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The not-so-ancient extinction of a relict mammoth population

THOUSANDS OF YEARS AGO our planet, gripped in the last of a series of ice ages, began to warm. Water bound up in glaciers was released, raising the sea level and submerging great portions of continental margins. The Bering Land Bridge, the isthmus that connected Asia and North America, was drowned until only a few outcrops protruded above the surface. On at least two of these islands, dotted with volcanic cinder cones, survived the last remnants of a herd of mammoth (*Mammuthus primigenius*), cut off from their mainland relatives. Mam-

moth populations on the now separated American and Asian mainlands dwindled to extinction 14,000–10,500 years ago, with the bulk of the population vanishing 13,200 years ago, but the Ice Age giants persisted on these islands, relict populations shielded by their isolation.

On Wrangel Island, north of Siberia, the latest mammoth appearance date has been placed at 4,020 years ago. That's 6,000 years after the mainland extinction, within the realm of ancient history and civilizations. Wrangel Island mammoths may have had to contend with humans,

INSIDE

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Previously unnoticed engravings on lithic artifacts at the Gault site get special attention, thanks to alert analysts and sophisticated photo enhancing.

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Initially attracted by stunning rock art at hundreds of sites, Niède Guidon now heads an international team of scientists who are confident they've found human presence at least 20,000 years ago. Part 1 of our series.

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Evidence that horse and camel were prey species for hunters at Wally's Beach was news. Rigorous radiocarbon dating now finds that butchered remains antedate Clovis by 300 years.

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The SAA Award for Excellence in Latin America and Caribbean Archaeology presented to Luis Borrero crowns years of praise from students and colleagues.

for artifacts dating to this period have been found on the island. South of mainland Alaska, however, on the

much smaller island of St. Paul (110 km², compared with 7,600 km² for Wrangel), the relict mammoth population suffered no human interference because people didn't set up shop on the island until the arrival of Russian whalers in 1787. Tiny, and 450 km distant from Alaska and the Aleutians, St. Paul knows even today what isolation really means. It became an island 14,700–13,500 years ago, and literally lost ground at a speedy pace until 9,000 years ago. Then the sea-level rise slowed, but nevertheless continued until 6,000 years ago. Although mammoths on St. Paul didn't survive as long as those on Wrangel, they persisted until 5,600 years ago, give or take a century.

That first step into the pit was a doozy

Long-standing knowledge of mammoth remains on St. Paul was confirmed when a pair of hunters almost stumbled into a pit cave. Though the hunters avoided the 9-m drop into the pit, plenty of animals hadn't been so lucky. The floor of the cave was covered with the bones of animals, earning it the name Qagnax (Aleut for *bone*) Cave. When researchers visited the cave in the early 2000s they discovered the floor littered with the remains of assorted animals including arctic fox, caribou, polar bear, and, of course, mammoth.

Mammoth fossils had been found on the island as far back as the early to middle 1800s. Discovering the cave opened a new avenue of research because scientists now had remains they could accurately date. When radiocarbon dated, the St. Paul mammoths proved to be many millennia younger than those last known to have existed on the American and Asian mainlands (**MT 23-1**, "Pribilof Islands mammoths: The last to fall").

This relict mammoth population most likely owed their survival to isolation, which protected them from predators (including the human kind) and from the ecological helter-skelter caused by the changing climate. Caribou were introduced to the island by humans in 1911. Bones of polar bears found in the cave date to 4,000–4,600 years ago, suggesting they may have arrived on the island around this time, the Neoglacial

period, aboard pack ice. The St. Paul mammoths had to share their sanctuary only with the likes of foxes, rabbits, and birds. So in this lost and tranquil sanctuary, what caused their extinction on St. Paul?

Such agents as changing vegetation, increased snowpack, predation by humans or polar bears, and volcanic activity were suspect causes of St. Paul's mammoth extinction, but with-

out proof they were only possibilities. The island was a test case, a chance to understand not only the timing and cause of mammoth extinction in this micro-environment, but also the effects of the extinction. For such a cold case (just in case you thought we were above a cheesy joke, we're not), a team of scientists from diverse fields and institutions brought to bear their arsenals of expertise on the problem. The plan to



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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

attack the question on multiple fronts was conceived by Russell Graham of Pennsylvania State University, who headed the project. Had the investigation not been approached as an interdisciplinary study, the extinction would likely have remained a mystery. Which goes to prove that good science means team work.

What goes to the bottom of a lake stays at the bottom

To build a strong case, the scientists followed five different lines of evidence. First they had to obtain refined radiocarbon dates from the mammoth remains of Qagnax Cave. The other four proxies were sedimentary ancient DNA (sedaDNA) and three separate coprophilous fungal spores known to be associated with megafauna. The team intended to acquire the last four from core samples taken from Lake Hill (quirky topography accounts for its oxymoronic name: it's a lake on a hill).

In the 1960s Paul Colinvaux, whose 2016 obituary describes him as "among the last generation of 'explorer' scientists," took core samples from Lake Hill. Colinvaux was the first to publish a pollen diagram from Beringia, which mapped the changing climate that contributed to the demise of so many species. Graham and his colleagues decided their answers might also be found beneath the lake, but new core samples would first have to be taken. From these samples the team hoped to acquire a range of data to help them fine-tune the timing of St. Paul's mammoth extinction. A more accurate date of this event might also answer ecologic questions relating to the extinction.

The expedition to take core samples from Lake Hill took place in spring 2013. Even in spring the work of driving pipe into the muddy bottom of the lake was complicated by formidable weather, freezing water, de-icing tools with a blow torch, and taking care to prevent cores retrieved from the bottom of the lake from freezing. Great care was taken to ship the numerous samples of ancient mud, a silent record, back to the continental United States, where they were carefully sliced into thin sections and divvied among the scientists, who took them back to their respective labs across the country.

Hunting mammoth in the lab—leave your spears at the door

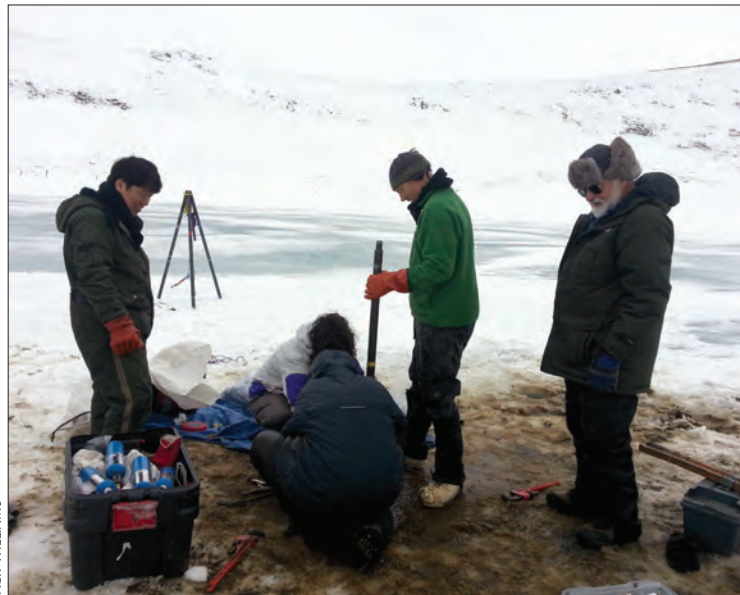
In their labs, the scientists proceeded with their specialized analyses. All studies were independent, with a common mission: to find mammoth, or some indication of when and why they became extinct.

The first task was to obtain new radiocarbon dates for St. Paul mammoth remains by measuring the stable isotopic composition of collagen extracts. The youngest of 14 samples registered a calibrated radiocarbon date of 5,585–5,330 years ago, which is 900 years younger than the previous date for St. Paul mammoths.

Four experiments analyzed the core samples taken from the lake. The samples were first examined for mammoth sedaDNA, which showed that mammoth were present in a

big way . . . well, at least as big as sedimentary ancient DNA can be. Mammoth sedaDNA was found in every sample from the oldest ($10,850 \pm 150$ CALYBP) until 5650 ± 80 CALYBP. But in all samples dating later than 5650 ± 80 CALYBP, no trace was found. And no mammoth sedaDNA means no mammoths.

The other three analyses tested for the presence of three types of coprophilous fungal spores: *Sordaria*, *Sporormiella*, and *Podospora*. These are usually associated with large animals, and on St. Paul, at the time leading up to the extinction, there were mammoths and no runner up. The spore count for *Sordaria* and *Sporormiella* dropped during the period of 9,000–5,650 years ago, which suggests mammoth population decline. *Sordaria* disappears from the core records around 5650 ± 80 CALYBP, exactly the same date as the last appearance of mammoth



JACK WILLIAMS

Coring Lake Hill lake: (left–right) Kyungcheol Choy, University of Alaska Fairbanks; Soumaya Belmecheri (kneeling facing camera), Pennsylvania State University; Nancy Bigelow (kneeling back to camera), UAF; Matthew Wooller, UAF; Russ Graham, PSU. The ridge in the background is the edge of the caldera.

sedaDNA. *Sporormiella* likewise vanished at the same time, only to reappear 1890 ± 50 years ago, which coincides with the 1911 introduction of caribou.

Podospora, the least numerous spores in the lake core samples, disappeared sooner, around 7020 ± 170 years ago. The time ranges of all five analyses—mammoth remains, sedaDNA, *Sordaria*, *Sporormiella*, and *Podospora*—overlap nicely and

point to 5600 ± 100 CALYBP as the time of the demise of St. Paul mammoths. The remarkable agreement of these independent tests makes this study one of the most precise timings of a prehistoric extinction to date.

So now we have our date. What was happening on St. Paul island 5,600 years ago?

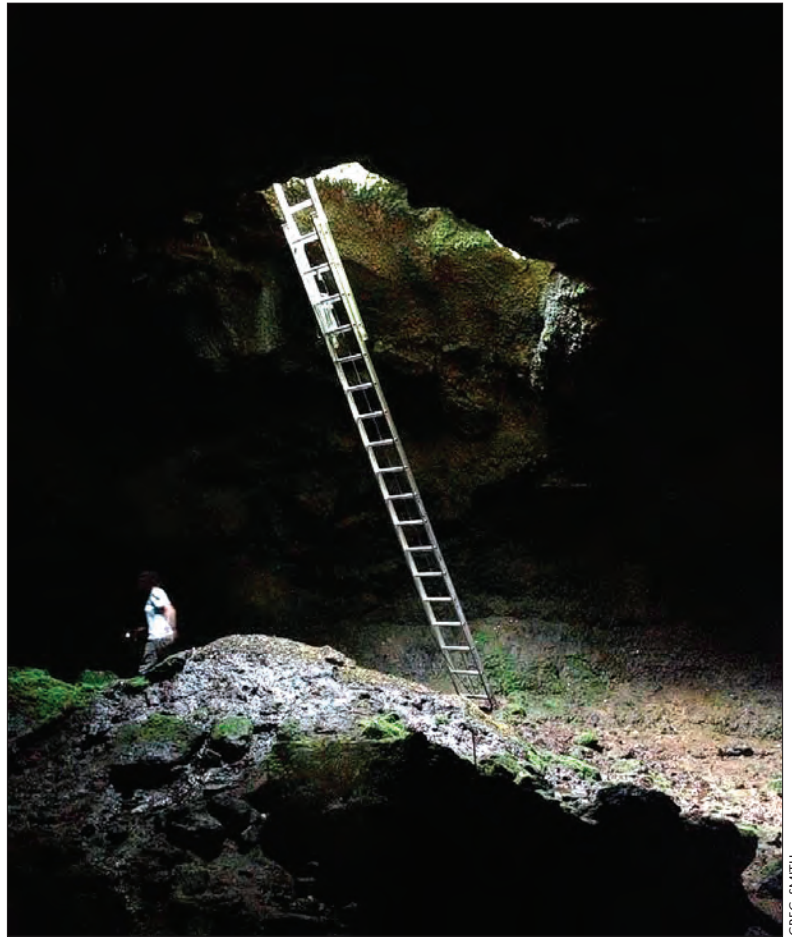
The usual and some unusual suspects

As work went on, possible extinction drivers were eliminated one by one. Changing vegetation was crossed off the list because all vegetation appears to have remained stable, at least until after the extinction. The snowpack theory also flew out the window: an increase in stable oxygen-isotope values contradicts the premise of a dense blanket of snow. Predation by humans was never a real contender in this case, since there's no evidence that the island hosted human inhabitants until the end of the 19th century. Likewise, polar bears didn't appear until long after the mammoths were gone, according to radiocarbon dates of polar bear remains in Qagnax Cave. Lastly, volcanic activity was crossed off the list. Telltale signs would have been found in the lake cores around the time of extinction, but none were found.

Reconstructing past environments

Data from the core samples indicate that the water of the lake became shallower, murkier, and less drinkable between 7,850 and 5,600 years ago. At this time an

The entrance to Qagnax cave and the debris cone below it.



GREG SMITH

increase in the numbers of diatoms (the siliceous skeletons of algae) and cladocerans (think water fleas) that are tolerant to variations in water salinity was observed in the core samples. Coincidentally, organisms less tolerant of salinity decreased.

Lake shallowing between 8,500 and 5,300 years ago is shown by an increase in stable oxygen-isotope values, which points to loss of water due to evaporation. Evaporation increased sharply after 5,600 years ago. Drier soils and decreased rainfall between 9,500 and 5,500 years ago are also indicated by an increase in stable nitrogen-isotope values in mammoth remains. Magnetic susceptibility drops suddenly at 5650 ± 80 CALYBP (exactly coinciding with the disappearance of

perhaps the result of decreased erosion after the mammoth extinction.

A sanctuary turned uninhabitable

Collectively these clues point to evaporation rates on the rise in a dwindling lake with increasingly cloudy water. It's ironic that after water had been consuming St. Paul Island for millennia as sea levels rose, there came a time when there wasn't enough drinking water on the island to sustain mammoth inhabitants.

The extinction event on St. Paul is one of a number of known instances where species on an island perished in time of drought when freshwater lakes became increasingly turbid and brackish. Enormous mammoths were especially susceptible to water deprivation. An elephant requires 70 to 200 liters of

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Landscape and vegetation of St. Paul Island. The doppler-radar tower (distant center) marks the rim of Lake Hill lake. Qagnax Cave lies in the ridge to the left.



LEE NEWSOM

sedDNA and *Sordaria* from the record), which suggests that less terrestrial sediment (dirt) was making its way into the lake,

IMAGINE you're in the middle of excavating a prehistoric site in North America and happen across a stone with a couple of parallel scratch marks on it. You take a closer look, but at the moment, with dirt on the stone and sunlight in your eyes, it's hard to tell what caused the scratches. You drop it into a bag with other artifacts you've found, intending to take a better look back in the lab. But as you continue your work, your mind keeps going back to that stone. Prehistoric art objects have never been uncovered at this site, but those scratches seemed so straight and deliberate. Do you assume those parallel lines appeared like that by chance, or do you start to wonder if this is the first prehistoric art object found at the site?

In 2015, Ashley Lemke, Clark Wernecke, and Mike Collins published a paper in *American Antiquity*, "Early art in North America: Clovis and Later Paleoindian incised artifacts from the Gault site, Texas (41BL323)," which voices their conviction that having an open mind to the possibility of finding early art during excavations offers great promise of discovering and identifying art objects. In their paper they argue that the "expectation to find such artifacts plays a principal role in their identification." In other words, if you assume you won't find an art object at your site just because you've never found one in the past, you risk the chance of failing to recognize an art object. A closed mind, they warn, can lead to losing valuable specimens. The authors put their doctrine into action when they created a systematic procedure for identifying art objects during their excavations at the Gault site.

Keeping an open mind

Prior to excavating at the Gault site in central Texas (MT20-1, -2, "Assault on Gault"), the authors knew that incised limestone tablets had been found in

1990 associated with a Clovis projectile point. At that time the landowners offered access to collectors as pay-to-dig land, and it was a collector who found these tablets. After they were

brought to the attention of Collins and his colleague Thomas Hester, a test excavation was completed in this same area, which confirmed the presence of more incised stones alongside Clovis artifacts. Wernecke explains that "we had always known that incised stones were found at Gault (it wasn't a surprise) because of A. T. Jackson's 1938 'Picture Writing of the Texas Indians,' in which he depicted a stone from Gault found by A. M. Wilson. The surprise wasn't the presence of stones at Gault but the fact that we had some in Paleoindian-age strata, which had never been found before in Texas."

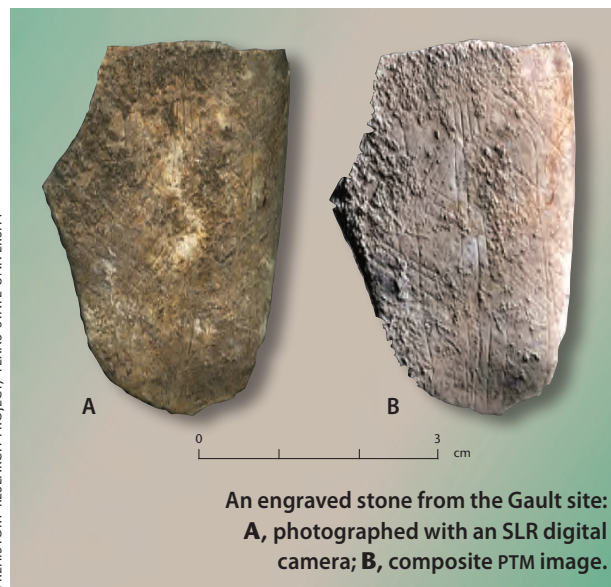
As a result of these findings, a protocol for identifying portable art was put into service during their most recent excavation at Gault. The first step was to ensure that all excavators were receptive to the possibility that they might find incised objects. They were in-

structed to study every artifact for potential engraved marks. An artifact flagged as potentially engraved was individually bagged and its exact provenience recorded. It was then sent to be inspected in the lab without being washed.

Artifacts more difficult to analyze were inspected microscopically at low and high magnification to detect unidirectional scoring, patterns, and any fragments left behind by an engraving tool. If evidence was found that the specimen had been culturally modified, it was then photographed with Polynomial Texture Mapping (PTM). The first set of artifacts that used the PTM technology was sent to Tom Malzbender at HP Labs in Palo Alto; others were photographed at Mercyhurst College in Erie, Pennsylvania. In this process, numerous digital photographs are taken of the artifact with varying lighting conditions. A strobe of light flashes at a different position with each photograph. All photos are then merged into a composite image made up of

To see, or not to see, that is the question

PALEOAMERICAN ART OBJECTS



Incised chert flake found at the Folsom level of the Gault site.

texture pixels (texels). This file can then be manipulated to enhance specific parts of the image for better viewing. "PTM technology," according to Wernecke, "is not so much for identification as it is for visualization of entire patterns." If PTM technology isn't available for analysis, Lemke and Wernecke tell us that incised marks can still be viewed on a basic level using raking natural light and either a low- or high-power microscope.

Using this protocol, the Gault team was able to identify at the time of publication at least 11 incised stones and one engraved bone, all dated as Paleoindian. The incised stones are either chert or limestone, and all but two date to the Clovis period. Most of the incised stones that date to the

Lemke preparing to photograph a unit under excavation at the Gault site. Now an Assistant Professor of Anthropology at the University of Texas at Arlington, her current research focuses on underwater prehistoric sites, as well as early hunter-gatherer sites in Texas and North America.



ASHLEY LEMKE

Clovis period are engraved with parallel lines; one bears a triangle intersected by one long line. The Clovis bone artifact is engraved with multiple parallel and perpendicular lines on both sides. Engravings on artifacts found by the Gault team consist chiefly of straight lines in rigid patterns, with no graceful curves or stylized designs like those seen on Paleoindian petroglyphs (MT 29-2, "Oldest dated petroglyphs in North America"). Since the paper was published, the team have completed their excavations and found at least eight more examples. Wernecke estimates more than 120 en-

Wernecke digs through sediments at the Gault site. Currently an Adjunct Faculty and project director for the Prehistory Research Project at Texas State University, as well as Executive Director of the Gault School of Archaeological Research, he is also involved in archaeological project management, early architecture, and archaeology of the Mexican-American War.



THE GAULT SCHOOL OF ARCHAEOLOGICAL RESEARCH

graved stones from varying time periods lie in their inventory from the larger Gault site. Any future specimens will have to be discovered in existing collections of roughly 2.6 million artifacts because no excavations are currently underway at the site.

Finding art across the continent

Lemke, Wernecke, and Collins credit their expectation of uncovering incised artifacts for the rich results they have enjoyed. Etchings in softer lithic material like limestone or sandstone may become worn over time and hard to recognize. Faint lines engraved on chert stones are likewise difficult to recognize

at first glance. But the authors agree that they were successful in recognizing markings because they were primed to be on the lookout for them. After finding so many artifacts that qualify as art, the Gault team suggests that these "engraved artifacts can help clarify how we describe Paleoindian 'art'" and encourage us

to "revise our expectations for what may be found in early archaeological contexts in North America."

They define art in a broad context as any etchings that could be interpreted as symbolic expression. They caution archaeologists, however, to walk a fine line in analyzing possible art objects. An artifact with incised lines could possibly be art, but the analyst must avoid trying to force the label "art" onto an object that happens to bear natural markings or may have

been a utilitarian tool. Archaeologists Lemke and Wernecke emphasize the need for a broad understanding of "art," and they warn that an artifact may register in more than one category, both art and utilitarian. In analyzing artifacts for possible examples of art, they "are not generally looking at single lines but use a combination of factors; cut morphology, orientation, patterning, and repetition to identify incised stones."

The Gault archaeologists argue that although a single site may produce only a few art objects, the possible yield from all North American Paleoindian sites begs that we rethink the notion that art objects are rare. Pursuing this idea, the team studied Paleoindian artifacts from other sites around the continent and compiled a list of arti-

facts that have already been identified as art as well as artifacts they believe could potentially be categorized as Paleoindian art objects from North America. These artifacts span various categories of art, including petroglyphs, painted bone, incised stones, engraved bone or ivory, and ornamentation. “I do believe that artistic objects, particularly in early time periods, and specifically in the Paleoindian sites from the Americas, have been traditionally overlooked,” says Lemke. “I think one of the archaeological record’s greatest strengths is its ability to surprise us—and show us things about the past we may not expect. It’s these surprises that give us something to explain as scientists—and we should embrace these challenges.”

Their *American Antiquity* paper sparked encouraging feedback for Lemke and Wernecke. One of their main goals for writing the paper, according to Lemke, was to bring awareness of these types of artistic objects to a larger audience, and she believes they’ve succeeded. Wernecke has also received a number of queries from collectors asking for him to look at their own artifacts. Others requested more information on PTM technology.

An early artifact revisited

An artifact that may be a Paleoindian art object is a stone recovered from Folsom levels at the Blackwater Draw site in eastern New Mexico, described in a 1972 paper by Hester James, Ernest Lundelius, Jr., and Roald Fryxell as an edge grinder or abrader. Reviewing the image of this artifact, Lemke and her colleagues recognized etched parallel and perpendicular lines similar to engravings they had found on some Gault artifacts. George Crawford, Director of the Blackwater Draw National Historic Landmark, agrees that of the entire collection housed with the site, only one stone shows possible evidence for intentional etching. The rest of the collection was closely reexamined in the late 1990s, and no other artifacts were re-classified as art. The Blackwater Draw team admits the possibility that more art-related artifacts might still lie buried at the site or in collections taken from the site through unauthorized removal or looting, but they’re confident that the current collection has been thoroughly scrutinized.

“It is my belief that the data must be collected first, then analyzed to the best of our abilities,” says Crawford of the excavations done at Blackwater Draw. “My extensive excavation experience has taught that preconceptions may skew empirical work (e.g., over-labeling function or temporal affiliation before form).” The Gault team’s recommended course of action differs from Crawford’s only slightly; recovering objects in situ, then following through with their step-by-step procedure for detecting



Collins (center) in the lab addresses students and other archaeologists about different lithic finds. He is a Research Professor of Anthropology at Texas State University in San Marcos, Texas. Specializing in the study of lithic technology, he has worked with prehistoric collections of North America, Central America, South America, the Near East, and southwestern Europe.

possible art (without trying to infer what these objects may have actually meant to their original owners) offers the best promise of enlarging our understanding of the social aspects of early hunter-gatherer cultures in North America. “The documentation of these objects,” they state in their paper, “allows for more detailed discussions of the creation, maintenance, and use of engraved art across the globe and enhances our understanding of shared patterns of symbolic behavior over vast amounts of time and space.”

Not as rare as it may seem?

Lemke, Wernecke, and Collins believe that their excavations at the Gault site and their recommended protocol for approaching Paleoindian excavations with an open mind will expand the collective database of Paleoindian art artifacts. North America lags behind the rest of the globe in numbers of recovered art objects

This incised chert flake found at the Dalton level of the Gault site is the most richly engraved artifact from the team’s excavation. Two groups of parallel lines intersect diagonally in a herringbone-like pattern.



from prehistoric cultures, owing to the meager numbers of art objects compared with other types of lithic or faunal artifacts. Wernecke finds it fascinating that “the geometrical patterns that we see on our stones are similar to stones found on every

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BRAZIL



LEAFING THROUGH PREHISTORY

Part 1: The trailblazer, *la grande dame*

THE CLOSING CEREMONY of the 2016 summer Olympic Games, hosted in Rio de Janeiro, paid tribute to the “art of the people,” alluding to the cave art of the first South Americans. The sequence began with the figure of a woman searching through the dark, cavernous expanse of the arena; as she explored its space, images of cave paintings flickered onto the arena floor. The phantasmagoria of lights glowing bright red and orange summoned images of the blazing sun striking the hills of Serra da Capivara, which lies in the southeast of Piauí State.

In the drama presented on the Olympic stage, the heroine represented estimable Niède Guidon, an extraordinary Brazilian pioneer who at 84 continues to work in the northern state of Piauí despite her unfortunate run-in with the Zika virus. Her home property lies in the Serra da Capivara National Park, an area where she first discovered the Serra da Capivara cave paintings and where she has identified more than 800 sites. Guidon dates human settlement in the region to 32,000 years ago, perhaps more than 40,000 years ago, tens of thousands of years older than conventional archaeological thinking would have it.

Beginning at Piauí

Situated in the northeast region of Brazil, Piauí State has the shortest Atlantic coastline (66 km) of any of the non-landlocked Brazilian states. In its southeast corner lies the Serra da Capivara National Park, a UNESCO World Heritage Site. In 1978, Guidon petitioned the Brazilian government to create the park and has since been responsible for the area’s preservation, development and management. The

national park boasts the highest concentration of rock art in the world, a distinction Guidon championed throughout the course of her archaeological career. And although Piauí is one of the poorest and most underdeveloped states in Brazil, it contains one of the richest prehistoric archaeological assemblages in the world. Pedra Furada, one of the most controversial sites in the Americas, threatens to rewrite the history of the first human colonization of the Americas. Not by coincidence, the site also divides archaeologists into two emotionally charged camps.

Reevaluating the paradigm

“Here in the forbidding thorn forests of the Piauí state, archaeologists say their discoveries are contributing to a pivotal reevaluation of the peopling of the Americas,” says *New York Times* Brazil bureau chief Simon Romero. What archaeologists have found in this remote site is evidence of human habitation going back tens of thousands of years, which upends previous theories of human migration across the Bering Strait, across North America, across the Amazon rain forest, and into this part of Brazil.

One model embedded in the minds of North American archaeologists, Clovis-First, maintains that humans first arrived in the Americas about 13,000 years ago after crossing the Bering Land Bridge linking Asia and Alaska and then rapidly spread southward. Named the Clovis culture after flint spearheads found in the 1930s at a site in Clovis, New Mexico, they occupied sites spanning the breadth of North America and from Canada to Mexico. Clovis archaeological sites, which date to the period 13,250–12,800 CALYBP, are considered in most publications



the first evidence of human occupation in the Americas.

In recent years, however, many archaeological assemblages that predate Clovis have been identified.

Geoarchaeologist Mike Waters, Director of the Center for the Study of the First Americans, and his team unearthed more than 15,000 stone artifacts at the Debra L. Friedkin site in Texas (**MT 27-2**, “Buttermilk Creek”). Using optically stimulated luminescence (OSL), which dates the deposition of sedimentary levels by calculating the time elapsed since the quartz grains within the sediments were last exposed to light (**MT 18-3**, “Luminescence dating of Quaternary sediments: New methods for dating archaeological components”), the researchers dated these artifacts to between 13,200 and 15,500 years old. The CSFA team found no evidence that the artifacts had migrated from younger sediment levels and thereby confirmed that the artifacts date to a time before Clovis people came on the scene. The discovery doesn’t suggest Clovis started earlier in North America than previously thought. Instead, it suggests that people using different tool types were present before Clovis appeared on the landscape and that this early technology could have evolved into the classic tools we see in Clovis assemblages.

Some critical members of the scientific community withhold accepting the Friedkin assemblage as pre-Clovis on the grounds that OSL dating technology lacks the bona fides of time-tested radiocarbon dating. At the Friedkin site, where sediments are starved of carbon-bearing materials, no other method of dating could be used. No such reservations can be brought to bear, however, on indisputable pre-Clovis artifacts found by fieldwork in 2012–2014 at the submerged Page-Ladson site in the Florida Panhandle (**MT 32-2**, “The Page-Ladson site”). Here underwater archaeologist Jessi Halligan of Florida State

University and co-PI Mike Waters recovered from a cushion of mastodon digesta a bifacial fragment of a blade that bears no evidence of Clovis toolmaking technology. Vegetal matter in the digesta returned a calibrated radiocarbon date of 14,550 CALYBP, fully 1,500 years before the birth of the Clovis culture.

Interestingly, the toolkit used by these pre-Clovis individuals is lighter than that used by Clovis, which suggests they were

Cave paintings from Boqueirão da Pedra Furada: (left) two anthropomorphs (human figures) face each other in a vignette that has become known as the “kiss scene”; (below) polychromatic (red, gray, yellow, and white) paintings represent anthropomorphs and zoomorphs (animal figures), including lizards, cervids, and felines.



BOTH: FUNDHAM (THE NATIONAL PARK OF SERRA DA CAPIVARA)

mobile hunter-gatherers moving across the landscape and left only small ephemeral campsites and workshops, unlike the larger campsites we find in Clovis and later cultures. “I think we’re moving toward understanding that the peopling of the Americas was not a singular event like the Clovis-First model would have us believe,” says Waters. Instead, it “was a process with people probably arriving at different times and taking different routes and potentially coming from different places.”

Non-Asian immigrants? Boat people?

Contrary to a fundamental precept of Clovis-First, Guidon contends that the First Americans probably weren’t all of Asian origin. One piece of evidence comes from David Reich’s genetics lab at Harvard. While analyzing the genomes from cultures in Central and South America, Pontus Skoglund, a researcher in Reich’s lab, noticed that the Surui and Karitiana people of the Amazon share with Aleutian Islanders and Athabascans a genetic affinity to indigenous groups in Australasia—Australians, New Guineans, and Andaman Islanders (**MT 32-1**, “Genetic clues answers fundamental questions about the peopling of the Americas”).

Guidon.

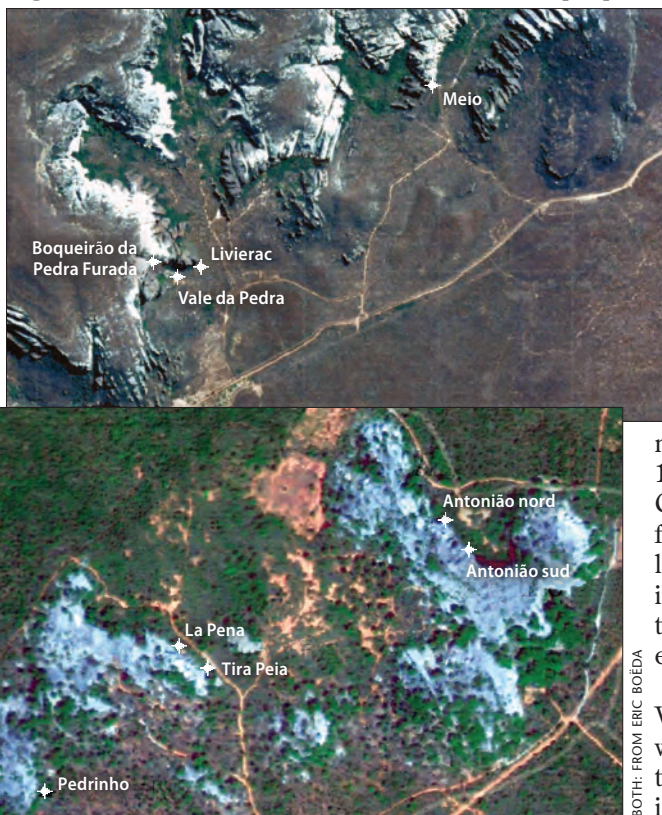


Supporting evidence comes from Walter Neves, an evolutionary anthropologist at the University of São Paulo, who reports that

an 11,000-year-old skull found in Brazil resembles aboriginal Australians more than Asians. (Gruhn cautions, however, against putting too much weight into craniometric data without a confirming genetic profile.)

A recent discovery likewise refutes the migration route of the First Americans proposed by the Clovis-First model. According to the model that dominated Peopling of the Americas thought for half a century, immigrants from Northern Asia via the Bering Land Bridge entered the lower regions of North America by way of the Ice-Free Corridor, a passage between the Cordilleran and Laurentide Ice Sheets. Before they separated, the consolidated glaciers barred overland travel from Beringia to North and South America. Research by paleogeneticist Eske Willerslev of the University of Copenhagen, however, disputes the time when the Ice-Free Corridor became a habitable passage for humans (MT 32-4, "Was the Ice-Free Corridor the route followed by the First Americans?"). To construct a picture of the environment as it emerged from the Ice Age, Willerslev's team analyzed environmental DNA (eDNA) in cores taken from beneath two lakes in what was the last stretch of the corridor to melt. The first plant life—thin grasses and sedges—appears 12,600 years ago. The region gradually became lush and

Aerial views of the sites of Serra da Capivara.



attracted mammals. Not until around 12,500 years ago did the corridor accumulate the resources needed to sustain hunter-gatherers on the 1,500-km journey. That's nearly 1,000 years after the formation of the Clovis culture, and even longer after other, pre-Clovis cultures settled the Americas.

The dates calculated by Willerslev rule out the corridor as a possible avenue of entry by Clovis people and earlier colonizers of the Americas. Instead, the first emigrants from Beringia were probably boat people who skirted the Pacific coast in search of a fruitful, less brutal environment. Thus has been reinvigorated the Coastal Migration model of the Peopling of the Americas, first introduced by Simon Fraser archaeologist Knut Fladmark in the mid 1970s and pursued in recent years by such notable anthropologists as Jon Erlandson of the University of Oregon (MT 26-4, "A story of ancient mariners"), Loren Davis of Oregon State University (MT 24-3, "Putting muscle into coastal-entry research"), Alan Bryan and Ruth Gruhn of the University of Alberta (MT 17-2, "The Baja connection"), and Jim Dixon of

the University of Colorado (MT 20-4, "Exploring the Northwest coast: E. James Dixon and the peopling of the New World").

The importance of Monte Verde

The Coastal Migration model garnered support from the ground-breaking findings at Monte Verde in southern Chile, the earliest site on the Pacific coast. The idea that people entered the Americas in watercraft and migrated south along the Pacific coast was supported by the presence of this early site in the southernmost portion of South America. At this site, structures, lithic artifacts, perishable materials, and many other artifacts show that people were occupying the site 14,500 years ago. The discoveries made at Monte Verde, the first to shatter the Clovis-First model so entrenched in the minds of North American archaeologists, offered an alternative view of human colonization.

From 1977 to 1985, Tom Dillehay of the University of Kentucky excavated at Monte Verde. Radiocarbon dates on water-saturated deposits, which account for the excellent preservation of organic remains, placed the level (designated MV-II) at 12,500 RCYBP (about 14,500 CALYBP). This date precedes Clovis sites in North America by a full millennium. Moreover, the site lies about 15,000 km from the Bering Strait, the place according to the traditional model where immigrants entered the Americas from Asia.

Artifacts identified at Monte Verde have raised questions of when and how people reached the tip of South America without leaving much other evidence in the New World. In "Monte Verde: Seaweed, Food, Medicine, and the Peopling of South America," Dillehay examines the remains of nine species of marine algae recovered from hearths and other features at Monte Verde II. These findings, which indicate that the occupants used seaweed from distant beaches and estuarine environments for food and medicine, corroborate Dillehay's contention that early settlement of South America was along the Pacific coast and that seaweeds were important to the diet and health of early humans in the Americas.

Pedra Furada

Although Monte Verde may be the earliest site on the Pacific coast, Pedra Furada is the earliest on the Atlantic, dated to more than 40,000 years ago. In 1963, while Guidon was still working for the Paulista Museum in São Paulo, a visitor to the exposition on rock art in Brazil (at that time only the sites in Minas Gerais had been discovered) showed her photos of paintings that he claimed existed in the south of the State of Piauí. "He gave me

40 Years, Pursuing Ancient Brazilians



Guidon and team excavating the Toca do Pinga da Escada (Drip of the Ladder) archaeological site, 1991.



Guidon's team excavating the Boqueirão Pedra Furada (Holed Stone) archaeological site, 1984.



Members of the first Franco-Brazilian archaeology project at Serra da Capivara in the 1970s.



Guidon and team excavating the Tenente Luiz (Lieutenant Luiz) archaeological site, 2003.



Boëda excavating at a site in Serra da Capivara.



Lahaye preparing the gamma spectrometer at the Vale da Pedra Furada site for in situ measurements needed for OSL dating, 2011.

ERIC BOËDA

ERIC BOËDA

UNLESS NOTED, ALL PHOTOS: FUMDHAM COLLECTION

the name of the town close to these sites,” Guidon recalls. “In December of that same year, I tried to drive to Piauí, but the rains had flooded a bridge over the São Francisco River, and I couldn’t pass.” In fact, when she started in the 1970s, the largest obstacle was a lack of roads to access the sites. Further hindrances were a lack of electricity and other modern conveniences.

In 1970, Guidon joined a French mission to the natives of Goiás and took that opportunity to visit the south of Piauí. Villagers of Várzea Grande, when asked about the paintings, guided her on a tour of five sites with abundant renderings of pictographs, which she photographed. In 1973 she received funding for a research mission from the French National Center for Scientific Research (*Le Centre National de la Recherche Scientifique*).

How is this for a nimble octogenarian! Guidon scaling a rocky outcrop in the Serra Branca near the Toca do Conflito (*Den of Conflict*) archaeological site.



COLLECTION FUMDHAM

Within a month she had discovered and photographed 50 sites with paintings. Her team also did ground surveys at some of the sites. Her initial efforts still bear fruit today: The permanent mission to Piauí, created by the French Ministry of Foreign Affairs, continues to pursue research in the region.


“Because of the large number of paintings at Pedra Furada,” Guidon explains, “we started excavations there that lasted 10 years.” When her team finally hit rock at a depth of 12 m, they had obtained samples of charcoal and heated quartzites whose dating suggests that humans may have arrived in the region more than 60,000 years ago. The diversity of the lithics industry, ceramics, burials, and other evidence of human occupation today still attract Brazilian and foreign researchers. Guidon rejoices that “every excavation brings new discoveries!”

An impressive legacy

Guidon says that what surprised her most during her 30 years of excavating at these sites has been the remarkably advanced technology evident in lithic and ceramic artifacts, and “the fact that we have proven that the rock art is as old as that of Europe, that it has several different perspectives and a wide variety of colors and subjects. Here, the ceramics industry also started to be practiced around the same time as in Africa and Europe.

That allows us to formulate the hypothesis that *Homo sapiens*, as a single species, has an identical genome regardless of where he settled in the world. Therefore, during his evolution and adaptation to the environment, he created the elements necessary for his survival. We cannot continue to claim that one technology was created in a certain region and then migrated to other areas from there.”

Although Guidon is now retired from active research, others continue her work. As scholars advance beyond Clovis-First, this long-impooverished region is now emerging as a flash point for research and discovery. FUMDHAM (the National Park of Serra da Capivara) now boasts a museum, laboratories, and a public university that trains young archaeologists, many of whom come from areas near the stunning park. Christelle Lahaye, Associate Professor in Archaeometry at Bordeaux Montaigne University and a key member of Guidon’s current research team, says that

if you “take a coffee with Guidon, you learn all about not only archaeology but the history of Brazil, her stay in France. All about life.” 

—Katy Dycus

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Suggested Readings

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Meltzer, D. J., J. M. Adovasio, and T. D. Dillehay 1994 On a Pleistocene human occupation at Pedra Furada, Brazil. *Antiquity*, pp. 695–714.

Website FUMDHAM (the National Park of Serra da Capivara): <http://www.fumdham.org.br/?lang=en>

Camels and Wild Horses of Canada

A Refined Chronology for Kills at Wally's Beach



Yesterday's Camel (*Camelops hesternus*)

UNTIL ABOUT 20 YEARS AGO, we had absolutely no idea whether the First Americans preyed on horses and camels. That may sound odd, since the bones of both have been found at many Paleoamerican campsites; but there was no “smoking gun” proving they actively hunted those species. That changed when dam repairs in the 1990s drastically lowered the level of a reservoir near Calgary, Canada, enabling the wind to carry away deposits that had sealed an ancient watering hole for 12,000–13,000 years. The erosion peeled back the pages of time to expose hundreds of preserved animal tracks—as well as the well-preserved bones of many extinct mammals, including seven horses and a camel that had clearly been hunted and butchered by humans.

To this day, Wally's Beach (DgPg-8) is still the only proof that Paleoamericans hunted horses and camels. And now that a series of carefully prepared radiocarbon ages has been performed on those bones, we know that those animals were killed 300 years before Clovis—adding yet another stone to the rising bulwark of evidence for a pre-Clovis occupation of the Americas.

They eat horses, don't they?

Horses and camels provide a significant amount of meat when slaughtered, making them well worth hunting—at least as much as bison, a well-known Paleoamerican food source. Although the meat of camel and horse may not be to everyone's taste, it's prized in some parts of the modern world. It seems some of the First Americans enjoyed this food source, too.

At the end of the Pleistocene, as the ice receded and disappeared, Wally's Beach was an island on the south side of the St. Mary's River. Today it lies near Cardston in southwest Alberta, normally inundated by the St. Mary's River Reservoir. Repairs made on the spillway and dam in the 1990s required the engineers to lower the reservoir by over 9 m, exposing fine-grained,

unvegetated sediments that composed the lake bottom. The wind immediately began removing thousands of years' worth of sediments, exposing the treasures entombed within. Local resident Shayne Tolman and his children soon discovered an area where up to 2 m of those sediments had gone with the wind, leaving behind a variety of interesting artifacts. Tolman reported their finds, and later investigations by archaeologist Brian Kooyman, geologist Leonard Hills, and geology grad student Paul McNeil of the University of Calgary, with Tolman's help, soon yielded much more: not just Early American artifacts, but intact trackways of mammoth, camel, horse, and other animals, and the remains of animals local or globally extinct for more than 10,000 RCYBP—including horse, bison, camel, muskox, and caribou.

Seven of the horses had clearly been butchered by human hands. Although the horse kills weren't directly dated, nearby animal bones yielded radiocarbon ages dating as far back as 11,000–11,350 RCYBP, suggesting a Clovis exploitation of the local game. Several Clovis points, found on the surface hundreds of meters away, seemed to clinch the Clovis conclusion.

The Clovis evidence was exciting, but the true value of Wally's Beach was that it provided the first indisputable evidence that Paleoamericans hunted horses for food. Later, close examination of other Wally's Beach remains added to the Paleoamerican diet another large animal genus: the camel, in the form of a single butchered skeleton. Its fate was made abundantly clear

not only by the presence of cutmarks on the bones, but also by the fact that the ribs had been deliberately severed from the vertebrae. Counting the Firelands Sloth from Ohio, an old find recently discovered to bear cutmarks of pre-Clovis butchering (MT 28-1, “Pre-Clovis butchered ground sloth in Ohio”), that brings to six the total genera of now-extinct megafauna proven



to have been hunted by the First Americans.

A second look

A multidisciplinary team of scientific big guns recently re-dated the Wally's Beach kills, for several rea-

Camel vertebrae and one of the ►
lithic tools in situ.

The remains of a horse, showing a ▼
cobble and utilized flake associated
with the find. The cobble may have
been a cache marker.

sons. First, the original dates weren't from the butchered horses themselves, but from the bones of bison, muskox, horse, and caribou from the same eolian deposits. Second, the material dated in the 1990s was unpurified bone collagen, the organic fraction of bone. CSFA Director Mike Waters was a member of the team that recently dated the kills. He emphasizes the importance of quality dating. "Looking at the original ages presented for the Wally's Beach site," he says, "I realized that none of the horse bones from the kill sites had been directly dated and that the dates presented were on unpurified collagen. As a consequence, there could be contaminants present. Thus, the ages initially presented were minimum ages; the bones could be that age or older. When I saw that, I thought those remains needed to be dated using proper techniques."

Brian Kooyman was equally concerned about the dates. "They had always seemed unexpected for Clovis, as the animals hunted were quite different: not mammoth and bison as usual in Clovis, but instead horse and camel. We had assumed it was most likely that they were very late or very early Clovis, or even pre-Clovis, and hence a transitional period into or out of the typical Clovis patterns. We also thought it was possible Wally's Beach represented a unique pattern in Clovis culture, something happening at the edge of Clovis distribution in different environmental and cultural circum-

Lithic artifacts associated with the horse kills: **A**, large biface; **B**, chopper; **C–E**, flake tools (the edge of **E** has been modified).



BRIAN KOOYMAN

stances. More precise dating seemed a good way to begin assessing these possibilities."

Kooyman, Waters, and geochronologist Tom Stafford then conducted a very careful round of new radiocarbon dating, in which they dated not only the eight clear kills but also the remains of a nearby muskox that may have died a natural death.

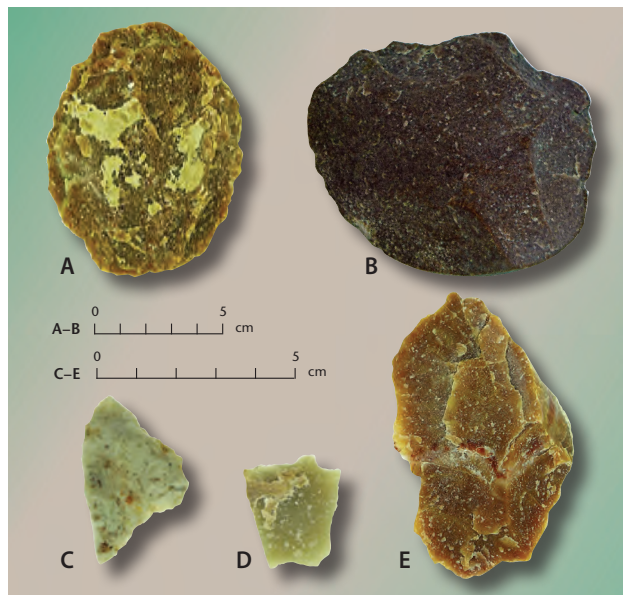
As Dr. Kooyman points out, "It is possible that the musk ox was also hunted, based on the finding of a flake tool near it. But overall the evidence for hunting is weak; if you look just at the evidence, it is more likely that it was not hunted." Ultimately, they were rewarded with a series of 27 radiocarbon ages, 23 of them tightly grouped, placing the ages of all 8 animal kills at about 11,445 ± 10 RCYBP, or

13,270–13,310 CALYBP—about 300 years before the accepted age range for Clovis, as established by Waters and Stafford in 2007 (**MT 22-3, -4**, "Clovis Dethroned: A New Perspective on the First Americans").

The new radiocarbon ages haven't changed their overall interpretation of what happened at Wally's Beach, but they obviously changed the significance of the site and pushed it further back in time. Kooyman suggests that "this is hunting of large game in its earlier development, before settling on a focus on mammoth and bison. It may represent more of a broad-spectrum hunting, employing game more opportunistically—although still, obviously, in a systematic and repeated pattern using a known ambush location." By opportunistically, he means "any good game in the area was taken. The high incidence of horse makes sense if they were such a common, perhaps the most abundant, game animal in the landscape."

One hunt, or several?

The tight grouping of dates brings up the intriguing possibility that the horses, at least,



were killed and processed during a single hunting episode. “They could have been, but that would be hard to say,” says Waters. “The dates are so tight, in terms of their overlap in age, that if you were so inclined, you could interpret this as a single hunting event—by which I mean the horses may have been killed on the same day, in the same week, month, or season. When the dates are calibrated, they give you a 40-year time window for the hunting event.” That’s tiny for radiocarbon dates that old. So many kills found in such a small area is rather dramatic, but then, it’s hard to tell how representative the sample we have is, given the vagaries of preservation. Other killed animals may have decomposed completely.

Kooyman is less sanguine about the possibility of a singular event. “Honestly, it’s hard to be certain one way or the other. The fact that the individual kill localities are well separated from each other suggests it’s more likely that this is a series of individual kills . . . multiple events seems most likely.”

The lithic technology from the kills is frustratingly non-definitive. It seems likely that the 29 lithic flakes, cores, core tools, and biface associated with the remains must have been used in the butchering, and that anything truly useful was taken along with the meat. All we have is a few leftovers, and sadly, the cutmarks on the bones are too short and shallow to make a convincing argument that they were made by any of the lithics found. One large stone found among the remains of one horse was probably an anchor stone for a cache, “perhaps holding down the skin laid over the bones and meat,” Kooyman theorizes.

Any other treasures out there?

Might Wally’s Beach hide other kills in its sandy deposits? It’s possible, though no definite kills have been identified yet. “Two other sets of faunal remains are suggestive, but not conclusive,” reports Kooyman. “[The aforementioned] group of muskox bones was recovered in the same area as the horses and camel, and a utilized flake was found within a meter of the remains.” But

the bones display no cutmarks; nor are they distributed in a pattern that indicates a human kill rather than the activity of scavengers or other carnivores, unlike the seven horses and the camel.

The other locale is a group of shed caribou antlers. “Caribou don’t shed left and right antlers at the same time,” Kooyman notes, “and since this grouping has both, it’s likely not just a natural shedding of antlers. This may be a cache of antlers left by people.” Both sets of remains are compelling, but First Americans archaeologists tend to be cautious by nature—and neither locale has offered up a smoking gun thus far.

One thing we do know is that even after more than 20 years, Wally’s Beach remains unique. No other undeniable horse or camel kills have been found anywhere else in the Americas, and not for lack of looking. “We know

Kooyman excavating the butchered camel.



LEN HILLS

of no other kill sites like Wally’s Beach, here or elsewhere,” Dr. Kooyman declares. “The coulee country around the area could certainly have provided other good kill locations, and there are other locations where rapid burial might have preserved such sites—but we know of none.”

Rereading the pages of history

Although the Wally’s Beach kills predate Clovis only by about 300 years, they are nonetheless pre-Clovis; and, as Kooyman points out, that makes Wally’s Beach significant, since we know so little about the pre-Clovis occupation of the Americas.

“The radiocarbon ages speak for themselves,” Waters agrees. He goes on to say that there are also important lessons to be learned about accurately and precisely dating such finds. It’s crucial when dating bone to date chemically pure samples. Collagen must be purified to remove all contaminants, and only amino acids derived from the bone should be dated. “Accurate and precise dating is fundamental to interpreting archaeological sites and building a solid empirical foundation to explain the peopling of the Americas. Without properly dating samples, erroneous ages will result and the importance of such sites as Wally’s Beach will be hidden. Accurate dating changed our understanding of this

Well-preserved mammoth trackway at Wally’s Beach, consisting of nine consecutive tracks.



BRIAN B. KOOYMAN

important site,” explains Waters. “I think this is one of the key takeaways from this site.”

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A MODEL OF EXCELLENCE IN LATIN AMERICAN ARCHAEOLOGY

Luis Borrero

Borrero in Death Valley, Nevada, 2013.

FABIANA MARTIN

THROUGH HIS CONTRIBUTIONS to Latin American archaeology, especially in the context of the peopling of South America, Luis Borrero has set a high standard for himself and fellow South American scientists. His unwavering focus on zooarchaeology and taphonomy has raised the bar in these disciplines. “The work of a quite famous late archaeologist, Lewis Binford, on the process of exploration-colonization was a big influence on me (as on most of the archaeologists of my generation),” Borrero says.

Born in the Patagonian city of Rio Gallegos and raised in Azul (Buenos Aires Province), Borrero completed his undergraduate studies in anthropology in 1978 and his Ph.D. in 1986 at the University of Buenos Aires, moving from student to professor at the university immediately upon receiving his degree. He has been there ever since.

“In a world full of people,” Borrero says, “I am fascinated by stories of entering empty lands like Australia or the Americas, even other planets. I read a lot of science fiction and find especially attractive stories of human survivors dealing with larger spaces and new social and subsistence resources.”

Debates on the peopling of South America

Borrero finds that debate about the peopling of America has experienced significant change in the last few years, owing in large measure to the increased reliance on sophisticated analytical techniques at the molecular level, more sharply focused fieldwork, and the gradual acceptance of human presence earlier than 14,000 calendar years ago. New site excavations foster new research problems, particularly in cases of ambiguous archaeological sites, which, alongside well-established claims for early human occupations in South America,

sometimes regrettably divert attention into needless disagreements.

Most archaeologists accept that ages obtained at the most secure South American sites represent minimal dates for when the continent was colonized. Borrero remarks that “since the Paleoamerican Odyssey conference in Santa Fe, New Mexico, in 2013, the discussion concerning the peopling of the Americas has changed direction. Beyond the classic discussion of how much time before Clovis is acceptable, we are more often discussing the specific adaptations of the early peoples.” Chronology, in Borrero’s opinion, is only one of many important variables to be considered in explaining the processes of exploration and colonization. The momentum of research today is toward developing more complex models and theories about the spread of Paleoamericans across South America. The classical model of the peopling of South America is straining to resist the offshoots of new theories about the first

colonizers of North America—notably a Solutrean migration (MT 17-1, “Immigrants from the *other* side?”) and a Pacific coastal route (MT 26-4, “A story of ancient mariners”). Even more exotic theories beg rethinking early models of the peopling of South America, such as independent colonization from Australia (MT 16-2, “The First Americans: Were they Australians?”), possible human origin from the Pampas, and south-to-north dispersal. Borrero finds these old theories, interesting in their time, now of value only for the history of research.

The chronology of the most discussed South American sites is less important to Borrero than the methods their occupants used to adapt to the region and to reshape the environment to support their subsistence strategy, as reflected in their tools. Of especial interest to today’s archaeologists are the systems Paleoamericans used to acquire and distribute raw materials.

South American sites yield scant evidence of megamammals, and toolkits from early sites are of generalized rather than specialized nature. Even when megamammal remains are found, as at Arroyo Seco 2, La Moderna, and Campo Laborde, what emerges from associated artifacts is a regional pattern of simple lithic technologies with minimal bifacial work. Borrero finds nothing wrong with comparing South American toolmaking with that of other continents, but he insists that at some point the local history of adaptations must be considered in isolation.

Investigating a unique prehistory

“Long-term continuity of a simple technology certainly needs to be explained,” Borrero emphasizes. “The evidence from archaeological cultures in east Asia is not relevant for South American industries because they explain nothing about their occurrence and persistence in Argentina, Brazil, or other southern sites.

Our evidence for the early peopling of Argentina is minimal; new evidence should be pursued. Archaeology is not in a position to ignore such evidence even when the context is not good.”

Borrero’s single-minded pursuit of unequivocal evidence has won him accolades from colleagues across the continent. “I was never officially one of Luis’s students,” says César Méndez Melgar of Chile. “However, for a long time I have felt like one. Having read his works in detail, I have come to consider him among the most insightful scholars I have been acquainted with. His perspective on the archaeological record is perhaps one of the most sound and solid and I must say I feel comfortable trying to understand the past as I think Luis Borrero does. He is also one of the most ethical professionals I have ever encountered in this line of work. He has systematically (and with an enormous judgment) acknowledged the work of students and highly renowned peers, alike.

“I remember once Luis participated in one of our field seasons in the area of Balmaceda, in central western Patagonia, and after several days of surveying enormous fields and having recorded nothing, he left us cheering and gave us hope; highlighting that negative evidence we recorded was as meaningful as any when we wanted to understand the differences in the regional distribution of the archaeological evidence.”

Tricky formation processes and taphonomy

Although Borrero concedes that most sites in South America were carefully excavated, he doesn’t exclude the possibility of misinterpreting evidence for human presence, particularly in identifying lithic tools. The perennial bugbear of archaeologists is distinguishing artifacts from geofacts. Some sites known for more than a decade have yielded artifact assemblages whose provenance is suspect. Ambiguous evidence is widespread in archaeological sites across



LUIS BORRERO

North and South America, but Borrero refuses to admit that as an excuse for abandoning further study. “Experimental and taphonomic work is required,” he tells us, “to construct adequate frameworks for separating tools from pseudo-tools and for distinguishing physical from behavioral associations.”

Such ground-breaking work has in fact produced exciting discoveries. Borrero points to high-altitude sites like Cuncaicha cave and Pucuncho lithic workshop in Peru (**MT 30-4, 31-1**, “Reaching new heights in the Peruvian Andes”) and the insightful application of predictive models, based on paleoecological data on the availability of water during the late Pleistocene, that led to site discoveries in northern Chile.

A test case: Ultima Esperanza, Chile

The dispersal of humans can be understood, Borrero explains, by studying biogeographical corridors and barriers. Although mapping and dating critical resources and archaeological remains are sometimes successful, quite often this approach is unworkable because most early South American cultures had low populations that left sparse evidence. The evidence for Ultima Esperanza, for example, is limited to two sites, Cueva del Medio and Cueva Lago Sofia, both located on the western fringe of southern Patagonia. Tools from these sites share a bifacial lithic technology with older sites in Fuego-Patagonia.

The geography of Fuego-Patagonia at the end of the Pleistocene differed dramatically from today. Tierra del Fuego was part of the continent during the Pleistocene, but it was severed by the Strait of Magellan, which was formed during the early Holocene. In the Southern Hemisphere the continental ice cap presented a formidable barrier, separating the eastern steppes from the southern archipelagos.

Borrero believes that the initial radiation of humans into the empty southern continent probably followed less resistant routes, perhaps by boat people that skirted the coast, and settlement took place at resource-rich locations. Standard radiocarbon dating indicates that the western fringe of Patagonia was most likely explored ca. 11,580 CALYBP or before; if only AMS dates are used, however, the oldest dates are ca. 11,100 CALYBP. For Borrero this

discrepancy means “that older standard dates must be replicated with modern dating techniques. The existence of archaeological sites of similar age, older than 10,000 radiocarbon years, in Ultima Esperanza at the western reaches of Fuego-Patagonia leads to questions of the conditions under which that region was incorporated within the human range.”

Does archaeological evidence

(Left-right) Fabiana Martin, Erik Lukoviek Bontes, Borrero, and José Díaz digging a late-Pleistocene accumulation of carnivore droppings and bones in Cueva Escondida, Ultima Esperanza, Chile, 2014.

define the first exploration of a region or its permanent colonization? Cueva Lago Sofia 1 yielded 37 lithics, all made of local raw materials abundant near the cave. Lithic tools recovered at Cueva del Medio are only partially described, but were also taken from glacial deposits nearby. These assemblages are evidence for Borrero that these sites may have been way stations of short-term seasonal circuits, after which the sites weren’t revisited for centuries. The region of Cerro Benitez–Lago Sofia area may have seen sporadic use, perhaps for big-game hunting forays.

Making the case for human-megafauna association

Although South American megafauna are rarely covered in detail

during a discussion of Pleistocene extinctions, megamammals made their homes in South America in surprising numbers. The Pampas alone were once home to 38 species of herbivores weighing more than 100 kg (**MT 29-2**, “Footprints of the Pampas: A past worth saving”), thus making South America a noteworthy case of megamammal extinction worthy of in-depth study. Although the literature registers a few claims for the presence of humans as long as 40,000 years ago, no site provides irrefutable evidence for human occupation, much less in association with Pleistocene megafauna.

Available evidence for the migration route for human colonization of South America points toward Panama, which appeared as a bridge around 3 million years ago. An assemblage of fluted projectile points discovered at Cueva de los Vampiros is one of the few bits of evidence from the region.

Borrero distinguishes between two approaches for studying the association of humans and megafauna:

- physical association—bones and tools found side by side;
- behavioral association—demonstrated human activities directly related to megafauna.

To observe this distinction requires taking into account the taphonomic history of the deposits. The lithics analyst must remain alert to a multiplicity of natural agents that can mimic human actions and must therefore exercise caution before accepting evidence on which to base interpretations. Eliminating cases that merely present physical associations is a safeguard that places the burden of evidence on sites for which a behavioral interpretation can be established.

Borrero cites numerous discoveries of Pleistocene colonization in Colombia, Venezuela, Ecuador, Peru, Bolivia, Uruguay, and Brazil. Most of these sites, however, only demonstrate physical association of artifacts with megafaunal bones and therefore cry for further investigation. A notable exception is the Taguatagua 2 site in Chile, where Fell Cave projectile points were discovered with the remains of several mastodons, including a fragment of tusk scored with geometric designs. Cutmarks on 7.6% of the bones rank among the best evidence for behavioral association in South American sites.

For Borrero, this is conclusive evidence that humans and Pleistocene fauna coexisted and interacted in South America. More difficult to determine, however, is whether megafaunal remains are the product of hunting or scaveng-

Borrero relaxing inside the crater of a volcano in the Pali Aike lava field in southern Patagonia, the region where the oldest evidence for humans was found.



FABIANA MARTIN

Contagious enthusiasm

“I have known Luis since we were students,” says Nora Flegenheimer, an Argentinean colleague. “Although we studied at different universities, we met often. What I remember most is his passion, passion for archaeology, for mountain climbing, for the Rolling Stones. Listening to him address the audience in the last SAA meeting, I could recognize that same passion which has been the driving force of his career. And although I never attended his classes, through his students I know he transmits this passion and his wide-reaching knowledge of bibliography; he is an avid and thorough reader. The ’70s were a time when in Argentina we had little access to international bibliography. As I was working with agronomist Ingeniero Augusto Cardich, I had access to the reprints he received; I still remember Luis’s exclamations of enthusiasm whenever I brought a new reprint from the lab.”

Inseparable: Evolutionary theory and the colonizing of South America

Borrero believes that when modeling the peopling of the Americas, scientists place too little emphasis on human skeletal remains. The fault for this lies, first, when the primacy of megamammals is exaggerated in subsistence strategies, and second, when the importance of rockshelters and caves is overemphasized in human occupations. These biases obscure the mission of anthropologists: to understand why settlement occurred, and how it was accomplished.

Biological, biogeographical, and archaeological data stand out in stark relief when viewed against the backdrop of evolutionary theory and the two pillars that support it, human behavioral ecology and natural selection. To fathom the process of human colonization, Borrero urges scientists not to ignore the wealth of evidence encoded in human bones, for they speak volumes about human adaptation at the individual level. Only when data from genetics, paleoecology, archaeology, and paleontology are integrated, Borrero preaches, can scientists detect and understand variations in the archaeological record.

The answer to precisely when and how South America was peopled is elusive. Borrero is confident, however, that ecologically disparate regions of the continent were occupied by 11,200–12,200 CALYBP and that the process surely involved generalist hunter-gatherers with the flexibility to seek and exploit different ecological niches.

In deciding which habitats Paleoamericans were likely to prefer, early archaeologists typically considered only

ing. At any rate, such distinctions cease to matter at the end of the Pleistocene: By then, megafauna were extinct and humans sought other prey.

the quality and availability of raw materials and basic subsistence needs. Borrero pursues a taphonomic approach to archaeology, discovering preserved pockets in the landscape, often in unexpected locations, and deciphering the mechanisms that accumulate and preserve materials. He readily admits that “the construction of a continental-scale taphonomy is a difficult task. The basic idea is to apply this approach at the same geographical scale at which archaeological projects work. The goal is a better definition of the archaeological problems implicated in the processes of exploration and colonization.” Borrero is convinced that only by considering the full archaeological record will we understand the motives that energized the first immigrants.



CLARA OTAOLA


Praise supremely warranted

Log onto website www.academia.edu and prepare to be dazzled by 30 years of Luis Borrero's contributions to more than a hundred major publications and praise from his peers for his service in furthering the academic underpinnings for archaeological research, capped by the Excellence in Latin American and Caribbean Archaeology Award bestowed by the Society for American Archaeology for his scholarship.

Central issues for his work “are constructing an evolutionary framework within which to derive hypotheses and implications to study and understand the process of exploration and colonization of new land, particularly in South America. The process of extinction of Pleistocene megamammals is an important part of what I have wished to understand since my student days. Most of my field work is related to that subject.”

As for his future work, Borrero intends to continue his search for late-Pleistocene archaeological and paleontological sites in unexpected locations, while avoiding obvious locales like large caves or

Jeff Altschul, President of the Society for American Archaeology, presenting Borrero the SAA Award for Excellence in Latin America and Caribbean Archaeology, 2014.

sites characterized by megafaunal remains. He is convinced that “First Americans studies call for well-organized field work on a wide continental scale.” 

—Martha Deering

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Wally's Beach

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Kooyman states that the hunting of species different from those favored in later eras is also important, and may suggest a logical progression from hunting a broad spectrum of prey to a more focused and perhaps more efficient hunting strategy. That is, the pre-Clovis hunters at Wally's Beach may have killed horses and camels only because they were common, rather than specifically stalking elephantids and bison as their descendants did.

Another significant contribution of Wally's Beach is that we can use the location and patterning in the kills to reconstruct the hunting strategy to some extent—something not always possible from kill localities of any era. Kooyman points out that this location on the bluffs along the river had easy access to the river. Before the reservoir was built, this location—still visible during draw-down of the reservoir—had a gradual slope down to the river that was used by local farmers. It may even

have served as a river ford. “The hunting shows repeated use of a good locality, and that the hunting is intercept hunting—a strategy based on knowledge of the animals and the local landscape,” Kooyman states. “This is not random encounter hunting, but is planned and clearly successful.” 

—Floyd Largent

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Isolated

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water a day, and a mammoth, if anything, needed even more. Elephants, today's proxies for mammoths, will excavate wells near a lake margin, but these are very inefficient sources of drinking water.

With today's rising oceans, St. Paul hasn't started slipping below again just yet. Ample freshwater may, however, again become a problem. The island's freshwater supply is provided by groundwater that literally floats on top of a saltwater wedge. But the wedge is swelling, and the ancient ecological disaster that caused the demise of one of the last groups of mammoths on Earth may become tomorrow's problem.

The collective group of scientists aren't done with St. Paul. According to Graham this is only one study that will spring from Lake Hill cores. Scientists including Yue Wang (University of Wisconsin–Madison) will revisit Colinvaux's earlier studies of isotopes, plant macrofossils, and data from other organisms to clarify the picture of the late-Pleistocene paleoenvironment and its changing climate. Perhaps what they learn from the ancient changing climate will help us deal with today's. 

–K. Hill


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Paleoamerican Art Objects

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continent except Antarctica going back some 450,000 years. While people at different times and in different places may have given them different meanings, the patterns are something that all humans share." 

–Jessy Schroeder

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Leaving Lake Hill after a day of coring.

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<http://www.gaultschool.org>

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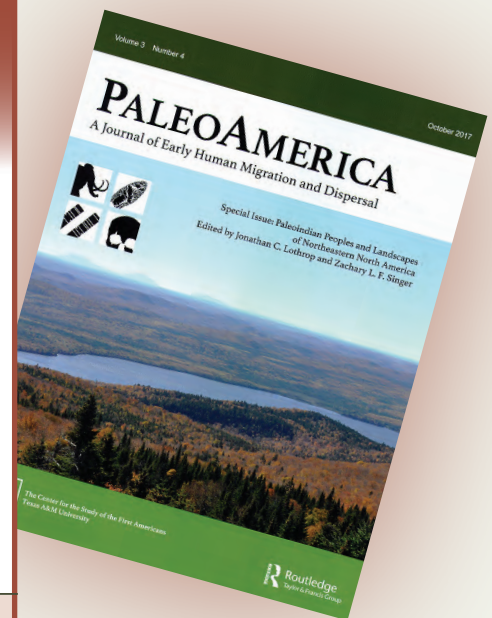
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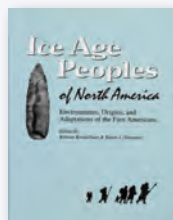
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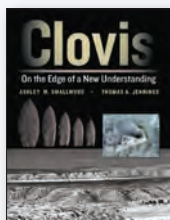
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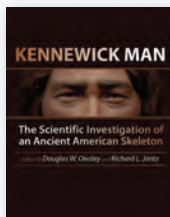
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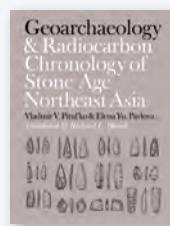
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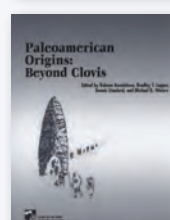
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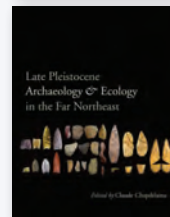
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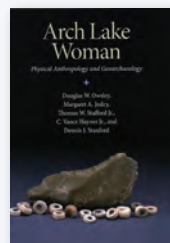
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