennia meter upon meter of sediments accumulated, and with them the remains of creatures then extant. At the Farola Monte Hermoso site, entombed in marine cliffs 12 m high that stretch for 3 km are members of every significant family of animals from the Pliocene into the Pleistocene, some that appear in popular literature—armadillos, glyptodons, ground sloths, and fish, amphibians, and reptiles—and now-vanished mammals with exotic names—Borhyaenids, Hegetotheridae, Mesotheriidae, Protherotheriidae, Macraucheniidae. So rich and varied is the paleontological record, in fact, that the locale has given its name to a specific evolutionary age, the Montehermosan Stage.

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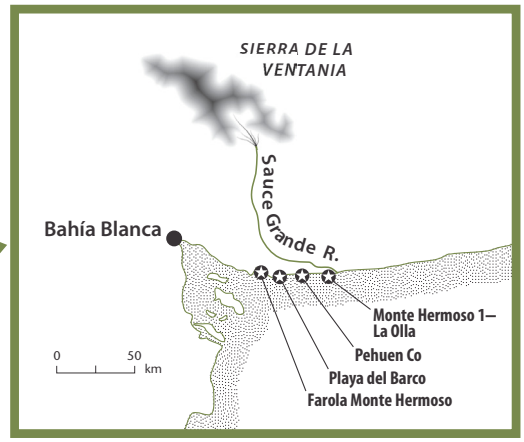
Many years may pass between the time an important discovery is made and the acceptance of research results by the scientific community. To facilitate communication among all parties interested in staying abreast of breaking news in First Americans studies, the **Mammoth Trumpet,** a science news magazine,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

*–Michael R. Waters, Director*

moso Formation. This mantle, called the Puerto Belgrano Formation, was itself overlain with fluvial deposits that eventually formed the Sauce Grande River, which initially flowed into the Atlantic near the Monte Hermoso cliffs. By the time of the late Pleistocene the ever-shifting terrain had altered the course of the river 11 km to the east, where the Playa del Barco site today lies. Its sediments contain the remains of fauna of a later evolutionary stage than those of the Farola Monte Hermosa site. Some are descendants of the same groups present in the Montehermosan Stage, now evolved into different genera—giant ground sloths, and glyptodons and their close relatives, the Dasypodidade. Making their first appearance are also animals of North American origin, including camelids, proboscideans, cervids, and carnivores. Preying on the late-Pleistocene megaherbivores of the Pampas was *Smilodon,* the saber-tooth tiger of Rancho la Brea fame.




## Setting the stage for recording footprints

A radical change in global climate at the end of the Pleistocene wrought equally radical changes in the Pampean paleoenvironment. At about 12,000 radiocarbon years ago the Ice Age hadn't yet released its grip. Glaciers still bound up so much water that the sea level lay 100 m lower than today. Consequently, roughly 100 km of the continental shelf lay exposed in the region of Bahía Blanca, which means that the shoreline of today was then grassland far distant from the ocean. What's more, the Pampean climate was markedly different from today. Cold, dry, and windy conditions prevailed, and the waterways that today drain the plain weren't yet established. Instead, water drained haphazardly into temporary pools, creating a landscape where marshes and muck abounded, the setting for the Pehuen Co paleoichnological site. (Ichnology is the study of ichnites, fossilized footprints.)


TERESA MANERA


TERESA MANERA

◀ The Monte Hermoso cliffs.

▼ Playa del Barco site.

"On the shores of these temporary ponds of the Pampean Late Pleistocene," say Bayón et al., "an exceptional record of animal footprints and tracks crops out on platforms along 5,000 meters of the modern coast. The process was repeated quite regularly, each after a short period of time, generating overlapping layers."

More than a hundred trackways and hundreds of random footprints record the passage of the most notable South American Pleistocene fauna. From the tracks Manera, Aramayo, and other scientists have identified Megatheridae, Mylodontidae, Glyptodontidae, Macrauchenia, *Paleolama, Lama,* Equidae, *Stegomastodon,* Carnivora (Ursidae, Canidae, Felidae), and Caviidae.

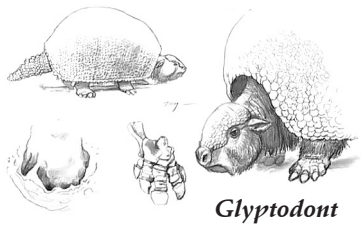
## A lifetime of caring

Manera has a deep attachment to the Pehuen Co site, which is evident in the 2004 Rolex Award for Enterprise she received for her work there. (To view an excellent reprise of her work, log on to http://www.rolexawards.com/gallery/videos/2004.) When she was growing up, her parents had a weekend house in Pehuen Co. Once, while walking between the beach and dunes as a child, she found fossilized bones. It was in 1986 that her husband went fossil hunting after a storm and found an area where sand had been swept away, exposing massive footprints. Since then Manera and others have found the prints of more than 24 species.

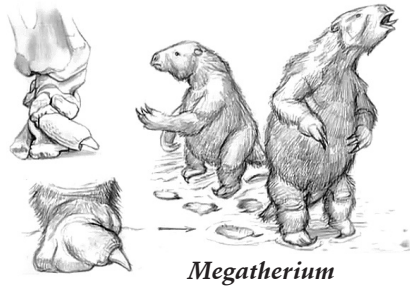
By far the most impressive tracks are those of the glyptodon, the car-sized ancestor of the armadillo, and *Megatherium,* the massive ground sloth. About 28 trackways assigned to *Megatherium* have been registered, each comprising at least five footprints. The most defined trackway was named *Neomegatherichnum pehuencoensis* by Manera and her colleague Silvia Aramayo. What is astonish-

ing about this trackway is that for nearly the entire extent the animal traveled by bipedal locomotion. This is a gargantuan beast fully 5 m tall when upright—picture if you can (except in a Walt Disney cartoon) an elephant-sized creature walking on its hind legs!

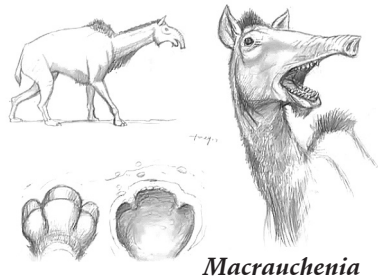
Pehuen Co footprints also record the presence of mastodon, the *Macrauchenia* (a creature that looked like a camel with a trunk), an extinct bear, and deer. Footprints reveal to Manera, with her practiced eye, such information as the speed at which an animal moved, whether it was solitary or social, its relationship with other animals, and its posture while walking. From time to time, footprints of new fauna appear. For Manera, "it's like having a fossilized zoo of the local fauna from 12,000 years ago."



*Glyptodont*



*Megatherium*



*Macrauchenia*

**Some of the megafauna whose footprints are found at the Pehuen Co site. Not only did the herbivorous *glyptodont*, a relative of the armadillo, resemble the Volkswagen Beetle in shape, it was about the same size and weight. The *macrauchenia* ("big llama," although it belongs to an extinct order of mega-herbivores not related to the llama) was as heavy as a draft horse, but taller and swifter; its trunklike proboscis resembles that of the saiga. *Megatherium*, the giant ground sloth, was simply enormous: 4 tons in weight, 6 m in overall length. It was the largest land animal in the terminal Pleistocene except the mammoth and mastodon. *Luis Rey, artist.***

## Marvelous footprints, but terribly fragile

The siltstone containing tracks hasn't completely consolidated. Consequently the footprints are soft when damp and crumble to dust if they dry out. For 12,000 years they lay preserved by a protective blanket of sand. Today the footprints are threatened with destruction from two directions: by erosion from wave action in the surf, which is inevitable; and by vehicles traversing the beach—trucks used by local fisherman, and off-road vehicles used by joyriders in summer. For years Manera lobbied local politicians to enact legislation to protect the footprints, but her efforts were frustrated by Argentina's economic and political turmoil. As a stopgap measure she turned to winning the hearts of the locals, even to educating children at Pehuen Co schools and encouraging them to enlighten their parents.

TERESA MANERA

**Human footprint found at the Pehuen Co site.**

After Manera received the Rolex award in 2004, the provincial legislature finally declared the area at Pehuen Co a protected geological reserve. In 2007, the provincial government assigned the first official guard to the site, and in 2009 the government fenced off 5 km of beach around the prints and stationed a guard at the location. The area is now well on its way to becoming an official UNESCO world heritage site.

In 1989 Manera established the Charles Darwin Municipal Natural Science Museum in Punta Alta, so people could identify with the region's natural resources. "It is from my experience at the Museum that I try to take to the University a message of respect for nature in general," she says. "Especially I try to raise awareness about the care of regional paleontological and archaeological heritage." Manera and her coworkers are devoting their efforts to create a record of the footprints. By surveying the whole site with GPS, she is making a map to show how animals behaved across this entire area. The footprints themselves are best recorded by making casts, but working conditions make that difficult because they have to wait for the tide to retreat and expose the footprints. That gives them only a 6-hour window in which to complete their task. Even so, just a quick trace of a footprint can preserve valuable evidence.

## Humans appear on the scene

Found embossed in the solidified mud at Pehuen Co are the footprints of representative megafauna species, including *Megatherium, Macrauchenia,* American horse, and guanaco. Among them are two footprints in sediments detached by the tide, and a trackway. The length of the two footprints, about 23 cm, and clearly defined impressions of toes identify their human origin (both prints are of the left foot). The trackway comprises 13 consecutive footprints of alternating left and right foot, as would be made by one indi-


ROLEX

**Manera with footprints of *Megatherium* at the Pehuen Co Paleoichnological site, 2004.**

vidual walking. Although toes aren't distinguished (sandals or moccasins would prevent their impressions), the dimensions of the prints, their spacing, and the angle between alternating footprints identify them as made by a human.

Manera, Bayón, and Politis are understandably excited by this discovery. A sample of organic matter from the midpoint of the stratigraphic level of the footprints yielded a radiocarbon date of 12,000±110 RCYBP. Although they regard this date as tentative, nonetheless it's commensurate with other evidence of early human presence in South America—sparse evidence at this moment, to be sure, but mounting. Manera, Bayón, and Politis cite the Monte Verde site in Chile dated at 12,500 RCYBP and a human tooth from Toca Do Gordo do Garrincho in Brazil dated at 12,210±40 RCYBP. Closer to home, at the Arroyo Seco site (a mere 130 km northeast of Pehuen Co), *Megatherium* bones bearing marks of impact and associated with stone tools were dated at 12,150 RCYBP. Increasingly, South American sites are imperiling the claim of Clovis (ca. 11,050–10,800 RCYBP) to the title of the First Americans.

The nearby sites of La Olla and Monte Hermoso I were occupied by Pampean hunter-gatherer groups from early to middle Holocene, ca. 6000–9000 CALYBP. Politis has found human footprints and a few artifacts at Monte Hermoso I. At La Olla, which has yielded faunal remains and artifacts of wood and stone, transitory campsites around the marsh environment suggest a few centuries of occupation by hunters and butchers who exploited the marine environment. "Sea mammals [sea lions] and some terrestrial animals like deer are here," Politis points out. "Maybe there were temporary camps composed of mobile hunter-gatherers. They remained hunter-gatherers till the arrival of the Spaniards."

## The race to save the footprints

Just as at Pehuen Co, wave action threatens the La Olla site. "The La Olla site is under water, only exposed during low tide," says Politis. "When exposed, we have to do a rushed excavation." Last year, Politis went to monitor the front of the outcrop, the layers containing archaeological materials. "It's eroding," he says. "We're finishing a GPS to be precise about mapping the front and to estimate the rate of erosion. We'll do more sophisticated scanning of footprints as well. In a few years, these footprints we're seeing now at Monte Hermoso I will disappear, but probably new footprints will show up. The erosion is eroding some, but exposing others—it's a dynamic process." In the ria, Politis explains, is a situation where "the erosion is more horizontal than vertical. You have a beach and a gentle slope. Because of this kind of erosion,

*continued on page 15*


GUSTAVO POLITIS

**Politis with a member of the Hoti tribe, a Stone Age culture in Venezuela.**

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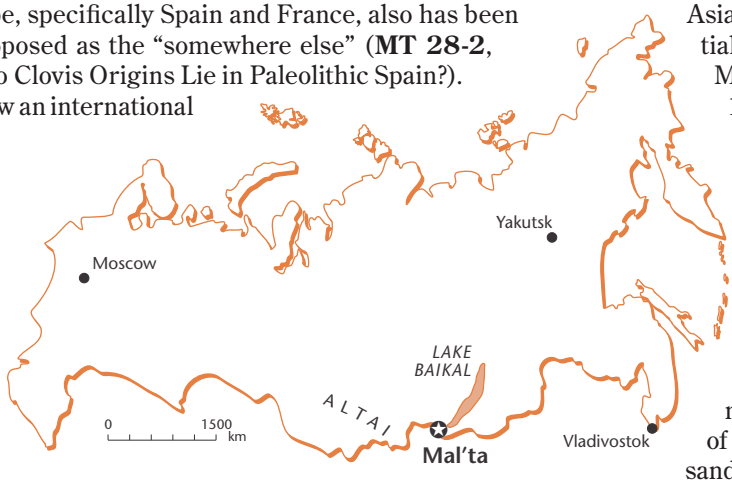
# Ancient Siberian Boy Reveals Complex Origins of First Americans

KELLY GRAF

Reconstruction of the Mal'ta burial on display at the Hermitage State Museum.

**Who were the First Americans?**

Since archaeologists have never found any fossils of early types of humans in this hemisphere, it's clear that the ancestors of the American Indians didn't evolve here, but came from somewhere else. Archaeological, genetic, and linguistic data assembled over the past several decades have pointed consistently to eastern Asia as the homeland of the earliest discoverers of this New World; but western Europe, specifically Spain and France, also has been proposed as the "somewhere else" (**MT 28-2**, "Do Clovis Origins Lie in Paleolithic Spain?). Now an international team of 31 researchers representing 23 institutions has successfully extracted DNA from the skeletal remains of a 3- to 4-year-old boy who lived in southern Siberia around 24,000 CALYBP, which may provide a definitive answer to this question. Their results are presented in a recent issue of the journal *Nature*.




The boy's genome indicates his group was ancestral to modern western Eurasians and contributed approximately 14% to 38% of the genes that make up the modern Native American genome. And yet he shared "no close affinity to east Asians." This indicates that the first Americans were an amalgam of east Asians and western Eurasians. This is a surprise, but it potentially explains why many Paleoamericans, such as Kennewick Man, have skull shapes similar to those of Eurasians (**MT 17-3, -4,** "When Politics and Science Collide") and how the X mitochondrial haplogroup, found mostly in western Europe and eastern North America, got to this continent.

## Mal'ta, a Paleolithic settlement in Siberia

The story begins in a large encampment of reindeer hunters on the banks of a river in south central Siberia. The time is 24,000 years ago. A family is devastated by tragedy. Two young children have died. They are buried together with several precious artifacts—last gifts from a mother and father who are left to contemplate the emptiness of a future without their beloved children. More than a thousand generations later, that family's tragedy is revealing the lost history of their people and clues to the fate of their descendants.

The large hunting camp is now known as the Mal'ta site.

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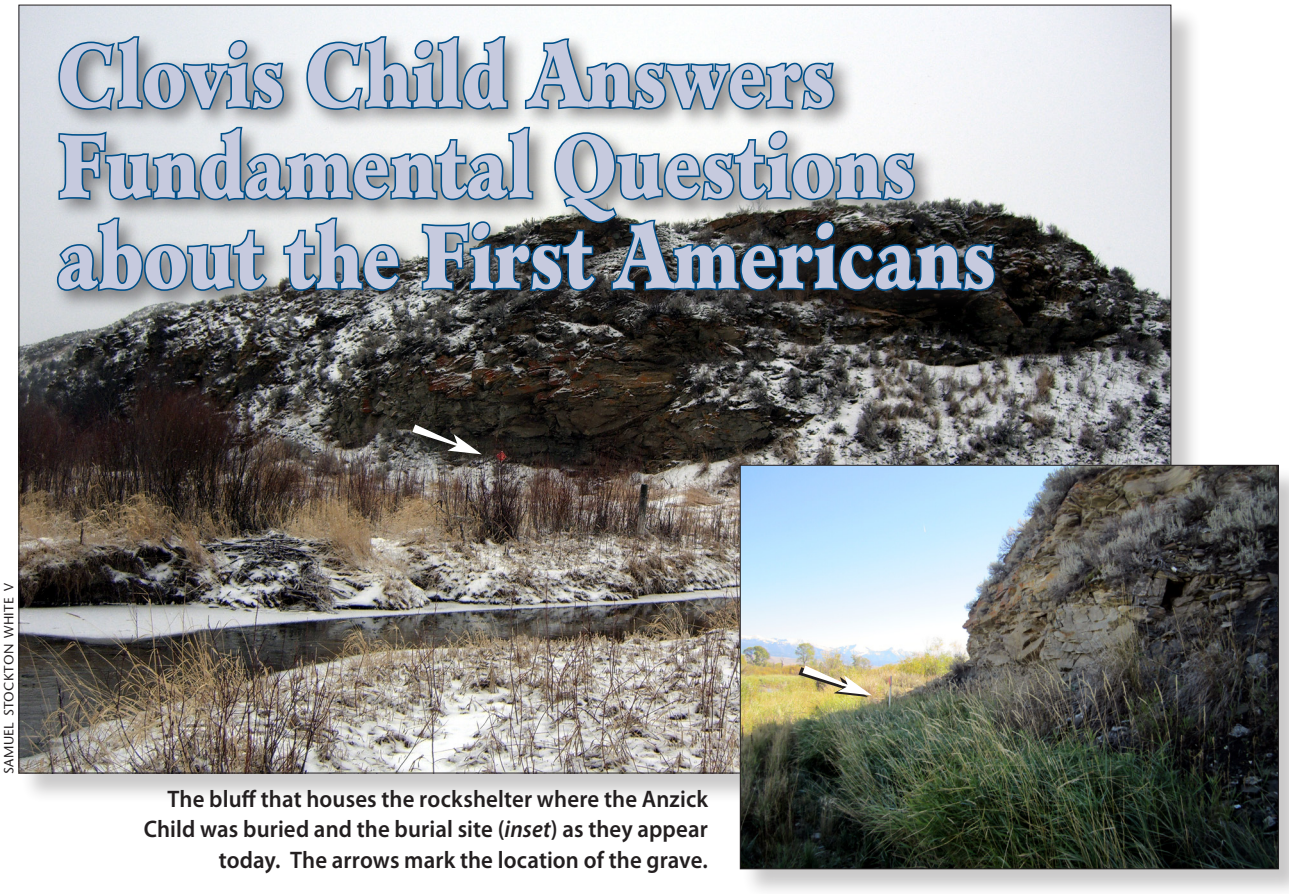
# Clovis Child Answers Fundamental Questions about the First Americans



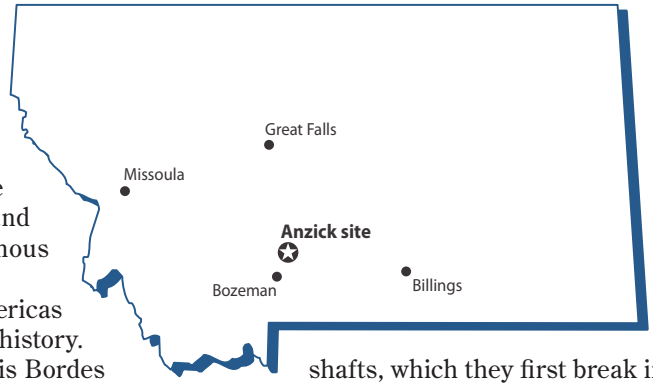
SAMUEL STOCKTON WHITE V

The bluff that houses the rockshelter where the Anzick Child was buried and the burial site (*inset*) as they appear today. The arrows mark the location of the grave.

**WHO WERE THE FIRST AMERICANS?**

Thanks to the stewardship of the Anzick family from Montana, a nearly five-decade-old discovery may at last have definitively answered this question.

One of the First Americans was a small child, little more than a toddler, who died and was buried with an array of spectacular Clovis tools made from stone and antler. His remains were uncovered accidentally at the Anzick site in southern Montana in 1968. A new investigation of this boy's DNA has revealed surprising new information about where the First Americans came from and their relationship to modern indigenous American peoples.




The original peopling of the Americas stands as a pivotal moment in world history. The late French prehistorian François Bordes once wrote that the exploration and settlement of this previously uninhabited hemisphere by modern humans "was an adventure unique in human history" and there could be "no repetition of this until man lands on a planet belonging to another star." Apart from the Polynesian colonization of the myriad Pacific islands, the peopling of the Americas was the final chapter in the peopling of the world. In that sense Mike Waters, Director of the Center for the Study of the First Americans, observed that the story of the Anzick child is "part of the story of all of us."

## Anzick: a Clovis burial in Montana

The story begins 12,700 years ago. A family living in what is now southern Montana is devastated by tragedy. A young boy, a toddler between one and two years old, has died. His family carries the body to a small rockshelter at the base of a prominent bluff. They dig a grave about 3 ft square and lay the boy to rest, covering his remains with red ocher. They then carefully place over the small body more than a hundred finely crafted stone tools and eight antler foreshafts, which they first break into pieces. These artifacts also are covered in red ocher before they and the boy are buried. Perhaps members of the family returned to the site over the years to mourn the loss of this special child, or they may have simply continued their interrupted journey and never returned to this sorrow-filled valley.

More than five hundred generations later, in 1968, two workmen, Ben Hargis and Calvin Sarver, were using a front-end

*continued on next page*

loader to remove the talus at the base of that prominent bluff. Over the course of the intervening centuries, the rockshelter had collapsed, leaving a fan of rocky debris covering the site. These coarse cobbles were to be used in a drain field at a nearby school. In the course of their excavation, Hargis and Sarver uncovered the burial and its extraordinary collection of artifacts. The magnificent artifacts were shared between the discoverers and landowners Mel and Helen Anzick.

Sarah Anzick, Mel and Helen's daughter, who was two years old in 1968, became a genome researcher at the National Institute of Health and participated in the human genome project. Now she is part of an international team of 42 researchers from 24 institutions that have recovered ancient DNA from one of the bones of this child, which the Anzick family had safeguarded for nearly half a century. That DNA was so well preserved that this team was able to retrieve the entire genome of the only human remains ever found in direct association with Clovis artifacts. This study, published in the 13 February issue of the journal *Nature,* is a landmark contribution to our understanding of the First Americans and their epic journey to this New World.

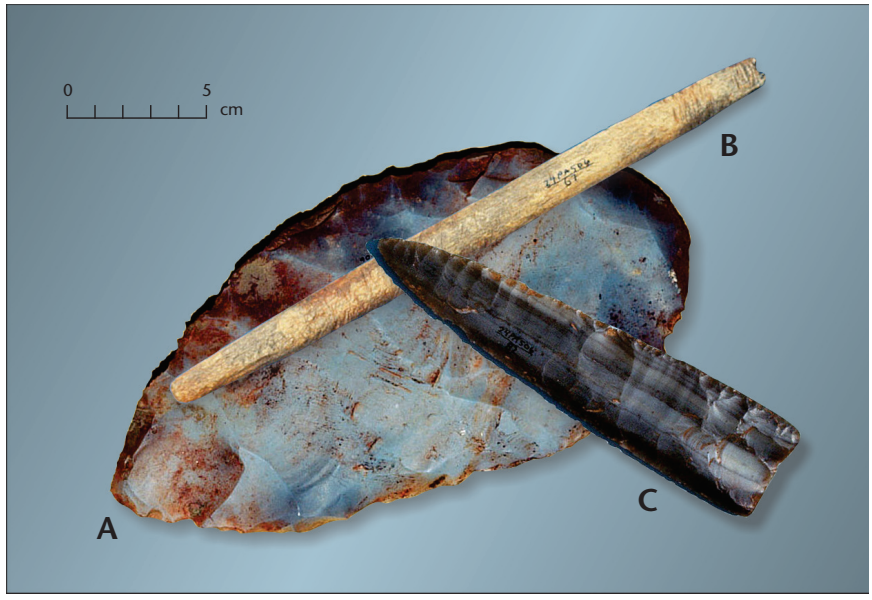
## The Anzick site

The Anzick site is located in southern Montana along Flathead Creek near its confluence with the Shields River, which flows into the Yellowstone River about 22 miles to the south. The site is located at the base of a prominent hogback ridge, which would have been an important landmark for anyone living in the region at any time in the past. One obvious reason why a roving hunter-gatherer band would choose such a place for a burial is that it would be relatively easy to relocate the grave site on return visits to the area. Archaeologists Julie Morrow and Stuart Feidel suggest that the location of the site near the southern opening of the Ice-Free Corridor could have made it "one of the first places visited by migrating Clovis bands as they explored North America."

## The only known Clovis burial

According to an analysis by Smithsonian anthropologists Douglas Owsley and David Hunt, the remains of the Clovis boy include 28 pieces of the skull, pieces of three ribs, and the left clavicle. From these meager remains, they were able to determine that the boy was one to two years old. Because the skeleton is so incomplete, it is difficult to conclude how the boy died or even his general state of health. It's actually surprising that any bones at all were preserved. Owsley and Hunt suspect that the thick coating of red ocher may have helped preserve them.

Owsley and Hunt concluded their 2001 study of the Anzick boy's remains with the observation that "as our ability to read these ancient bones increases through advances in osteology, and appreciation of what other areas of science can contribute to multidisciplinary studies of the First Americans, we can only marvel at what else will be learned" from the Anzick child "in the decades to come." Just 13 years later, University of Copenhagen geneticist Eske Willerslev and his team have proved them spectacularly right.




SAMUEL STOCKTON WHITE V

**Artifacts from the Anzick Child burial: A, biface; B, artifact made of elk antler; C, fluted point.**

## The artifacts

Various researchers have studied the Anzick collection over the years, but unfortunately there is no agreed-upon inventory of all the artifacts. This is partly because several of the artifacts are broken; whereas some investigators count all the fragments, others try to determine how many artifacts would be represented if you reassembled all the pieces. For example, in the collection there are around 83 bifaces, counting all the fragments, but these appear to represent a minimum of about 68 complete artifacts. And there are between 11 and 15 antler rod fragments, which are variously thought to represent between 8 and 12 original foreshafts.

Another reason for the confusion relates to how you classify the various tools. Everyone agrees that there are eight Clovis points in the collection, but whereas some investigators count bifaces as a single category, others think it important to distinguish among bifacially flaked cores, percussion- and pressure-flaked bifacial blanks, and other sorts of bifaces.

According to Morrow and Fiedel, the offerings included with the Anzick burial include 84 bifacial cores and preforms, 8 fluted points, 15 fragments of elk antler rods probably representing 8 foreshafts to accommodate the 8 spear points, 6 unifacial cutting and scraping tools, and 2 flint chips. Many of the bifaces are enormous. The largest, just over a foot long (32 cm), is bigger than most dinner plates.

These super-sized stone tools may appear to us to be extraordinary artifacts made exclusively for ritual purposes, but Bill McConnell, an instructor in primitive wilderness skills, told an audience at the Museum of the Rockies in January that in his judgment they were "functioning mammoth hunting tools."

Quoting the poet Robinson Jeffers, McConnell claimed these tools were not ceremonial objects possessing "divinely superfluous beauty," but instead constituted a remarkably complete, more or less ordinary Clovis toolkit. It was "a gift to this child," McConnell suggests, "that says 'this is what it takes to be a mammoth hunter.'"

Many of the artifacts show evidence of reworking, resharpening, or usewear, confirming that the tools weren't made especially for burial offerings. They were functional tools the boy's family selected to accompany the child, presumably in the belief he would need them in the afterlife. There's clear evidence that the antler foreshafts were deliberately broken before being placed with the burial and that a few of the stone tools were ritually shattered as part of the funerary ceremonies.

The team: (*left–right*) Eske Willerslev, Mike Waters, Shane Doyle, and Sarah Anzick.

The raw material used to make the 37 pounds of stone tools, which appears to have been gathered from between 6 and 9 different sources, includes various cherts and agates from Montana, porcellinite from northeastern Wyoming, and silicified wood from southwestern North Dakota.

According to Hargis and Sarver, the large bifaces were tightly packed together "as in a stack of cards" and the artifacts had been placed above the child's remains. All the artifacts and the human bones had been covered with red ocher. Hargis and Sarver reported that when cleaning the red ocher from the stone tools they "were up to their elbows in that red stuff." Owsley and Hunt, observing that the bones of the child were completely covered by ocher, note that "very little of the natural bone color can be seen on any of the elements and the reddish coloration is infused into the cortex." All this suggests that extravagant quantities of red ocher were lavished on the burial and associated offerings.

Radiocarbon dates obtained for the human remains and the antler foreshafts pose something of a mystery. The bones date to 12,707–12,556 CALYBP, the foreshafts to 13,053–12,753 CALYBP, which suggests that the foreshafts may be as much as a couple of centuries older than the boy. This apparent disparity in age may be due to some undetected source of contamination in the bones or the antler artifacts. More likely, however, the foreshafts were treasured heirlooms handed down from generation to generation. That the rich offerings were intentionally broken and buried with this child may reflect the high social status of the child's family, since the child himself had no opportunity to earn the respect of his group by great deeds. Or the funerary riches may simply manifest the extended family's extraordinary depth of grief.

The Clovis culture dates to around 13,000–12,600 CALYBP. At the press conference announcing the results of the DNA analysis, Waters remarked that the Anzick burial "represents the very beginnings of Clovis [the antler foreshafts] as well as the end of Clovis [the human remains] all in one place."

## The first ancient American genome

Because the Anzick family had preserved the human remains along with the largest portion of the spectacular artifact assemblage, the international team of scientists led by Willerslev and Morten Rasmussen of the University of Copenhagen was able to recover DNA from the bones. During the press conference announcing the successful results, Waters specifically recognized the Anzick family as "a terrific steward" of one of the most important discoveries related to the First Americans.

The initial genetic screening of the Anzick child's bones analyzed his mitochondrial DNA. The mitochondria are organelles within the cytoplasm of the cell with their own DNA. Mitochondrial DNA (mtDNA) is much more common and simpler to recover than nuclear DNA, which is restricted to the cell's nucleus. Analysis of the mtDNA yielded the first startling discovery: The Anzick child was a member of the D4h3a haplogroup, a rare lineage among American Indians. In contemporary populations as well as in a few ancient skeletons, it's largely restricted to groups living along the Pacific coast in North and South America. That distribution has been interpreted as evidence of a coastal migration route for the earliest Americans. Willerslev and his coauthors point out the significance of the discovery of this haplogroup in an individual from southern Montana, which is the oldest skeleton from the Americas from which mtDNA has been recovered: It means that "current distributions of genetic markers are not necessarily indicative of the movement or distribution of peoples in the past."

Because individuals receive their mitochondrial DNA ex-

clusively from their mothers, the mitochondrial haplogroup reflects only the maternal lineage. Since the Anzick child was found to be a male, the Y chromosome, found only in males, provided a complementary view of his father's lineage. The Anzick child's Y-chromosome haplogroup was found to be Q-L54*(xM3), "one of the major founding Y-chromosome lineages of the Americas."

Willerslev's team compared the nuclear DNA of the Anzick child with a large database of 143 modern populations, including 52 Native American groups "from which recent European and African admixture have been excluded." What they discovered was remarkable. The Anzick boy was found to be more closely related to all Native American groups than to "any extant Eurasian population." When the Anzick child's DNA was compared with just the sample of Native American populations, his DNA was shown to be more closely related to 44 Native American groups from Central and South America than to 7 northern Native American groups from Canada and the Arctic, three Northern Amerind-speaking groups, and the Central American Yaqui.

What all this means is that *80% of all living Native Americans are descended directly from this child's extended family.* And the child is more closely related to the other 20% than to anyone else in the world. Reflecting on these results, Willerslev says, "It's crazy. Finding someone who is directly ancestral to the entire population of a continent—that just does not happen. I don't think it would ever happen in Europe, or in Siberia. There are very few places where this could happen." In fact, the only way it could have happened is if "this skeleton is really close to the source—really close to the 'Adam.' "

The stunning significance of Willerslev's team's discovery doesn't end there. Since the Anzick boy's extended family isn't directly ancestral to 20% of modern Native Americans, but is nonetheless closely related to them, the American Indian "Adam" must date to an even earlier period—a time before the direct ancestors of that 20% diverged from their close cousins. Based on these data, and other genetic and archaeological evidence, *Willerslev and his team estimate that humans must have entered the Americas "a few thousand years before Clovis."*

Moreover, for 80% of contemporary Native Americans to be descended from the Anzick boy's extended family, the founding population of pre-Clovis people must have been quite small. Yet another conclusion to be drawn from these data is that *all living Native Americans descend from the first humans in the Americas.* There is no evidence for additional pre-Columbian migrations from Europe or Africa. In particular, Willerslev and his colleagues claim their "genome analysis [of the Anzick boy] refutes the possibility that Clovis originated via a European (Solutrean) migration to the Americas."

Bruce Bradley, one of the main proponents of the Solutrean theory, rejects the idea that the Anzick boy's genome completely undermines the possibility of an early European migration. As he told the journal *Science,* "This is a single individual and can in no way represent all that was happening." Nevertheless the Anzick boy's genome analysis, when combined with the results of the study of the Mal'ta boy's DNA, is a hammer blow to the Solutrean theory, which already had significant problems (**MT 28-3,** "Alternative views of the Solutrean theory"). In an article accompanying the Anzick genome paper in *Nature,* biological anthropologists Jennifer Raff and Deborah Bolnik write that "the Solutrean theory can no longer be treated as a credible alternative for Clovis (or Native American) origins. It is time to move on to more interesting questions."



## Native American perspectives

In 2013, Willerslev traveled to the reservations of most of the American Indian tribes in Montana. He wanted to share the results of his team's work with them and hopefully gain their support. He says, "I didn't want a situation where the first time they heard about this was when it's published."

The team enlisted the help of Shane Doyle, a Crow Indian and a professor at Montana State University, whose grandfather was born less than 50 miles from where the Anzick burial was discovered. They went to the burial site, and there Willerslev shared with him the results of the study. Doyle says he was "overcome with emotion" and that his "life hasn't been the same since that day." Doyle accompanied Willerslev to the reservations to meet with the tribes.

None of the tribes expressed insurmountable objections to the research. Most of the tribal representatives expressed the wish that the boy's remains be reburied.

Doyle expressed his views concerning why some of the tribes felt some ambivalence about the research: "Our whole life experience has been: 'You are not important, you have no culture, you're cavemen.' So for them to get excited about scientific discoveries where science has in large part either ignored or neglected us . . . there's a lot of mixed emotions."

Perhaps the main reasons the tribes ultimately supported the research were the respect Willerslev showed by reaching out to them and his acknowledging what the research demonstrated: "The Native American groups that said that their oral history showed that they were deriving from the first peoples here, well, it turned out to be right." Now "we have to assume, with this result, that all early skeletons in the Americas . . . are related to contemporary Native American groups."

## Reburial

Most of the tribal representatives agreed that the Anzick child should be reburied. Sarah Anzick also felt "a moral obligation to return the child to the earth." Willerslev admitted that "being a scientist, reburying probably the most important skeleton in the history of the Americas—it's hard. But I think—I realized that if scientists and Native Americans want to pursue their past together, there needs to be compromises from both sides."

When Doyle was asked whether reburying the Anzick bones might run the risk of sacrificing future discoveries that might result from the development of new techniques for studying the bones, he replied, "It's not a risk; it's a foregone conclusion. We will be putting scientific data back in the ground. . . . This boy is not meant to be put on somebody's shelf and taken off when they feel like it. That's not what his parents put him in the ground for. You find out a little bit about that burial and you see the love that was put in there. He's given us about as much as we can ask from him."

Most scientists, on the other hand, would agree with Owsley and Hunt, who write that "as our ability to read these ancient bones increases through advances in osteology, and appreciation of what other areas of science can contribute to multidisciplinary studies of the First Americans, we can only marvel at what else will be learned [from the Anzick child] in the decades to come." This is why Willerslev and some of the other participating scientists find it hard to contemplate a final, irrevocable reburial of this remarkable child's remains. There are so many stories he has not yet been able to share with the world.

SAMUEL STOCKTON WHITE V

**Some of the artifacts from the Anzick Child burial.**

After much discussion, a reasonable compromise was reached that showed respect for the Clovis child and Native Americans, and satisfied scientists' desire to learn more about the past from the ancient remains. According to Mike Waters, the Anzick boy's remains will be reburied in a special time capsule to prevent degradation of the bones. And every 50 years there will be an opportunity to open the time capsule and take additional samples to answer new questions with new technologies. The number of samples that can be removed each time the capsule is opened will be limited. Currently the agreed limit is three or four samples per opening, but as new techniques make it possible to use smaller and smaller samples for various analyses, that number perhaps can be renegotiated down the road. Although there remain a number of other details to be worked out, such as who will evaluate and approve proposals for additional sampling, nonetheless the compromise serves as a ground-breaking model for resolving complications that may arise from future discoveries of Paleoamerican human remains. This sort of thoughtful compromise might have prevented the bitter legal dispute over the Kennewick Man skeleton (**MT 18-1,** "Judge rules scientists can study Kennewick Man"). It ensures the respectful interment of the Anzick child without denying scientists of the future the opportunity to listen to the stories written in his bones.

## Love beyond measure

The DNA recovered from the little boy buried more than 12,000 years ago in southern Montana has answered many questions about the First Americans. Willerslev and his coauthors conclude their paper with the observation that the Anzick genome "serves to unify the genetic and archaeological records of early North America." Not only are the people who made Clovis points and hunted mammoths and mastodons related to all living American Indians, they are more closely related to Central and South Americans than to peoples living in the Far North. The first peopling of the Americans must therefore have preceded Clovis by a few thousand years. The Clovis culture arose from American Indian antecedents, such as those that have been documented at Meadowcroft Rockshelter, Cactus Hill, and Buttermilk Creek (**MT 27-2,** "A Pre-Clovis Occupation along the Margins of the Southern High Plains"). If any Solutrean boat people reached our shores, they were few and far between and made no lasting contribution to American Indian biology and culture.

There is still much to be learned about the earliest peoples of the Americas. When did they get here? What routes did they follow? In an interview with National Public Radio, Willerslev admitted that "to be completely honest, we have no idea how they actually moved through time, these different groups throughout the continent. In order to answer that question there's only one way to go, and that is sequencing more genomes from ancient remains."

Rasmussen hopes the dialogue with local American Indian tribes entices them "to participate in genetic studies" in the future. Whether that happens may depend on whether contemporary American Indians see the value in the archaeological excavation of Paleoamerican burial sites and the genetic analysis of those human remains. Thanks to their commitment to consulting with tribes, Willerslev and his team are helping make that happen.

At the February 12 press conference announcing the results of the DNA analysis, when Doyle was asked what lessons he wanted schoolchildren to learn from the Anzick burial, he replied that the burial shows how native people have always cared for their children. He said that the Anzick child "wasn't a chief. He wasn't a great hunter. He wasn't a great warrior. He had never really contributed any economic benefits to his tribe. But the respect and love that was shown for him was really beyond measure and would probably match or go beyond anything people do today. I guess the grief that those people expressed in that burial is kind of timeless in my mind. And I think it's a story that probably everyone around the world should know." MT

*–Brad Lepper*

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## Ancient Siberian Boy

*continued from page 6*

It was excavated between 1928 and 1958 by the great Russian archaeologist Mikhail Gerasimov. Today, the site occupies a terrace of the Belaya River near the modern village of Mal'ta. Gerasimov identified 41 clusters of artifacts, which he interpreted as the remains of ancient dwellings though they likely weren't all occupied at one time, but instead reflect periodic reoccupations of the site.

Gerasimov's most remarkable discovery was a double burial of two young children. This double burial is one of only two known human burials in the Siberian Paleolithic. One of the children was a boy 3–4 years old, the other a one-year-old infant. The boy's remains were a generally poorly preserved partial skeleton; those of the infant consisted of only a few teeth. Kelly Graf, Texas A&M University and CSFA archaeologist and a member of the research team, wrote about the Mal'ta burials in her chapter in *Paleoamerican Odyssey*, published last year by the Center for the Study of the First Americans. She wrote that the children had been buried with a "wide array of grave goods," including a necklace of 120 mammoth-ivory beads, a large ivory pendant that appears to represent a bird in flight, and four figure eight–shaped pendants. In addition, the offerings included a figurine in the shape of a swan, an engraved ivory plaque, a long curved bone point or dagger, a bone bracelet, and a few unifacial stone tools. This is a remarkable assemblage of objects to accompany the burial of such young children. Perhaps it reflects the terrible sense of loss felt by the family and their desire to send their children to the next world with regalia that would show how much they were loved.

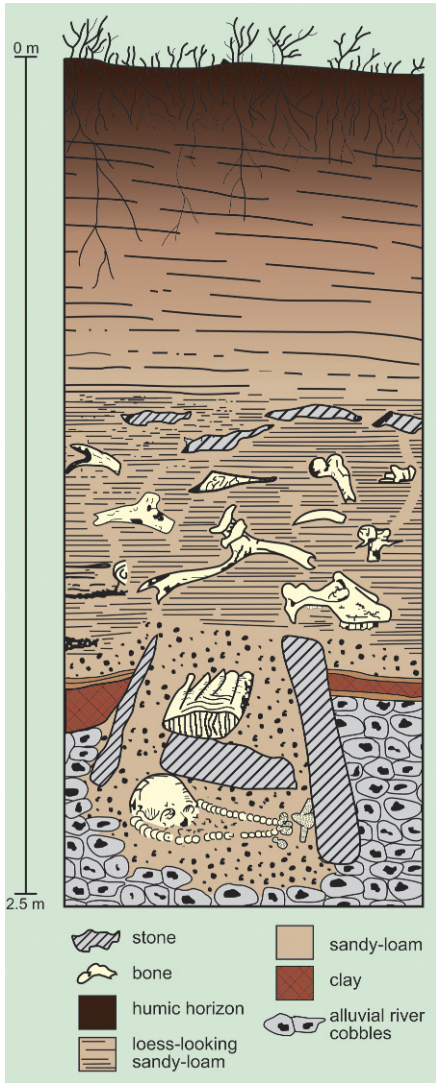
TED GOEBEL

**Demishchenko explains the curated collection to Graf and Willerslev.**

Dr. Graf, recognizing the potential importance of what could be learned from the DNA of the Mal'ta children, in September 2009 brought this important collection of human remains to the

attention of Eske Willerslev of the Centre for GeoGenetics at the Natural History Museum of Denmark. She obtained a National Science Foundation grant, which allowed her to meet Dr. Willerslev in St. Petersburg to examine the collection. There they met Svetlana Demishchenko, curator of Paleolithic archaeology at the Hermitage State Museum, whom Graf had first met in 2005 while conducting research for her doctoral dissertation.

Graf and Willerslev examined the remains of the children and collected from the humerus, or upper arm bone, of the older boy 0.15 grams of bone—about the weight of a small pea. And from this tiny piece of bone Willerslev and his team have reconstructed the story of the people who would become the First Americans. Graf's NSF grant also provided funding for radiocarbon dating the bone, thus further demonstrating the remarkable wealth of information that can now be gleaned from a miniscule amount of bone. The worldwide scientific community owes a debt of gratitude to the Hermitage State Museum; if their staff hadn't curated these remains for all these years, these new genetic analyses wouldn't have been possible.




FROM GERASIMOV 1931. REDRAWN BY H. L. SMITH.

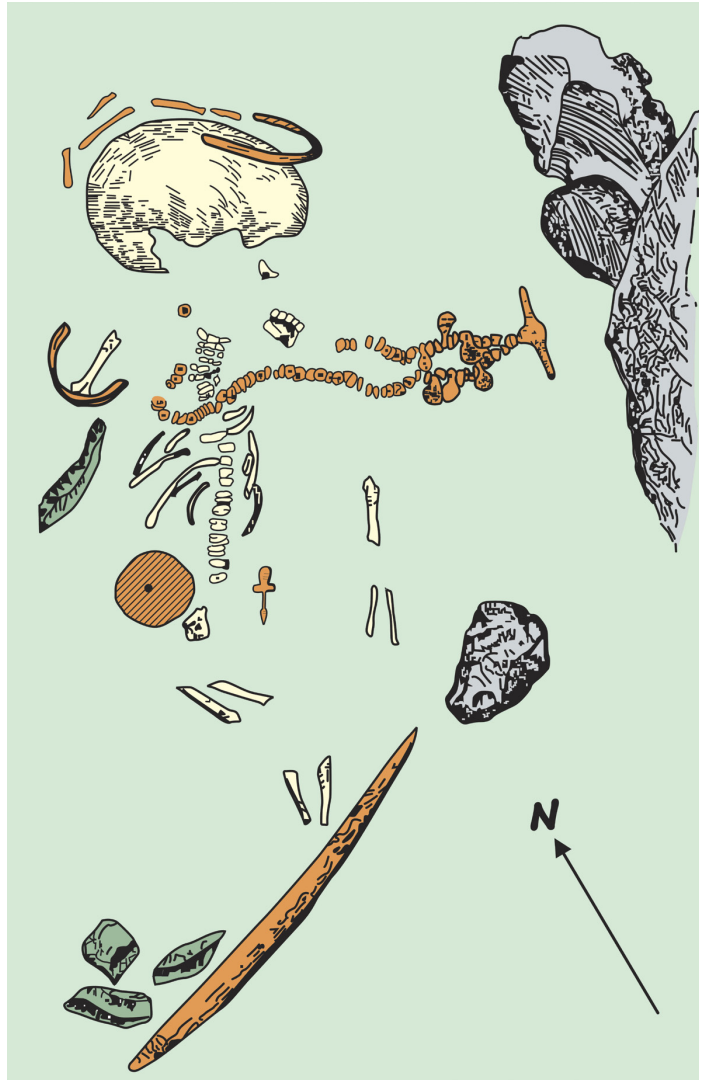
## The "oldest anatomically modern human genome reported to date"

Back in the lab, Willerslev and his team succeeded in extracting well-preserved DNA from the bone. Remarkably, it exhibited little contamination from outside sources. Some level of contamination is virtually inevitable in ancient DNA, whether from the archaeologists who excavated the bone or possibly from bacteria in the soil. Svante Pääbo, in his account of sequencing the Neanderthal genome, compared the number of Neanderthal mtDNA molecules in the bone samples his team processed—"about 50"—with the "tens of thousands, or hundreds of thousands" of mtDNA molecules on a single dust particle. This is why DNA is extracted from ancient bones in clean rooms in laboratories. Willerslev and his team took additional precautions, including sequencing the genome of the researcher who extracted the DNA and prepared the samples so it could be compared with the results obtained from the sample from the Mal'ta boy to ensure that the researcher didn't introduce contamination.

The team recovered mitochondrial DNA (mtDNA), which is DNA from the mitochondria that inhabited the cytoplasm of the child's cells, as well as the nuclear DNA, which constituted his genetic blueprint. Both kinds of DNA give us insight into the child's history.

◀ **The profile of the Mal'ta burial.**

▼ **Map of the Mal'ta burial.**




FROM GERASIMOV 1935. REDRAWN BY H. L. SMITH.

From his mitochondrial DNA, which provides a window only on the maternal ancestry, Willerslev and his team determined that the boy belonged to haplogroup U, which is common in people living today in North Africa, the Middle East, south and central Asia, western Siberia and Europe. That the Mal'ta boy doesn't belong to any of the known extant subgroups of U suggests his particular branch of the haplogroup U family tree is

extinct. Haplogroup U has also been detected in other ancient bones from the Upper Paleolithic and Mesolithic of Europe, which suggests a connection between the Paleolithic peoples of Europe and Siberia.

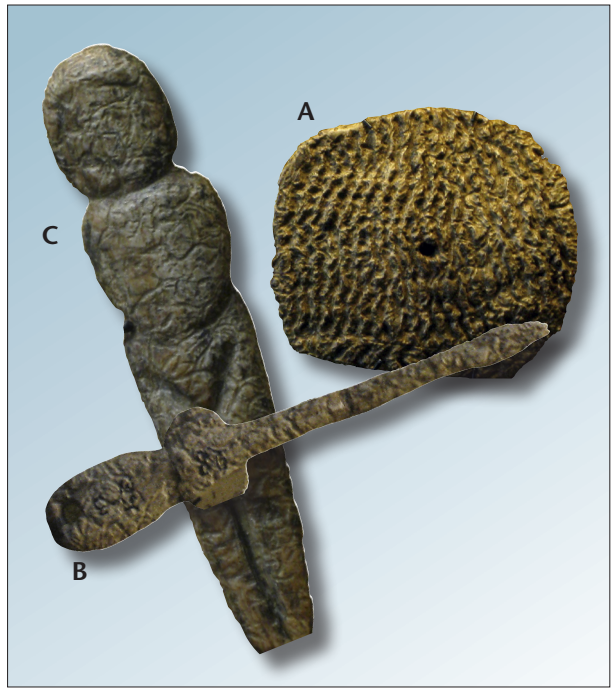
Looking specifically at the Mal'ta boy's Y chromosome, which is passed from father to son and thus complements the mother-to-child mtDNA lineage, Willerslev and his colleagues determined that his Y chromosome DNA is most likely derived from haplogroup R. Modern groups sharing this haplogroup are found in western Eurasia, south Asia, and southern Siberia, including the Altai region. Haplogroup Q, a closely related "sister lineage" to R, is the "most common haplogroup in Native Americans." Moreover, among the haplogroup lineages in Europe, the ones most closely related to Native Americans are "found in southern Altai."

TED GOEBEL

**Willerslev and Graf take a bone sample from the Mal'ta boy.**

Using the Mal'ta boy's entire DNA profile, Willerslev and his team did a worldwide comparative analysis with existing DNA databases and determined that the overall "genomic signature" of the Mal'ta boy closely linked him to two present-day regions: "first, the Americas; and second, northeast Europe and northwest Siberia." The lack of a strong connection to south-central Siberia, where the Mal'ta site is located, came as something of a surprise, but the team proposes that the modern gene pool of the region was shaped by subsequent immigrations of people from east Asia.

When the Mal'ta boy's DNA was compared with a database of 48 American Indian populations, Willerslev and his group determined that he was "equally related" to all of them. Since American Indians also are closely related to east Asians, Willerslev and his team propose that sometime after 24,000 years ago, "peoples related to modern-day east Asians and western Eurasians" combined to become the ancestors of all American Indians.




KELLY GRAF

**Ivory artifacts from the Mal'ta site: plaque (A) and swan figurine (B) are from the burial; Venus figurine (C) was found not in the burial but in the same cultural layer.**

## From Russia with Love

This scenario would provide a simple explanation for two perplexing mysteries of American archaeology. First, why do many of the earliest American human skeletal remains, such as Kennewick Man, exhibit cranial characteristics that appear more Eurasian than east Asian? And second, why do some contemporary and even ancient American Indians belong to the X mitochondrial haplogroup, which is common in western Eurasia but not in east Asia? Dennis Stanford and Bruce Bradley use both these facts to support their Solutrean theory, which proposes that Upper Paleolithic people of the Solutrean culture from France and Spain crossed the Atlantic Ocean to become the first Americans. These first immigrants from Iberia, Stanford and Bradley suggest, mixed with a later migration from east Asia, became the ancestors of modern Native Americans.

Graf argues that the Mal'ta boy's DNA shows that the western Eurasian aspects of the earliest Americans have "deeper roots" and that those roots lie in Siberia, not Iberia: "It shows he had close genetic ties to today's Native Americans and some western Eurasians, specifically some groups living in central Asia, South Asia, and Europe. Also, he shared close genetic ties with other Ice Age western Eurasians living in European Russia, Czech Republic, and even Germany. We think these Ice Age people were quite mobile and capable of maintaining a far-reaching gene pool that extended from central Siberia all the way west to central Europe." Willerslev puts it more bluntly in an interview with *Nature*: "At some point in the past, a branch of east Asians and a branch of western Eurasians met each other and had sex a lot."

Where and when did this happen? In a *Nature* podcast on 21 November, Willerslev says that "it could have happened in the Old World somewhere in Siberia obviously, but in principle it could also have happened in the New World. So the . . . most direct way at least to address this question would be to genome sequence some of the early skeletons from the Americas, because if that turns out to already

have the admixture of the east Asian and the Mal'ta, we will know it happened before then, right?"

As for when, Graf points out that although the team's data "cannot speak directly to [the timing of the first entry into the Americas], they do indicate Native American ancestors could have been in Beringia—extreme northeastern Russia and Alaska—anytime after 24,000 years ago and therefore could have colonized Alaska and the Americas much earlier than 14,500 years ago, the age suggested by the archaeological record. What we need to do is continue searching for earlier sites and additional clues to piece together this very big puzzle." MT

*–Brad Lepper*

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## Footprints of the Pampas

*continued from page 5*

you can see different layers erode. These conditions are peculiar to this part of the Argentine coast. In Patagonia you have very tall cliffs and no Holocene layers. Maybe there are pockets here and there, but they're rare. In the tidal zone in this area of the coast, there are several footprints and different layers [Pleistocene and Holocene]."

The layers at Monte Hermoso 1 are extremely silky clay, ideal conditions for preserving footprints. The mantle that covers the footprints is a gentle shield, and the ocean produces such smooth erosion that the layers effectively constitute a timeline. According to Politis, "Preservation is very, very good in Monte Hermoso and La Olla. There are marshes and lagoons close to the sea and estuarine environments between the dunes."

TERESA MANERA

**Pleistocene deer jaw, Playa del Barco site.**

### The memory of Darwin is very much alive

The year 2009 marked the 200th anniversary of Charles Darwin's birth and the 150th anniversary of the publication of *The Origin of Species.* Manera was among many scientists who noted that Darwin spent several months along the Argentine coast area during 1832 and 1833 while on board *Beagle,* and his discovery of fossils at Monte Hermoso and Punta Alta—sites near Manera's home—was essential in developing his theory of evolution. Teresa Manera, Gustavo Politis, Cristina Bayón, and their colleagues hope to make a permanent record of the tracks before they are lost forever. MT

*–Katy Dycus*

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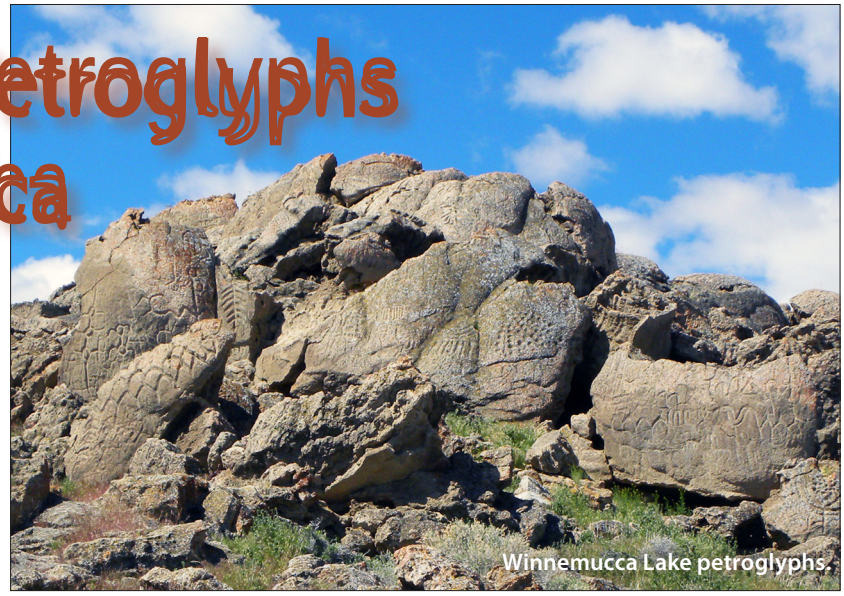
# Oldest Dated Petroglyphs in North America


Winnemucca Lake petroglyphs.
LARRY BENSON


EUGENE HATTORI


EUGENE HATTORI

**AS FAR BACK AS THE 1950S** archaeologists knew of the fabulously large and deeply incised petroglyphs in the Winnemucca Lake basin in western Nevada. Now dried up, Winnemucca Lake, along with present-day Pyramid Lake, was part of ancient pluvial Lake Lahontan. The antiquity of the site is apparent and the unusual petroglyphs were long assumed to be quite old, but it wasn't until a revisit to the site by geochemist Larry Benson, of the U.S. Geological Survey and Adjunct Curator of Anthropology at the University of Colorado Natural History Museum, and others that its age was scientifically validated: at least 10,300 CALYBP and possibly as old as 14,400 CALYBP. Regional archaeological evidence supports both date ranges.

Quite similar petroglyphs at Long Lake, Oregon, about 500 miles away, previously held the record for the oldest dated petroglyphs in North America at 7300 CALYBP. This episode confirms that methodologies are constantly improving. Interdisciplinary assays of prehistoric sites are becoming more frequent, and known archaeological sites are getting a second look from scientists with new knowledge and better tools in their kits. The successful revisit to Winnemucca basin underscores the rewards that lie ahead.

## Not your typical artist's studio

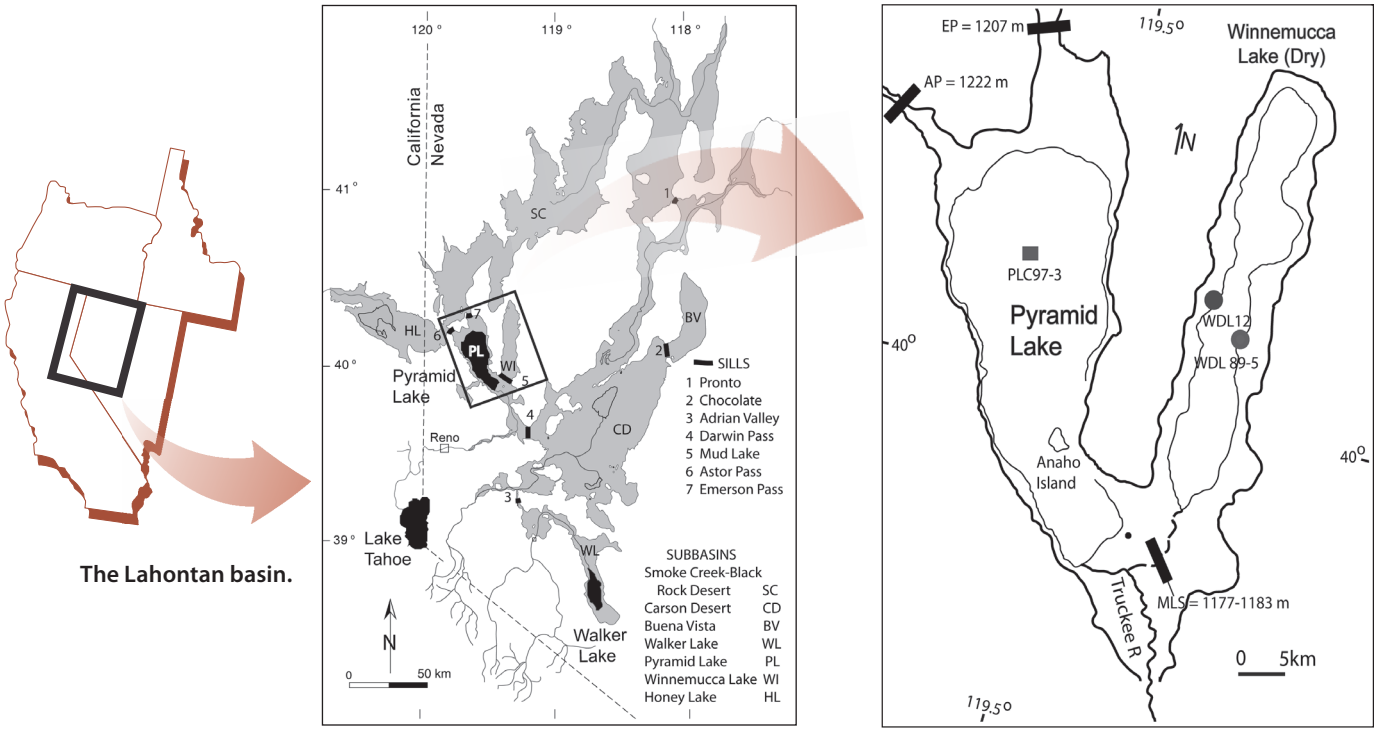
The petroglyphs are carved into a calcite tufa mound located on the western side of the now dry Winnemucca Lake basin, which lies on Pyramid Lake Paiute land. (To enter the site you need permission from the Tribal Council.) Although some panels face north, the primary exposure for the petroglyphs is to the east. Their style can be described as "Pit & Groove," a term coined in the 1960s to describe the deeply picked lines and cupules of Great Basin petroglyphs, which, based on their pronounced patination, have long been considered older than other petroglyphs.

The symbols on the Winnemucca Lake petroglyphs are large, deeply incised and densely grouped linear, curved, and circular geometric designs. The vertical faces of the mounds are covered in symmetrical groupings of cupules, which Eugene Hattori, curator of Anthropology at Nevada State Museum, describes as "little

mortar holes." Cupules are a distinctive design element found elsewhere in the Great Basin, in California, and on the Columbia Plateau, as are stacked chevrons, sometimes bisected, that resemble pine trees or fish skeletons. There are no carvings depicting humans or animals or handprints, but that only adds to the mystery of the meaning of these images.

Dr. Hattori's curiosity about the odd symbols was first piqued when he was still a graduate student. "I got to visit the site in the mid-1970s," he recalls, "and I was most impressed with how different these petroglyphs appeared from other petroglyphs and pictographs I had visited up to that point. The elements were very large, and they completely covered the tufa mounds. I also remember seeing the chevron designs and the large concentric circles."

ist Benson, geochronologist John Southon of the University of California–Irvine, and Ben Aleck (a Native American observer who was present during the site visit to ensure that samples were taken in accordance with an agreement struck with the Tribal Council), published their findings in the December 2013 issue of *Journal of Archaeological Science*. One e-mail suggests a "giant fish complete with scales going around the rock and ending in a head," another reports "a snake." Because tufa mounds are relatively fragile and collapse over time, one observant reader suggests that an ancient statue of a reptilian bird could be perceived if the boulders were restored to a vertical position. Hattori, unconvinced, says the comments are more creative than objective. "I'm more cut and dried," he confesses. "Most rock-art researchers are more imaginative than I am." Hattori




The Lahontan basin.

## Reading meaning into ancient carvings

Theories about the meaning of the petroglyphs abound. "Some people think shamans dreamed these things up," says Dr. Benson, and others think "they are just things that reside in our subconscious." Benson doesn't believe that design similarities in rock art at various times and places necessarily point to a common origin. "It's not like they have been carried from one place to another by people on the move," he explains. "The same symbols may appear somewhere else like Africa, but I'm no expert on that." Clearly he isn't interested in getting in on the controversy of either origin or meaning. For him, it's sufficient that "the designs, whatever they mean, are really cool."

Hattori, on the other hand, whose feet are planted firmly on the ground, still can't help wondering, "Well, what are they representing? Is that a giant conifer or is it a fish skeleton?" He has received a lot of advice since he, together with geochem- says he outlined images of the different designs in red for the project, but was cautious for fear that his own bias might subvert the intent of the original creator of the petroglyphs, "It isn't as if you are just following the lines," he explains. "There's a lot of interpolation." Some lines are obvious, but sometimes you have to ask yourself, " 'Well, was this a line?' And that happens more often than not, especially if they are really jammed full of design elements."

Connick and Connick ("Suggested Readings") liken the designs on the Winnemucca Lake petroglyphs to symbols used by ethnographic cultures in the Southwest and Southern California to represent such meteorological events as lightning and clouds. Aleck notes similarities between the Winnemucca Lake petroglyphs and traditional Paiute design motifs used in beadwork and basketry designs. Beyond these observations, the exact nature of the designs and their origin are unclear. Because the aim of the investigation was to date the carvings,

the team didn't attempt to explore the origin or interpretation of the designs.

## History of Winnemucca Lake

It was thought the Winnemucca Lake petroglyphs had no more to teach researchers, Hattori recalls. Then several years ago he and Benson took Southwestern archaeologists to see the beautiful oversized petroglyphs. Serendipitously Benson noticed that the petroglyphs bore a coating of calcium carbonate along the lower portion of the panel. Being a geochemist with a specialty in paleoclimatology and ancient lakes, he saw a solution to the problem of dating: "If we radiocarbon dated the tufa mound as well as the thin layer of calcium carbonate coating the lower portion, we could bracket a time period in which the petroglyphs were created." Study coauthor Southon radiocarbon dated the mound in his lab to a calibrated date of 14,800 CALYBP and the thin coating to 10,500 CALYBP, meaning the petroglyphs were carved sometime between these two dates. Benson's intimate knowledge of the Lahontan Basin was key in moving forward. "The petroglyphs are at an elevation of 1206 meters," he reasoned. "The lake overflows at 1207 meters. By knowing when the lake was spilling between 14,800 and 10,500 years ago, we could further narrow down the time frame." The key to his logic is that the mound was submerged and inaccessible for carving when the lake was spilling.

RORY GAUTHIER

**Benson *(left)* and Hattori near the entrance of Hidden Cave in the Carson Desert, northeast of Fallon, Nevada.**

Benson appeared before the Pyramid Lake Paiute Tribal Council to explain his research design. It can be difficult to get permission to do geochemical sampling and testing on tribal lands. The task at hand was to convince the council that the information gained from their proposed study was as much their history as anyone's—some would say more—and Benson hoped that patience and persistence would pay. An agreement with clearly outlined conditions was finally reached between the researchers (Benson as a research associate of the University of Colorado) and the Tribal Council, who authorized collecting and dating tufa samples, and work on the investigation was ready to begin.

## Geochemistry at work

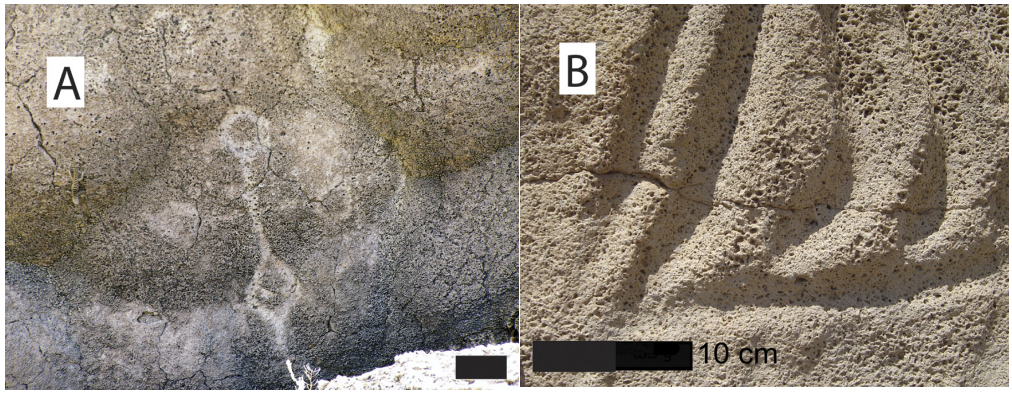
When Winnemucca Lake wasn't spilling over, calcium and carbonate ions would combine and produce the chalky mineral, calcium carbonate. Just as salt doesn't evaporate from a basin of saltwater, calcium carbonate would become concentrated if the only exit was evaporation. In the closed lake, calcium carbonate eventually reached saturation level and precipitated, forming tufa deposits like the distinctive mound that gives Pyramid Lake its name. When the lake spilled at the place known today as Emerson Pass, however, Benson describes it as "almost like a wide spot in the river. The ions don't stay in the overflowing lake very long, so the calcium and carbonate are more dilute. If there's no saturation it won't deposit calcium carbonate."

To determine when Winnemucca Lake underwent a spilling episode, the researchers analyzed a well-dated sediment core from nearby Pyramid Lake to measure the concentration of calcium carbonate at various depths; a lower concentration would point to a time when the lake was spilling. The results indicated the coalesced water body was below the 1207-m spill point between 14,800 and 13,200 CALYBP, and again from approximately 11,200 to 10,500 CALYBP. Benson says there is archaeological evidence for human occupation of the Great Basin during both time periods. "The younger time frame corresponds with Paleoindian or early Archaic materials

| Material | Age (RCYBP) | Age (CALYBP, 1σ) | Lab no. |
|---|---|---|---|
| Pyramid Lake Subbasin, Wizards Beach skeleton | 9515±155 | 10,652–11,094 | UCR3445 |
| | 9250±60 | 10,371–10,510 | CAMS–28214 |
| Pyramid Lake Subbasin, sagebrush fishing line | 9660±170 | 10,761–11,215 | GX–13744 |
| Winnemucca Lake Subbasin, Falcon Hill basketry | 9450±120 | 10,545–10,805 | UCLA675 |
| Carson Lake Subbasin, Spirit Cave Man hair | 9360±60 | 10,508–10,665 | CAMS–12353 |
| | 9350±70 | 10,494–10,676 | CAMS–12354 |
| | 9440±60 | 10,582–10,742 | UCR3261–2 |
| Carson Lake Subbasin, Spirit Cave Man bone | 9430±60 | 10,580–10,730 | CAMS–12352 |
| Carson Lake Subbasin, Spirit Cave female bone | 9300±70 | 10,392–10,587 | UCR3475 |
| Carson Lake Subbasin, Spirit Cave matting | 9410±60 | 10,570–10,713 | CAMS–24194 |
| | 9460±60 | 10,583–10,778 | CAMS–24197 |
| | 9430±70 | 10,566–10,756 | CAMS–24199 |
| Carson Lake Subbasin, Grimes Burial Cave diamond plaiting | 9470±60 | 10,645–10,785 | CAMS–3691 |

**C-14 and calibrated ages of Paleoindian materials from the Lahontan Basin (Hattori, 1982; Tuohy and Dansie 1997).**

of the Lahontan Basin," he explains. "The oldest widely accepted dated materials are from Paisley Cave number 5 in the northern Great Basin, where Dennis Jenkins found human coprolites dating to 14,400 CALYBP (**MT 25-4, 26-1,** "Paisley Caves"). Benson frankly confesses he has no way of knowing which date range applies to the petroglyphs at Winnemucca Lake.




EUGENE HATTORI

**Winnemucca Lake petroglyph details.**

## Long Lake now holds second place

Regardless of whether it was the earlier or the later date range, the Winnemucca Lake site is now home to the oldest dated petroglyphs in North America. The Long Lake site in southern Oregon, another Great Basin petroglyph site, previously held that title. It exhibits many of the same designs, which, though carved into very hard basalt, are just as deeply incised as those in the soft and porous tufa at Winnemucca. Partial burial in primary ash fall from Mount Mazama dates the Long Lake carvings at before 7600 CALYBP, but how much earlier is unknown today. Because the Long Lake site lacks a maximum limiting age, Hattori cautions that the Long Lake petroglyphs may someday prove to be older than those from Winnemucca Lake. He hopes an interdisciplinary approach might go further in dating the Long Lake petroglyphs. "We didn't even think about dating these petroglyphs at Winnemucca until Larry Benson noticed the overlay of calcium carbonate," he tells us. "Archaeologists had been missing that for decades. So there is the potential in the future that different methodologies may allow us to date other petroglyphs in the desert West."

EUGENE HATTORI

**Winnemucca Lake petroglyphs displaying cupules.**

What's the likelihood that the Long Lake and Winnemucca Lake petroglyphs were made by the same people? "In my mind," says Hattori, "it is comparable to other cultural manifestations such as projectile points. You have similarities in styles in different, diverse, disparate areas. I couldn't say it is the same culture, but there are some connections between these groups in the Western Basin and the Northern Basin."

## Closing thoughts

Because of the way they are formed, tufa mounds are porous and don't hold up well under the stresses of nature. They have a weak, tubular internal structure through which water percolates up and deposits calcium carbonate. Algae that form on the outside of the mounds deposit their own layer of calcium carbonate and thereby gives the mound most of its structural strength. Nonetheless the mounds are vulnerable to weathering and physical abuse. Hattori identifies erosion and seismic activity as the principal agents that threaten the Winnemucca Lake basin petroglyphs. Though these petroglyphs have stood for thousands of years, they are continuously degraded.

This study was important, not only for the archaeological knowledge gained now, but also as a perfect example of the importance of interdisci-

plinary research and the importance of reexamining previously reported sites. Hattori points out that "archaeologists have known about this site for over half a century. Its potential to yield an age was not realized until a researcher with his principal expertise outside of archaeology visited the site."

Benson announces proudly, "We have gotten the oldest dates on petroglyphs in North America." And though he's understandably gratified by this accomplishment, he doffs his cap to ancient man who is often portrayed in popular media as ignorant and savage. In Benson's view, they command enormous respect: "Clovis points are some of the most beautiful points ever produced, Spirit Cave Man was wrapped in a hand-loomed cloth, and these petroglyphs in the West are impressive—deeply incised and sometimes meters across. And all these things are incredibly beautiful." For Benson, all the evidence of the nature of prehistoric man in North America displays a level of technology and expertise that indicates people haven't gotten smarter or more artistic over the millennia. Benson believes that "we've always had the ability."

*–Dale Graham*

Winnemucca Lake petroglyphs displaying deeply picked lines.

LARRY BENSON

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## Suggested Readings

Benson, L. V., E. M. Hattori, J. Southon, and B. Aleck 2013 Dating North America's oldest petroglyphs, Winnemucca Lake subbasin, Nevada. *Journal of Archaeological Science,* 40:12.

Cannon, W., and M. J. Ricks 1986 The Lake County rock art inventory: Implications for prehistoric settlement and land use patterns. In *Contributions to the Archaeology of Oregon* 1983–86, K. M. Ames, ed., vol. 3, pp. 1–23. Association of Oregon Archaeologists Occasional Papers.

Cannon, W. J. and M. Ricks 2008 Ethnobotanical Clues to Rock Art Placement. Paper presented at the 31st Great Basin Anthropological Conference, Portland, Oregon.

Connick, R.E., and F. Connick, F. 1992 The hitherto unrecognized importance of Nevada site 26Wa3329: A monumental site with southwestern connections. In *Rock Art Papers,* K. Hedges, ed., San Diego Museum Papers, vol. 28(9), pp. 73–99.

Heizer, R. F., and M. A. Baumhoff 1962 *Prehistoric Rock Art of Nevada and Eastern California.* University of California Press, Berkeley and Los Angeles.

For readers with an interest in the carbonate deposits of the area (one into which the petroglyphs have been carved) Benson recommends they go to the Pyramid Lake Paiute site (http://plpt.nsn.us/) and click on the "Geology" tab to find a USGS circular that he publishes that illustrates the types of carbonate deposits found in the Lahontan Basin.