MAMMOTH TRUMPET

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C. Vance Haynes, Jr.

A LEGACY OF IMPECCABLE SCHOLARSHIP

PALEOINDIAN research in North America relies heavily on geoarchaeological and geochronological components. No single geoscientist has contributed more essential information to current ideas on Paleoindian occupations than C. Vance Haynes, Jr., Regents Professor at the University of Arizona. The title of Regents Professor is the highest faculty rank, reserved for full professors whose exceptional achievements have brought them national or international recognition. In a career spanning 50 years Dr. Haynes, one of the early geoscientists to utilize stratigraphy and geochronology, contributed to North American archaeology well-dated environmental reconstructions of Paleoindian sites throughout the Southwest.

Haynes excavating the Lehner site, 1974.

HELGA TEWEIS ASM

Caleb Vance Haynes brought a life-long interest in avocational archaeology to bear on his training in engineering geology during the 1950s. While pursuing his undergraduate degree from the Colorado School of Mines near Denver and serving four years in the Air Force at postings in Albuquerque, Austin, and Fairbanks, Haynes rubbed shoulders with leading Paleoindian archaeologists of the day. Contact with such luminaries as Frank Hibben, Fred Wendorf, Alex Krieger, E. H. Sellards, Glen Evans, Dave Hopkins, Marie Wormington, Henry and Cynthia Irwin, and George Agogino inspired Haynes to enroll in the Geochronology program at the University of Arizona, where he received a Ph.D. in Geosciences in 1965.

INSIDE

Haynes was born in 1928 in Spokane, Washington. His early training in rocketry, engineering, and economic geology led him by way of Johns Hopkins University to the Colorado School of Mines. His father, Caleb Vance Haynes, a pioneering U. S. Air Force aviator, reached the rank of major general in the Air Force. Another famous relative, great-grandfather Chang Bunker, was one of the original set of world-famous conjoined twins. Born near Bangkok, the brothers Chang and Eng later moved to North Carolina, where they both married and fathered many children.

Questions about chronological relationships

Discoveries at the Folsom site in the late 1920s posed new questions for Paleoindian archaeologists about the chronological relationship of many different artifact types. Geologic-climatic dating, the fundamental method used before Libby developed radiocarbon dating in the 1940s, relied on regional and site stratigraphy. Three of the most important Great Plains Paleoindian sites, Clovis, Lindenmeier, and Sandia Cave, were still a cause for debate in the 1960s when Vance Haynes entered the equation. Haynes and George Agogino began a systematic search for charcoal in Paleoindian sites. Their efforts resulted in the first regional applications of the new radiocarbon-dating method. Departing from earlier efforts based on occasional discoveries of suitable materials, Haynes and Agogino paid special attention to the associated geology and stratigraphic provenience of samples.

Haynes and Rich Fox surveying the Custer battlefield, 1984–85.

SANDY BERNARD

A defining moment in the debate about pre-Clovis occupation of America came to him in 1962 as a geologist on the Tule Springs excavation in Nevada. He was reasonably convinced of the evidence for a pre-28,000 CALYBP human occupation of the Las Vegas Valley and looked forward to helping prove the existence of pre-Clovis man. By early 1963, however, he found that all the evidence for a pre-Clovis presence was based on misinterpretations of geological data. A similar situtation existed at Sandia Cave.

Haynes's 1964 article in *Science,* which describes applying the new radiocarbon method, defined a new and more accu-

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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

rate Paleoindian chronology. An equally far-reaching impact was its reopening the Ice-Free Corridor hypothesis proposed by W. A. Johnson in 1933. Environmental archaeology was taking off at the time, and Haynes was one of the few geologists with an interest in archaeology who climbed on board. He quickly got involved in some of the most important archaeological projects of the early 1960s, particularly Hell Gap and Sister's Hill in Wyoming. An invitation from Fred Wendorf to join the High Plains Paleoecology Project led to work at the Clovis site and launched Haynes's career in geoarchaeology and Paleoindian studies.

Both the Hell Gap and Clovis sites had revealed a long record of Paleoindian habitation, but Haynes brought something unique to his work there in the early 1960s. His approach, which emphasized systematic application of radiocarbon dating and comprehensive assessments of stratigraphy and geochronology, became the Hallmark of "Haynesian geoarchaeology." Paying very close attention to microstratigraphic detail, he focused on sedimentology and depositional environments, and especially to archaeological relationships and radiocarbon sampling. To these data he brought a solid footing in field geology and an understanding of radiocarbon geochemistry. This was the first time an individual had studied both the site and regional stratigraphy, assessed the archaeology, and collected and processed the radiocarbon samples.

VANCE HOLLIDAY

Haynes guiding a tour at the Murray Springs site, Arizona, 2006.

Highest standards

Haynes is highly respected for insisting that archaeologists adhere to the highest standards of research in their quest for New World origins. His work on the Great Plains along with his similar studies in the Southwest came together in his 1968 article "Geochronology of Late Quaternary Alluvium." Haynes drew on Kirk Bryan's long-standing interest in the cycles, causes, and chronology of erosion and deposition in arroyos in the southwestern United States. Bryan had developed a stratigraphic model for these cycles, which became known as the "alluvial chronology." Haynes radiocarbon dated Bryan's chronology and put it into a regional context. Using data collected from 17 sites and regions, Haynes's article, even though it was oriented toward geoarchaeology, became a classic study in regional Late Quaternary stratigraphy and environmental reconstructions that furthered our understanding of semiarid alluvial systems. It gave scientists the physical and temporal framework for comparing archaeological sites.

During the 1960s Vance Haynes became well known as one of the nation's leading geoarchaeologists and Paleoindian researchers in a discipline where few others were qualified. In the San Pedro Valley of Arizona, Haynes began his own long-term research project in interdisciplinary archaeology. The 1970s saw a resurgence of interest in geoarchaeology throughout North America, and often his work was interrupted by trips to apply his skills at sites in such diverse areas as the northern Ozarks, Egypt, and the Sudan.

In 1996 Haynes and Smithsonian geologist T. A. Maxwell, in collaboration with the Geological Survey of Egypt and the USGS, explored buried river

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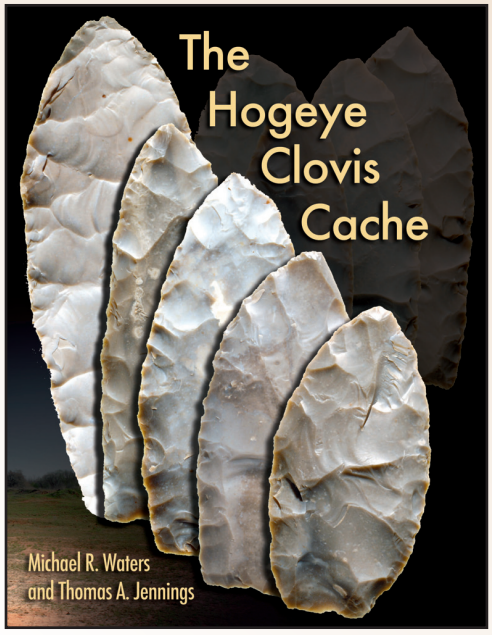
"If only all Clovis caches were investigated and reported in this level of detail."

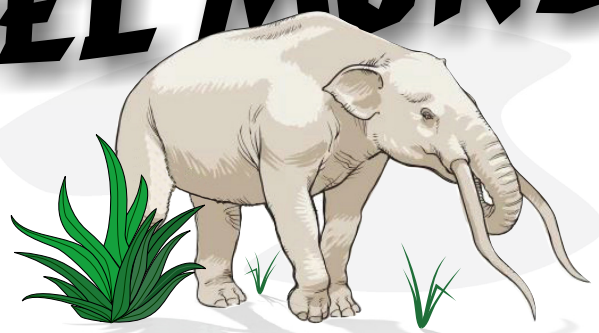
–David Kilby, Eastern New Mexico University



MORE THAN 50 projectile points, preforms, and knives cached by Clovis hunters lay buried at the toe of a gentle slope in central Texas for 13,000 years. After the artifacts were unearthed in 2003 in a commercial sand-mining operation, alert citizens brought them to the attention of Texas A&M geoarchaeologist Mike Waters. With coauthor Tom Jennings, Waters excavated and dated the geological layers to reconstruct how the cache had been buried.

The site also yielded evidence of later occupations that shed light on successive cultures from Folsom to Late Prehistoric. Especially well described are the cached Clovis artifacts in various stages of completion. Profuse illustrations in ***The Hogeye Clovis Cache*** (59 color photos and 33 drawings) are virtual freeze frames of bifaces captured at various stages along the lithic-reduction trajectory by which Clovis toolmakers shaped stone blanks into tools or weapons. Lithics analysts will value this book as a how-to manual for the Clovis flintknapper. See the outside rear cover of this issue for ordering information.

EL FIN DEL MUNDO

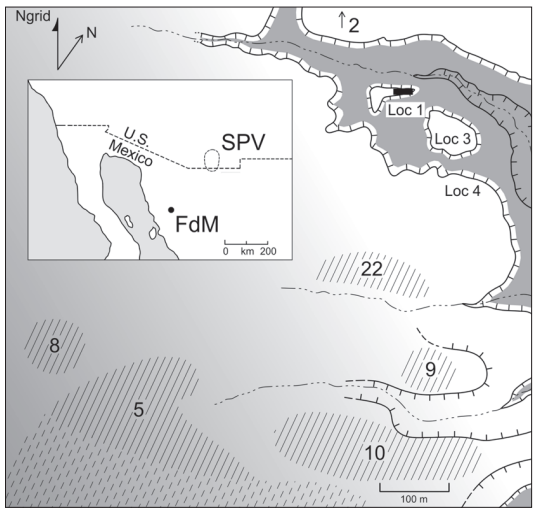


Gomphothere (*Cuvieronius* sp.)

News from the End of the World . . . as we know it?

IF YOU MISSED IT, the End of the World came in 2007 when a rancher reported artifacts and large bones eroding out of an arroyo wall in Sonora, Mexico. Thus sprang to life El Fin del Mundo (Spanish for *End of the World*), a site that crosses borders in more ways than one. El Fin del Mundo is only the second Clovis site found south of the border (**MT 24-3,** "Beyond the Border: Paleoamericans in Sonora, Mexico"). Its findings expand the known geographic and temporal range of the Clovis culture and reintroduce the gomphothere, a North American proboscidean thought to have gone extinct earlier in the Pleistocene. Clovis points found associated with gomphothere remains confirm for the first time that the megamammal was part of the (ahem) Paleo diet.

El Fin del Mundo today stands as the oldest Clovis kill site. And it adds a shot of vigor to the theory of a possible southerly origin of Clovis.



JIM ABBOTT

Site map of El Fin del Mundo with location of Locality 1, non-archaeological Localities 3 and 4, and the area of the upland Clovis camp (hachured along the south and southwest margins). Insert shows location of the site (FdM) in northern Mexico relative to Clovis mammoth kills in the upper San Pedro Valley (SPV) of southern Arizona.

The site at the End of the World

Primary researchers at the El Fin del Mundo site include Vance Holliday of the University of Arizona, Guadalupe Sanchez-Miranda of Instituto de Geología–Universidad Nacional Autónoma de México, and Joaquín Arroyo-Cabrales of the Laboratorio de Arqueozoología, Subdirección de Laboratorios y Apoyo Académico, INAH. The site lies in the Sonoran Desert, within an intermontane basin surrounded by volcanic hills. Dr. Holliday explains that it got its name because to reach it requires a bone-jarring 3-hour drive from the nearest paved road.

Survey and excavation of the site, which took place between 2007 and 2012, revealed a Clovis camp and butchering site, with nearby toolstone sources. Sediments in this area were deposited during the Pleistocene and earlier periods. The camp portion of the site lies in the uplands above an arroyo system, which has carved islands from the sediments. Only one of these islands, Locality 1, houses an extensive bone bed and associated Clovis artifacts. The extensive erosion that created the islands destroyed much of the evidence for the stratigraphic relationship between the island with the archaeology and the surrounding islands and deposits.

Locality 1 consists of three strata. The top two strata, 3 and 4, resemble the stratigraphy of Lubbock Lake in northwest Texas, a Paleo site associated with megamammals (**MT 18-4,** "Lubbock Lake"). The bone bed straddles strata 3 and 4, and bones in both strata are equally weathered, signifying a single butchering event. Noteworthy is a layer of diatomite, which signifies a lake; diatomaceous earth above it is a telltale sign of a marshy setting, which covered the bone bed either in its initial burial or later if it somehow became exposed and reburied.

Unusual suspects

Researchers excavating El Fin del Mundo found disarticulated skeletal remains of two individual proboscideans, initially thought to be mammoth or mastodon. The first set comprised bones of the lower legs and feet (astragali, phalanxes, and metapodials), plus vertebrae, long bones, and all the elements of a complete pelvis. This set of bones (Individual No. 1) was a subadult, age 13–24, probably closer to 13, judging by the state of bone development. A single bone in an adult may be separate bones in a juvenile that ankylose (fuse together) as the individual matures. Data on modern creatures tell us the age when certain bones typically fuse. For example, in the human body typically the last bone to fuse is the clavicle, which generally ankyloses

in the early- to mid-twenties. In the case of extinct proboscideans, data are gathered from modern elephants, their closest living proxy. The age of Individual No. 1 was estimated by the state of ankylosis of the foot and lower leg bones.

The second bone pile, also those of a single individual (No. 2), include pelvis, ribs, vertebrae, scapula, mandible, molar fragments, and pieces of the cranium. Unfused vertebrae indicate an age in the range of 1–12 years. Teeth, which erupt at known ages, also help determine an animal's age range. The mandible from Individual No. 2 contains the premolar and first molar, which indicates that the animal was toward the older end of the age range at death, perhaps 11 years old.

G. SANCHEZ

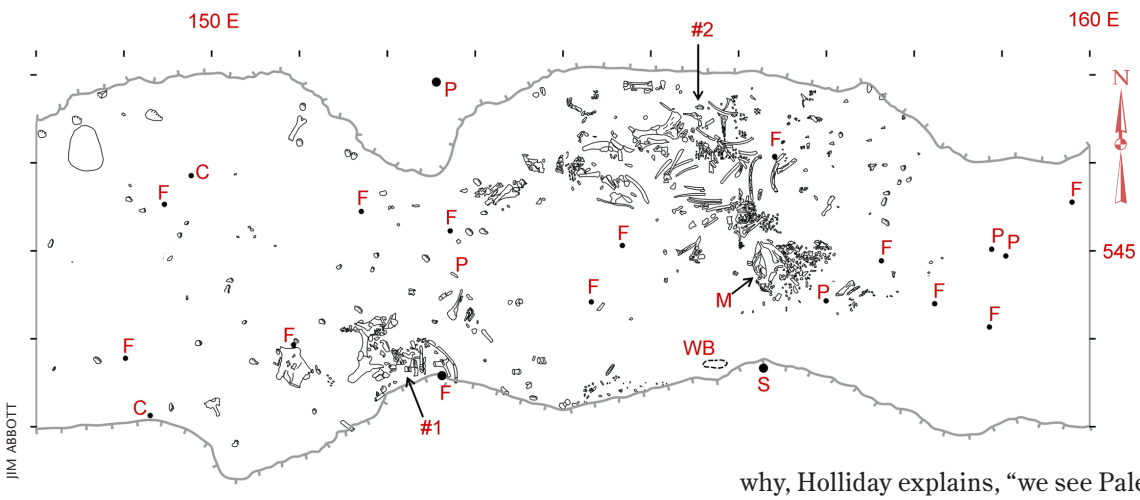
Excavating the gomphothere mandible in Locality 1, December 2007.

It was, in fact, the teeth of Individual No. 2 that told the researchers they had made a remarkable discovery. Holliday explains that although the mandibles of all proboscideans are similar in shape, gomphothere teeth are different from those of mammoth or mastodon. Mammoth molars bear rows of parallel plates perpendicular to the jaw; mastodon molars have cusps like ours. Gomphothere molars have cusps as well, but more of them, arranged in what is known as a bunodont pattern. The molars in the mandible from Individual No. 2 demonstrate this unmistakable gomphothere pattern. Although the skeleton of a gomphothere is considerably smaller than that of a mammoth or mastodon, it was the molars that Holliday describes as "the smoking gun."

Clovis calling cards

Gomphotheres are generally found in settings such as marshes, lakes, and springs that were also home to other megamammals. In the late Pleistocene they inhabited the vast expanse from Mexico to the tip of South America. El Fin del Mundo confirms that these animals were coeval with Clovis and, moreover, may have been prey for Clovis hunters.

Four Clovis points were found associated with the bones, and three others were found in disturbed context. All these points are fluted lanceolate bifaces that conform nicely to Clovis criteria. One point (63177) was found only 60 cm from the mandible of Individual No. 2; teeth and bone fragments were found below and above it. Holliday describes this artifact as a multipurpose tool that could have been used as a projectile for hunting or a knife for butchering. Two other points were found together within 2 m of Individual No. 2. One (62943) is complete and demonstrates skilled pressure flaking. The other is the distal end of a point broken by a snap break, the kind of break usually associated with an impact fracture. A snap break occurs when a hafted artifact (used either as a projectile or knife), subjected to great pressure, snaps off at its base. This is why, Holliday explains, "we see Paleoindian point bases more commonly in camps, probably because the broken bases are taken out of the haft and, if too short to rework into another base, are then discarded." A fourth in situ point, 63008, was also complete.

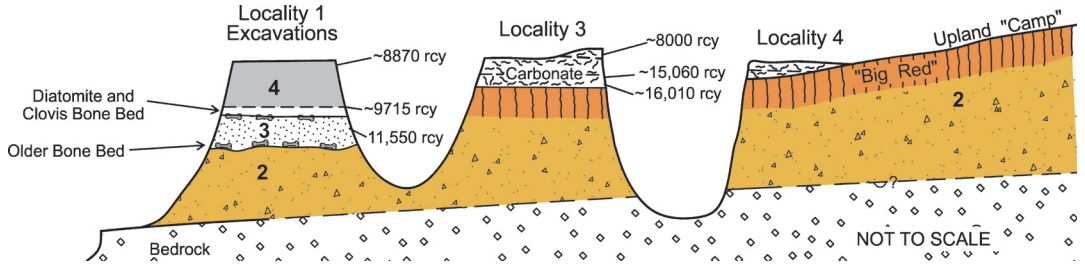


JIM ABBOTT

The bone bed in Locality 1, showing gomphothere-bone concentrations (#1 and #2), the mandible M, and archaeological finds recovered in situ: projectile point P; flake F; charcoal C; and worked bone with incised V WB.

Of the three disturbed points, one made from clear quartz

(58342) was found about 1 m from Individual No. 2, another (59569) was found in a krotovina (a rodent burrow filled in with sediments), and the last (46023) was found on the surface about 8 m from Locality 1. Another artifact, a scraper, fell out of the arroyo wall before survey or excavation was started.



Schematic geologic cross section through Locality 1 (the main excavation area) south through the Locality 3 island and then southwest to the uplands, the camp site where diagnostic Clovis and later-period archaeological materials were found on the surface of an eroded soil named "Big Red" owing to its striking color. In other localities "Big Red" soil is buried and is equivalent to upper stratum 2. Dates are means in radiocarbon years (rcy).

Besides these tools, 21 flakes were also found, 12 in situ and 9 when sediments were screened. They are fine retouched flakes and bifacial thinning flakes that could have been the by-product of resharpening tools during butchering. Some but not all points show signs of resharpening, and the lithic material of the flakes matches the toolstone of the points and other tools from Locality 1 and the upland camp. This toolstone likely came from local sources: clear quartz from an outcropping 5 km distant, rhyolite from Locality 2, and chert from cobbles found within the gravel channels. Most of these 21 flakes were found either directly associated with the bone concentrations or at the same level as the bones. Some were also found among charcoal concentrations.

G. SANCHEZ-MIRANDA

Holliday and Natalia Martinez-Tagüeña, 2012 crew chief at El Fin del Mundo, examine the first two points recovered in situ *(inset)*.

Sanchez-Miranda at Tetabejo shelter in Sonora, Mexico.

Evidence from bones

The bones themselves, which are considerably weathered, bear damage from trampling and carnivore gnawing. No butchering marks have been found, although study is ongoing. It may be that the severe weathering of the bones could make cutmarks impossible to discern. The way the bones are disarticulated, yet gathered in two distinct piles, makes it appear that the animals were butchered by humans and the bones later disturbed by scavengers. It's also possible, of course, that humans were only scavengers and not gomphothere hunters. The fractured point, however, suggests it was broken from impact of great force, the kind of damage expected from a flying projectile instead of a butchering tool. Does its in situ location 2 m from Individual No. 2 alongside point 62943 suggest the pair were laid aside intentionally? There's no way to know for certain.

Artifact assemblages of complete points and basal fragments found at the camp fit the pattern of other Paleoamerican kill and camp sites. The extensive area of the site leads the research team to suggest that it was either used over a long period of time or visited repeatedly.

Besides stone tools, charcoal concentrations and some modified bone were found between the two bone concentrations. Modified bones include burnt bone and two bone ornaments. One ornament is engraved in a distinct V shape. Charcoal flecks associated with the stone tools and flakes, as well as some of burnt bone, were radiocarbon dated. One charcoal fleck yielded the most reliable date for the site of 11,550±60 RCYBP with a calibrated age range of 13,325–13,440 CALYBP. This ranks El Fin del Mundo with the Aubrey site in Texas as the oldest Clovis sites.

V. T. HOLLIDAY

What does El Fin del Mundo tell us?

El Fin del Mundo wasn't an overnight stop for Clovis people. Holliday and his colleagues point to an extensive inventory of lithic artifacts in the upland camp that argue for a long-term occupation. Geographically the El Fin del Mundo site adds another Clovis occupation south of the border, thus confirming that the Clovis culture was more widespread than originally thought.

The startling discovery of a probable gomphothere kill adds to the Clovis cuisine another significant entrée previously unknown, like the Yesterday's camel found at Wally's Beach in Alberta (**MT 28-1,** "A revised Paleoamerican menu: Wally's Beach camel"). Like the camel, the gomphothere was supposedly prey only for South American Paleoamericans. Camel and gomphothere kills, both megamammals, support the claim of University of Nevada anthropologist Gary Haynes that the Clovis diet, although it varied regionally, focused "on big game, indeed the biggest game, whenever and wherever it was available" (**MT 30-1,** "The Clovis diet: Mostly mammoths?"). What's more, other gomphothere remains are now of greater interest to archaeologists. Dr. Sanchez-Miranda finds that a slightly different species of gomphothere has been discovered near Puebla, Mexico, and it too may possibly be associated with stone tools.

The most profound effect of the El Fin del Mundo site, however, is on the origin of the Clovis culture. Chronologically it has extended the ancient limit to about 13,390 CALYBP. Not only is El Fin del Mundo among the southernmost of Clovis sites, it's also the oldest known Clovis occupation. These two facts support Florida State University anthropologist Michael Faught's contention that Clovis got its start in the South (**MT 18-4,** "Rethinking Clovis origins: A conversation with Michael Faught"). The two oldest Clovis kill sites, El Fin del Mundo and Aubrey, lie in the southern part of North America, which Faught interprets as evidence that this is where the Clovis lithic technology was born, not in the North and Northwest, which are relatively barren of Clovis sites.

With the end of the world safely past us, how do you feel about the El Fin del Mundo site? Me? I feel fine.

–K. Hill

JOAQUÍN ARROYO-CABRALES

"The smoking gun," the mandible from gomphothere Individual 2. The numerous cusps on the molars identify this as gomphothere dentition.

Four seasons of field work at El Fin del Mundo (2007–12) were funded by the Argonaut Archaeological Research Foundation (University of Arizona), endowed by Joe and Ruth Cramer, along with INAH (Instituto Nacional de Antropología e Historia, Mexico City) and the National Geographic Society (2008–11).

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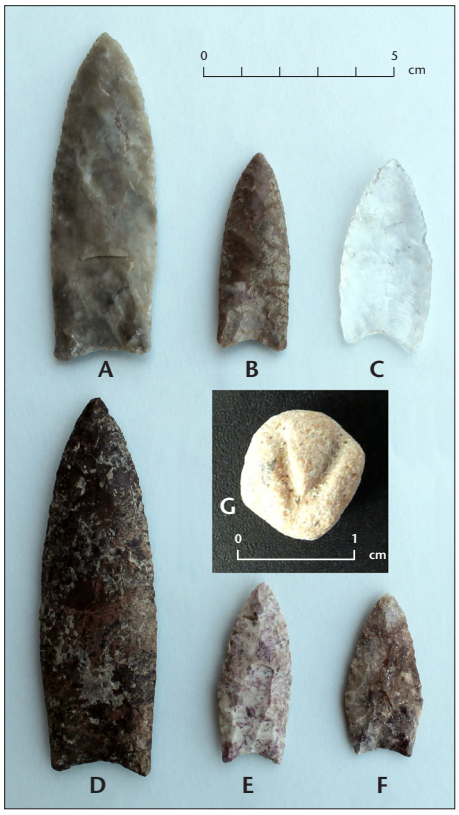


G. SANCHEZ

Artifacts found at Locality 1. Clovis points A (46023), B (59569), and C (59342) were not found in context; D (63177), E (63008), and F (62943) were found in context. Engraved bone fragment G (59892) was found in context.

Suggested Readings

Sanchez, G., and J. Carpenter 2012 Paleoindian and Archaic traditions in Sonora, Mexico. *In From the Pleistocene to the Holocene: Human Organization and Cultural Transformations in Prehistoric North America,* C. B. B. Bousman and B. J. Vierra, editors, pp. 125–48, Texas A&M University Press, College Station.

Sanchez, G., V. T. Holliday, E. P. Gaines, J. Arroyo-Cabrales, N. Martínez-Tagüeña, A. Kowler, T. Lange, G. W. L. Hodgins, S. M. Mentzer, and I. Sanchez-Morales 2014 Human (Clovis)–gomphothere (*Cuvieronius* sp.) association ~13,390 calibrated yBP in Sonora, Mexico. *PNAS,* 111:30, 10972–10977.

DNA Links Mexican Paleoamerican to Native Americans

SOMETIME between 13,000 and 12,000 years ago a young woman no more than 17 years old wandered into a network of caves in the Yucatan Peninsula of Mexico. In what appears to be a tragic accident she fell from a subterranean cliff into the blackness of the lower chamber of the cave. If she didn't die from the fall, she drowned in a pool at the base of the cliff. Even if she had somehow survived the fall, there was no way out of this natural trap. Her mother and father would never know what happened to her.

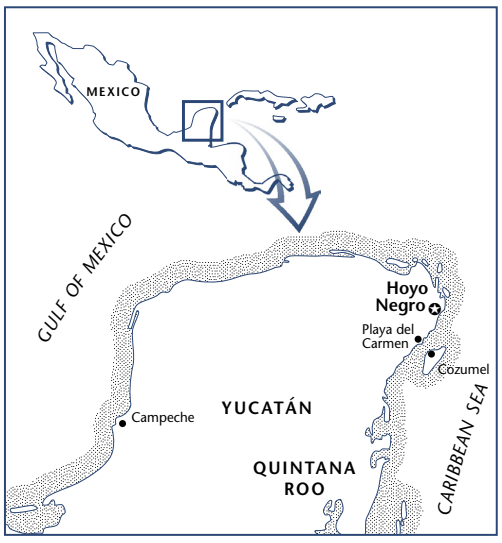
That ancient Mexican family's tragedy has led to important new insights into the peopling of the Americas. Underwater explorers discovered the well-preserved skeleton of the young woman, and her remains have been studied by an international team of scientists. DNA recovered from her bones is helping to resolve a decades-old debate about the relationship between the earliest humans to inhabit the Americas—the Paleoamericans—and the later American Indians who have distinctly different morphologies of the skull and teeth. Do those differences mean the two groups have different ancestors who came to America by different routes? Or do they simply reflect evolutionary changes within a single population over time?

Remarkably, the research undertaken to answer these questions required only minimal disturbance to the young woman's remains and her final resting place. Her story and the story of how a team of 16 scientists and divers from Canada, Denmark, Mexico, and the United States was able to recover it are both landmark chapters in the search for the First Americans. It's such an epic story, in fact, that *Archaeology* magazine listed it as one of the Top Ten Discoveries of 2014.

The first author of the research paper, published in May in the journal *Science*, is James Chatters of Applied Paleoscience and DirectAMS. Chatters is best known for his work with Kennewick Man, a famous Paleoamerican (**MT 30-1** "Ambassador from our ancient past" and "Setting precedents: A legal odyssey").

JAMES CHATTERS

Brian Kemp in his ancient DNA laboratory at Washington State University, holding the upper third molar of Naia, which was used by the Hoyo Negro team for both DNA extraction and radiocarbon dating.



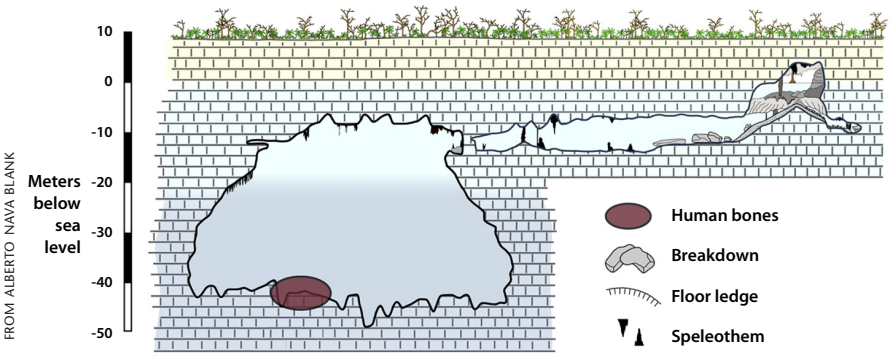
Hoyo Negro: A Black Hole gives up its secrets

Hoyo Negro (Spanish for *Black Hole*), a bell-shaped chamber 62 m in diameter and more than 30 m deep, is now underwater. It became inundated at the end of the Pleistocene, sometime between 10,000 and 8,000 years ago. Prior to that, much of the cave system was open to people and animals and that bell-shaped pit was a natural trap for the unwary.

Divers discovered Hoyo Negro in 2007. After they swam down a tunnel more than a kilometer long, the floor disappeared beneath them and they were unable to see the bottom or even the other side of the chasm. They returned with more powerful underwater lights and began to investigate the rocky floor of this enormous pit, where they found and photographed large numbers of bones. Eventually the scientific team would identify at least 26 large mammals, including extinct species such as sabertooth cat, gomphothere (a cousin of the elephant; see "El Fin del Mundo" in this issue), and giant ground sloth, as well as living species such as puma, coyotes, and tapir. In the midst of this Ice Age bestiary, they found a nearly complete human skeleton.

The various bones were "concentrated on the south side of the floor on wall projections or sloping boulders" about 30 m

below the rim of the pit. The human bones had become separated into two clusters 3–4 m apart. The main cluster included the skull, mandible, cervical vertebrae, the arm and shoulder bones, and most of the ribs. The other cluster consisted of the pelvic girdle. This distribution of the bones likely occurred when the floating body decomposed and parts of the skeleton became detached and lodged upon rocky prominences.



FROM ALBERTO NAVA BLANK

A profile of Hoyo Negro, showing a portion of the eastern access tunnel. At upper right is Ich Balam, the small cenote through which the study team gains access to the site. The nearest ground-level entrance in antiquity would have been 600 m to the east.

Chatters and his team have named the young woman Naia after the naiads, or water nymphs, of Greek mythology. She was about 4 feet 10 inches tall and is estimated to have been between 15 and 16 years old at the time of her death. The pubic bones of her pelvis exhibit breakage that occurred at or shortly before the time of her death. The researchers concluded that such injuries are "consistent with a fall into a shallow pool from one of the upper passages."

Based on AMS radiocarbon dates on one of her teeth and corroborating Uranium-Thorium dates on calcium carbonate deposits that formed on the bones, we know that Naia lived 12,000–13,000 calendar years ago. This makes her one of the earliest ancient American skeletons so far identified.

One of the most interesting things about Naia is her skull, which bears many characteristics of Paleoamericans compared with later American Indians and Siberians: her skull is long and narrow; her face is small, short, and somewhat projecting; her teeth lack specialized dentition seen in later American Indians and East Asians, such as reduced or missing third molars.

Who were the Paleoamericans?

The stark differences between Paleoamerican and modern American Indian populations are a puzzle with two possible solutions. Either Naia and her kind were a distinct but small population that was absorbed into or replaced by a later-arriving, more numerous population from eastern Asia who were the ancestors of later American Indians, or evolutionary forces reshaped the skulls and teeth of Paleoamericans over time and they became the direct ancestors of modern American Indians—with or without subsequent migrations from east Asia.

Until recently, the only evidence and arguments that could be brought to bear on the question centered on the degree of difference between ancient and more recent skeletons. Physical anthropologists and archaeologists who focus on craniometric analyses maintain that the differences argue for separate migration events from different source areas in Eurasia. Chatters initially was among those who favored this interpretation.

Other scholars, such as biological anthropologist Benjamin Auerbach of the University of Tennessee–Knoxville, who examined the entire skeleton, emphasize the similarities and conclude that there was only a single source population for both Paleoamericans and the ancestors of modern American Indians (**MT 28-3**, "Early skeletons point to a single source population for the First Americans").

Genetic studies of modern American Indians and a few ancient skeletons, such as the Anzick Child (**MT 29-2,** "Clovis child answers fundamental questions about the First Americans"), have convincingly supported the hypothesis that all American Indian populations trace their ancestry back to a single source population or a small number of closely related source populations. But no one had ever recovered ancient DNA from a Paleoamerican skeleton with its distinctive skull and teeth. Could it be that Paleoamericans trace their ancestry to a separate population from some other region of Eurasia?

Naia: Different, yet the same

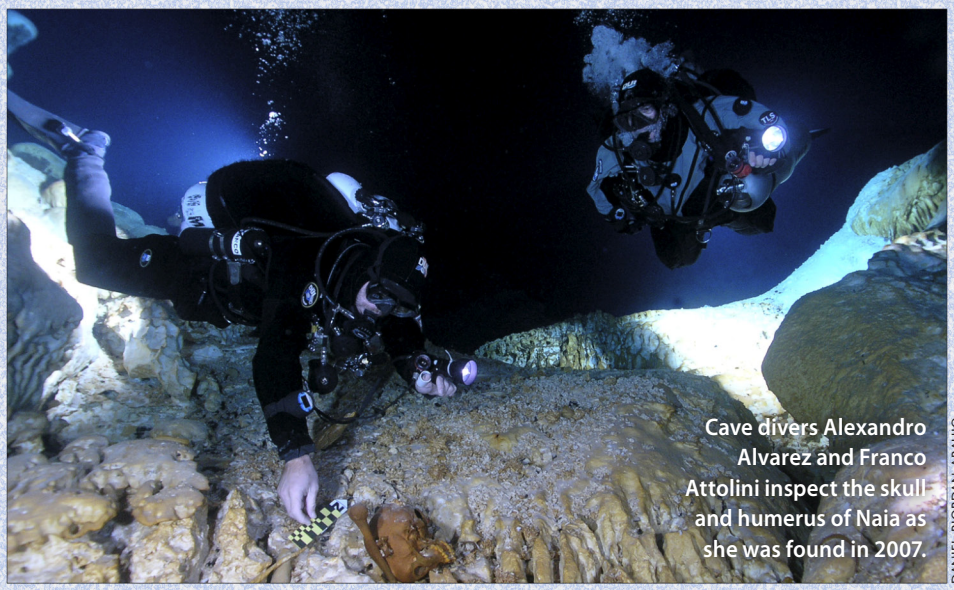
The discovery of Naia provided the opportunity to answer the question. Her bones were well preserved, and if ancient DNA could be recovered it would indicate the degree to which Paleoamericans were related to modern American Indians.


JAMES CHATTERS

Preparing to recover Naia's skull, Chatters uses a plastic 3-D print of Naia's skull to show diver Susan Bird *(right)* and conservator Diana Arano *(left)* proper handling and placement into the collection box. The model for the skull was produced from underwater photos by Anna and Corey Jaskolski using structure-from-motion software.

Chatters and the other members of the scientific team princi-

Diving into HOYO NEGRO



Cave divers Alexandro Alvarez and Franco Attolini inspect the skull and humerus of Naia as she was found in 2007.

DANIEL RIORDAN ARAUJO

The Hoyo Negro team gains access to the site through Ich Balam, a small cenote, using a stairway built with a grant from the Archaeological Institute of America. The water surface and diving dock are more than 7 m below.

JIM CHATTERS

The skull of one of three pumas found in Hoyo Negro shows the exceptional preservation of the animal fossils and absence of covering sediment.

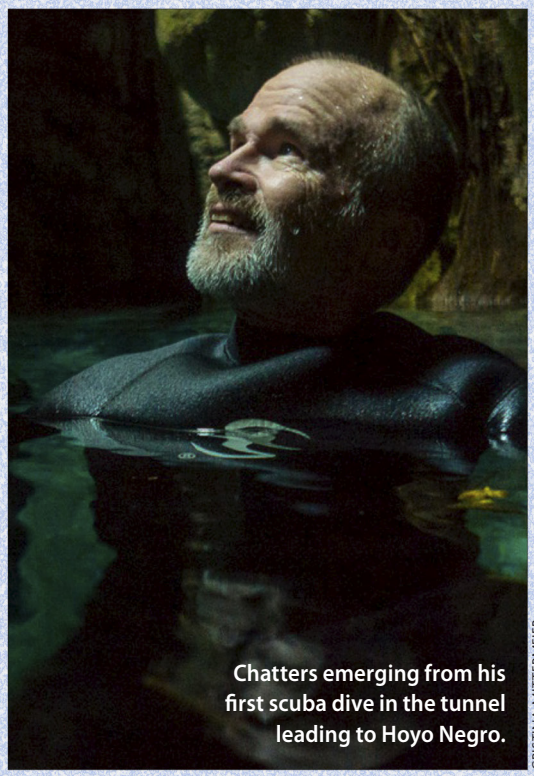
ROBERTO CHAVEZ ARCE

Alberto Nava at 44 m depth in Hoyo Negro, inspecting a forelimb of an extinct Shasta ground sloth, one of two sloth species found in the cave. The Shasta ground sloth hadn't previously been found so far south in the Americas.

ROBERTO CHAVEZ ARCE

Divers Susan Bird and Alberto Nava approach scattered human and gomphothere bones at 43 m depth. The pelvis and femur of the gomphothere are at the bottom; human ribs and arm bones along with gomphothere rib and foot bones lie directly in front of them. The human skull in this picture is a replica, placed after the actual skull was temporarily stored.

ROBERTO CHAVEZ ARCE

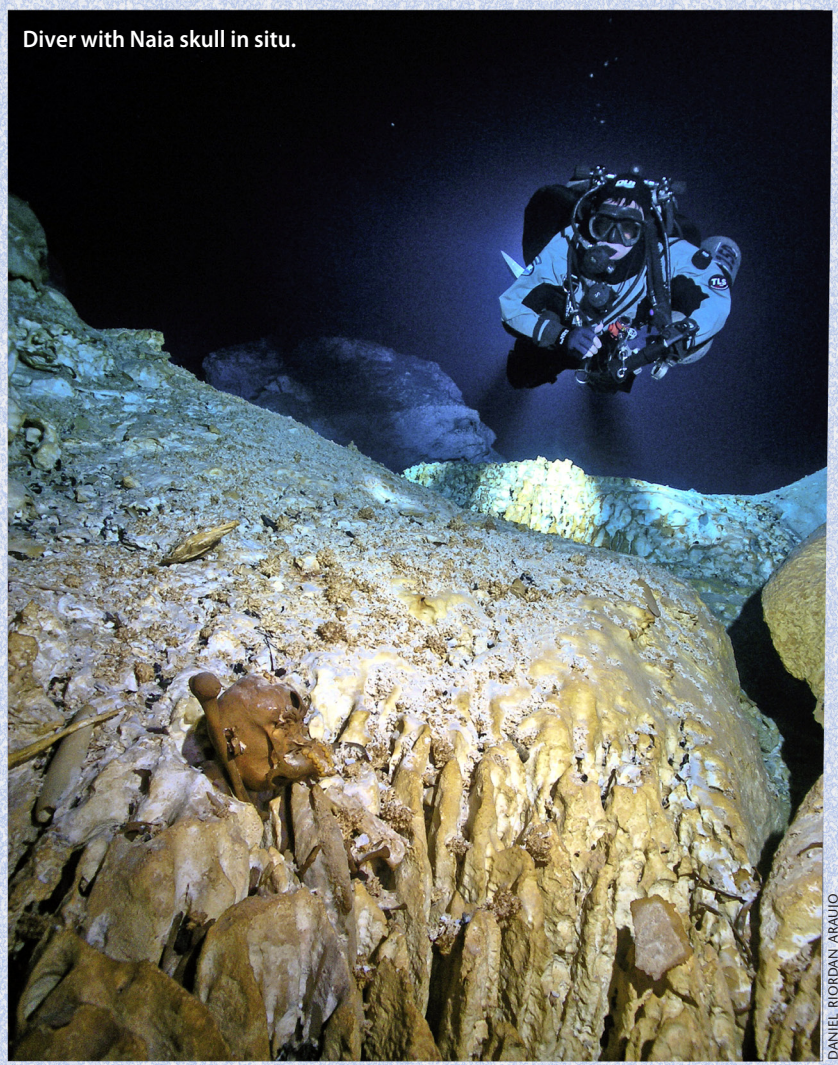


Chatters emerging from his first scuba dive in the tunnel leading to Hoyo Negro.

CRISTINA MITTERMEIER

The skull of a sabertooth *(Smilodon fatalis)* rests on that of a collared peccary on the south wall of Hoyo Negro. These specimens illustrate the exceptional preservation of skeletal remains found in the bottom of the pit.

ROBERTO CHAVEZ ARCE



Diver with Naia skull in situ.

DANIEL RIORDAN ARAUJO

Diver Susan Bird moves the mandible of Naia to a platform for 3-D photography.

ROBERTO CHAVEZ ARCE

pally have studied Naia's remains "remotely, in much the same way NASA scientists studied the moon." Her bones, with the exception of two teeth and a rib, were studied largely in place and not removed to a museum or laboratory. The extraordinary decision to leave the majority of the bones where they had been found was made for several reasons. First of all, removing large or fragile bones from the site is challenging. Once removed, the bones have to be transported over rugged terrain to a distant facility, where they must be desalinized and stabilized. There are risks that the bones could be damaged in the process. Second, "ethics of the cave diving community require the divers to leave conditions exactly as they are found."

Chatters and his team initially attempted to surmount these difficulties by establishing "a new standard for minimally invasive scientific research in a delicate, dangerous environment, replacing collection with videography, high-resolution scaled photography and 3-dimensional modeling."

Of course, this left the bones susceptible to damage or removal by less scrupulous divers. Indeed, in "Supplementary Materials" to the *Science* article available online, the authors are quite candid about this possibility. They show a photo of the site with the skull apparently in place, but the skull is actually a "plastic stand-in" placed at the site because "unauthorized divers put the original at risk." In addition, leaving the bones in place would make it difficult for other investigators to try to replicate the team's research or to undertake additional studies on the remains.

Eventually, the increasing threat posed by unauthorized divers and the extreme importance of Naia's remains led the team to abandon their original plan and decide instead to recover her skull and a few other bones. Moreover, Chatters says that "at the behest of the governing body of Mexican archaeology," they will be collecting the rest of her skeleton later this year. Chatters calls the original plan "a worthwhile effort—to try using modern technology to study her entirely in place," but circumstances beyond the team's control made it necessary to give up on the experiment.

DEBORAH A. BOLNICK

Graduate student Jaime Mata-Miguez working in the ancient DNA lab, University of Texas.

Naia's mtDNA points to Beringia origin

One of the teeth the team removed for study turned out to have importance far beyond its small size. The team successfully extracted mitochondrial DNA from the tooth "using methods developed for poorly preserved skeletal elements." Mitochondrial DNA, or mtDNA, is the DNA contained in the mitochondria, which are organelles in the cytoplasm of a cell, as opposed to nuclear DNA contained in the nucleus of a cell. As a result, mtDNA occurs in much higher frequencies than nuclear DNA and is therefore easier to recover.

The genetic information scientists can recover from mtDNA is limited to the maternal lineage, since the mitochondria in your cells are derived entirely from your mother, but it can provide a clear indication of a person's maternal line of descent. In Naia's case, Chatters and his coauthors determined that she is a member of haplogroup D, subhaplogroup D1, "an Asian lineage but occurs only in the Americas, having probably developed in Beringia after divergence from other Asian populations." It is one of the "founding lineages" present in more than 10% of living American Indians.

In the 20 February issue of *Science*, Kay Prufer and Matthias Meyer, genetic anthropologists from the Max Planck Institute for Evolutionary Anthropology, present evidence they claim indicates the haplogroup D sequences of mtDNA attributed to Naia actually represent modern contamination of the samples "through contaminated equipment" or other sources. Chatters and several of the coauthors of the original paper defend their conclusions in a response to Prufer and Meyer published in the same issue of *Science*. Since the results were corroborated by "analyses of three DNA extracts from two laboratories," it is unlikely that the haplogroup D1 represents contamination. Nevertheless they resolve to pay closer attention to the issues raised by Prufer and Meyer in the "ongoing analysis of DNA of the Hoyo Negro remains."

Chatters and his team conclude that "Paleoamericans represent an early population expansion out of Beringia, not an earlier migration from elsewhere in Eurasia." Therefore "both Paleoamericans and Native Americans derive from a single source population" and "the differences in cranio-facial form between Native Americans and the Paleoamerican predecessors are best explained as evolutionary changes that postdate the divergence of Beringians from their Siberian ancestors."

Science writer Michael Balter, in a summary article that accompanied the technical report by Chatters and the other team members in the same issue of *Science*, points out that, for lead author Chatters, this paper represents a change in his thinking. Chatters, best known for being the first archaeologist to set eyes upon Kennewick Man (**MT 17-3,** "New Books," a review of *Ancient Encounters: Kennewick Man and the First Americans*), initially had thought that the distinctive cranial characteristics of Paleoamericans indicated they were a separate and earlier migration. In the light of Naia's genetic legacy, along with the results of other analyses of ancient American DNA, Chatters has come to the conclusion that Paleoamericans and American Indians came from "the same root stock." The idea that Paleoamericans represent a distinct population from some other part of eastern Asia or even western Europe he now regards as untenable.

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The Shape of Clovis

IN STUDYING STYLISTIC TRENDS in the shape and manufacture of Clovis projectile points, Heather Smith seeks clues to Clovis behavior and cultural norms 13,000 years ago across North America. To investigate Clovis technology, Smith, a doctoral candidate in anthropology at Texas A&M University, employs a technological system with roots in the biological sciences—Geometric Morphometrics (GM).

Previous morphological studies of Clovis and related Paleoindian fluted points analyzed linear distances and indices measured between specific locations on an artifact. Smith's study analyzes the curvature of tool margins using geometric morphometric analysis. "It allows us to take a huge dataset and compare the overall shape of these points," she says. Distinctly homogeneous morphology suggests the desired shape that toolmakers aspired to. You can see what was important to them, and you can discern what was taught and what was learned.

Examples from the Fenn Cache, a splendid assemblage of Western Clovis points and preforms.

HEATHER SMITH

Only shape matters to GM

GM can analyze the shape of anything—sound waves, fish, pottery. With GM, you first digitize photographs or 3D scans of a sample of objects, then employ specialized computer software that measures the variation in shapes and investigates major characteristics in shape with multivariate statistical analyses. Geometric morphometrics compares the shape of individual specimens with an average shape of the entire sample. What's important is that differences are quantified—each variation in shape is expressed by a specific algorithm from which principal components can be produced and analyzed statistically. It's perfect for understanding the variability in a sample of artifacts, such as projectile points, from locations across the entire country. Because most cultures, including Clovis, are self-regulating—standards in manufacturing tools are defined and imposed on toolmakers—a defined range of variability of a particular characteristic constitutes a style that can be used to investigate the behavior behind it.

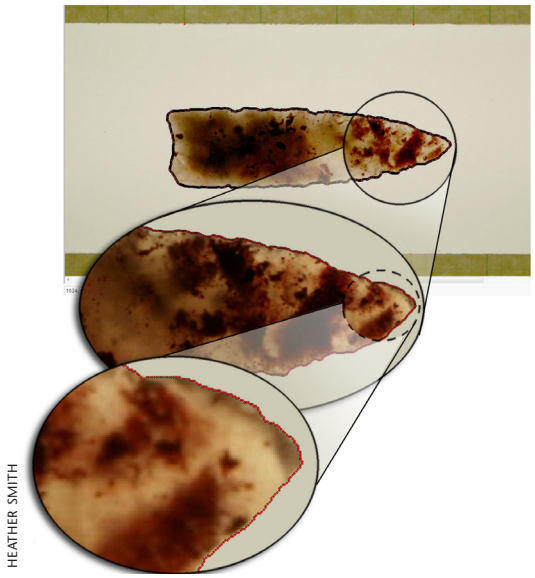
To illustrate how GM works, assume we have a set of objects, say a sample of 20 people, and wish to measure how differently one person's left hand is shaped from those of the others. "First, you select locations on the hand that can be considered uniform and present in each specimen, for example, fingertips," says Smith. "Then you assemble photographs or 3-D scans of each hand and assign a point, or landmark, to each uniform location on each hand." The computer program assigns x-y coordinates to each landmark and places them on a grid. By superimposing the dots from all hands on the same grid, you end up with a cluster of 20 landmarks at each uniform location.

The GM program first computes the average location of all the landmarks at a specific location, then measures the displacement of each landmark from the average position, which describes how much variability is present in the sample. If the location of every dot in a landmark is close to the average, that means there's not much variability and all hands are fairly similar; if the dots representing that landmark are spread out, however, that signifies greater variation in the shape of people's hands. The trick is to remove all variation that is irrelevant to the actual shape and can impose false measures of shape differences. In our example of the hand, for instance, the different attitudes of the fingers—bent or straight or even crossed—when the hands are scanned will give us a measure of variation in hand position, not true hand shape. This is why

quality control is very important when the data are first collected and digitized.

In applying GM to analyzing artifacts, Smith conducts what is called Outline Analysis by plotting landmarks around the entire perimeter of each artifact in a sample. Software then calculates the displacement of each landmark from the average location of corresponding landmarks present on each specimen in the sample and renders an index corresponding to the variable position of each landmark around the perimeter of the artifact.

With her professional background in graphic design, Smith can jump onto the computer end of things without much trouble. She uses a combination of programs, principally a package called the TPS series developed by James Rohlf, distinguished professor emeritus at SUNY Stonybrook, in conjunction with a program called MorphoJ developed by Chris Klingenberg, an evolutionary biologist at the University of Manchester.

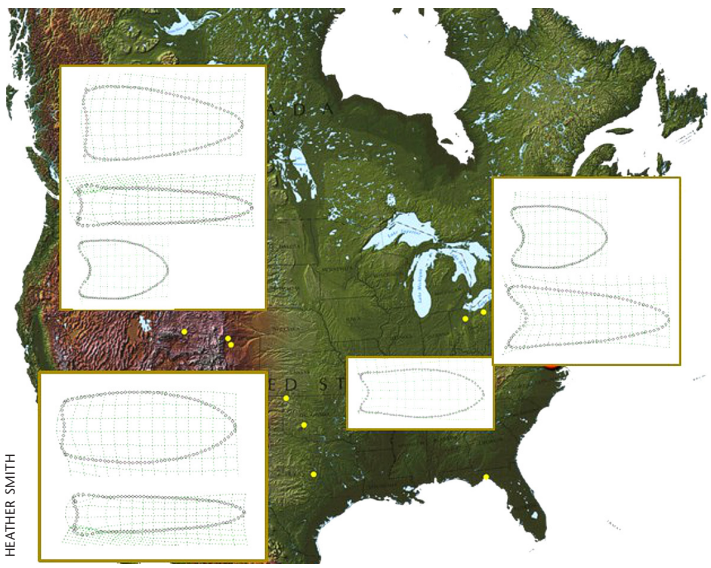


HEATHER SMITH

Landmarks placed around the perimeter of a Clovis point in the tpsDig program seen in a series of magnifications.

Gauging variability across the use life of a point

For her project, Smith applied GM to analyze 107 projectile points from 21 North American Clovis sites. Smith included in her dataset only complete points from securely buried and dated contexts or from caches technologically attributed to Clovis. Points from caches are important because the shape and metrics of a point change throughout its use life until it is no longer salvageable. She included cached points in addition to points from other types of archaeological sites because in order to see a full range of variation "you must have the brand-new artifact in all its splendor, *and* its appearance at different stages in its use life after it's been broken and resharpened and so on." Cached points can, however, lead to misleading results if you are considering size as a major variable. "If all points in the sample are shorties that have been resharpened a lot," Smith cautions, "they could look like a uniform sample and seemingly different from the cached specimens, when in reality they're just different sizes." Geometric morphometrics allows Smith to look at shape, regardless of size, and identify which characteristics in shape are present on both pristine points from caches, and points that have been used and resharpened.



HEATHER SMITH

Major shape characteristics of Clovis points in each region generated using geometric morphometrics.

Resharpening may seem potentially problematic because its reductive nature alters the appearance of the original tool. If the technology is strategically designed with future resharpening in mind, however, some elements of shape imposed on the tool during resharpening may also be normative. In other words, regardless of the starting place—whether starting from virgin toolstone or reworking an existing point—the toolmaker's product must conform to a specific shape. This is Smith's hypothesis that she tested in her master's research. She found that in Clovis lithic technology there exists both a consensus norm and a modification norm, the former invoked during original tool construction, the latter when reworking. When creating a point from new toolstone, the toolmaker envisions the shape of the ideal point, the consensus norm. The modification norm comes into play when reworking an existing point. After all, Smith emphasizes, "the reason these points were strategically made was to make them repairable—after hitting rock and bone, they're going to break. The advantage to having such high-quality tools is that you can repair them."

What determines the shape of a knapper's product?

Smith's project seeks to identify this "normative shape," the template of a projectile point specific to a culture and representative of what is acceptable. "What is an effective point? How do we make it as a people?" she asks. "When one goes against the mainstream, there can be technological or even social consequences." Cultural characteristics, which translate to modernity and conforming to its societal norms, express the humanness of Clovis people. Through the course of her research, Smith focuses on a sequence of research questions. Is there variability in artifact shape? If so, is this variability patterned, and is that pattern developed during use or imposed by manufacturers? Caches

give you a baseline for where the sequence of reduction or resharpening begins. So that's the prime, primo shape. Do whittled-down forms retain the shape of the original? When toolmakers resharpen projectile points, are they trying to maintain the shape that's so important to their culture and technological standards, or do they just want a pointy rock? Hypothetically, a resharpened point must maintain a certain shape so it can be hafted to a spear shaft. Although this is a technological requirement and not necessarily socially imposed, it's a normative requirement all the same.

Smith regrets that we lack the necessary evidence to fully understand Clovis hafting technology. What sort of mechanism, in terms of a spear or a lance, were these points prepared to be mounted on? "To answer that question," she says, "we need the actual lance itself and the foreshaft, the part that actually connects the stone tool to the lance." These technological units were typically made of organic materials, which, unlike stone tools, haven't survived the passage of time. Only a few artifacts that may represent foreshafts made of bone have been found at such sites as Blackwater Draw in New Mexico and Anzick in Montana.

There may also be a religious or ceremonial purpose associated with Clovis points, which could explain the importance of conforming to a certain style. She points out that some caches contain huge, elaborate points that may have served as religious offerings. She cites as examples the East Wenatchee Cache, which has particularly large, elaborate points, and the Anzick Cache, which contains a child's burial. Here we see hints of daily life intertwined with the spiritual.

Toolstone and novice knappers

In addition to cached artifacts described above, Smith included in her study discarded artifacts, tools that lie beyond the boundary of what was considered acceptable and are essentially lost in the archaeological record. She didn't excavate any new sites for her study; instead, she visited museum collections to study assemblages from a variety of Clovis sites. Discarded artifacts are found at many types of sites from kill sites to quarry sites, where toolstone was acquired. One such site is the Gault site north of Austin, a quarry site excavated by Michael Collins of University of Texas and CSFA Director Mike Waters (**MT 20-1, -2,** "Assault on Gault"), where discarded points and fragments may be evidence of apprentice knappers learning how to make points. "You wouldn't want to be practicing the craft of making tools at a cache," she explains, where toolstone was brought from a distant source and was now a precious commodity, "but rather at a quarry where there's tons of material to use and practice on." This is just one more example of the importance Clovis placed on preserving tool shape and ensuring their survival as a people.

HEATH ROBSON

Smith collecting data on Clovis points at the Smithsonian National Museum of Natural History.

Clovis knappers required high-quality toolstone as the medium for executing their normative point style. "If you have raw material with flaws in it—like a vein of quartz running through it—when you try to impose force to begin removing flakes and that force travels through rock and hits this impurity, it's going to stop that force and mess it all up," says Smith. "The whole thing could break and prevent you from creating the shape you want." If you work with lower-quality raw material, you may still be able to make your point, but there are greater risks involved. In the early Paleoindian era, Clovis toolmakers made sure they had the best raw material at their fingertips. They went to the sources of the best toolstone and carried it throughout the Plains, depositing it in caches because "they wanted to make sure the piece they were choosing lacked impurities. They wanted to obtain the desired shape."

Variability across the continent

The Clovis projectile-point shape is defined by such characteristics as shallow basal concavities, low-profile basal corners, and excurvate blade shape. But departures from this normative style exist, and this variability is geographically patterned. There is a stronger affinity between Clovis points from the Northwest and Southwest than affinity of either with points from the Northeast. There is also less variability among sites in the Northwest and Southwest than in the Northeast.

Clovis tools from eastern North America differ in shape from those in the West. A noticeable difference is that the base of Eastern Clovis projectile points is much more concave than that of Western points. Hypotheses have been developed to explain this pattern by Smith and other anthropologists surveying variability in Clovis point shape using geometric morphometrics such as David Thulman, Briggs Buchanan, and Sabrina Sholts. They suggest that different types of toolstone available in the East, in terms of geological deposit and the size of pieces available (package size), differences in organic material

available for the hafting mechanism, and overall cultural change and innovation may be responsible for the differences in point morphology between Western and Eastern points.

Smith's study reveals basic differences in shape across North America. "In general, Clovis points in the West had excurvate blade morphology and relatively shallow basal concavities," she explains. "Instead of the sides of the projectile points being straight, they curve out a bit after leaving the base before returning to meet at the tip. In the East the sides are straighter. They don't have that kind of curvature and the increased depth in basal morphology is statistically significant." This tells her that the people in the East were changing the form of the fluted projectile point—perhaps they were descendants of Clovis, or members of a non-Clovis culture who adopted this type of fluting technology as it made its way eastward. A shape that had been stable and uniform across the entire plains region from Texas to Canada for 200–300 years had changed by the time it arrived in the East. "Is this a migration of people or a word-of-mouth idea being adopted by people?" Smith asks.

Quintessential examples of the Western and Eastern shape of Clovis points. The Western point from the Lehner site in Arizona has a shallower basal cavity and more highly curved sides than the Eastern point from the Lamb site in New York.

Eastern Clovis points are characterized by straighter sides and deeper basal cavities. There is also more variation among points than with those in the West, where tools are stylistically quite similar. Smith notes that "by the time we start seeing these points in the East, people have been on the continent longer. They may have larger populations, there may be more opportunity or necessity to be creative and inventive, and there may exist different resources and ecological settings." The greatest change is seen in the Northeast, which Smith finds exciting, because the Northeast, glaciated until late in the Clovis time period, was largely unpopulated. "By the time these characteristics are appearing in the East," she says, "you have people living in the Northeast." It's not surprising to Smith that Clovis points in the Northeast show the greatest variability.

How to account for the spread of Clovis toolmaking

According to Smith, migration likely explains the geographic spread of the characteristic shape of the Clovis point because of the close affinities in point shape between the Southwest and Northwest and the limited duration of Clovis technology. Moreover, variability seen in the Northeast may signify a "frontier situation," where outgrowths of an original population adapted technological standards to meet new ecological challenges. As populations dispersed eastward, they may have altered the morphology of the original Clovis point, the better to exploit new ecological conditions.

Technology was essential to Clovis for dispersal, subsistence, and adaptation, just as it is for modern humans. "These people I study were living and surviving," Smith tells us. "We're looking at a snapshot of their lives." Equally fascinating to Smith is the passage of time—how things change and how things remain the same. This constancy across time is evident in the reverence for beauty Clovis expressed in creating tools. "Even in the raw material they chose," Smith points out, "a really beautiful piece of quality stone may have been preferred over others." Clovis toolmakers wanted stone they could take pride in, and apparently chose toolstone for both its esthetic and practical qualities. In Smith's view, "They are not unlike us. This is only 13,000 years ago. We're not genetically different from these people at all. We likely have very similar values, concerns, and anxieties. You just can't say enough about the security of knowing that you and your family will have food on your plate tomorrow, as well as today; and the Clovis projectile point played an important role in providing this."

–Katy Dycus

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DNA Links Mexican Paleoamerican

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These results strongly support the idea that Paleoamericans were the ancestors of later American Indians and that they came to America from Asia by way of Beringia. Of course additional studies of ancient DNA from other Paleoamerican skeletons are needed to strengthen this argument and flesh out the details of the genetic histories of American Indians, but those studies are already underway. Preliminary results suggest that DNA from Kennewick Man, the most studied of all Paleoamericans (**MT 30-1,** "Kennewick Man: Ambassador from our ancient past"), corroborates what we've learned from Naia. Chatters told the *Seattle Times*, "The result from Kennewick is the same one we're getting from the other early individuals."

For all her distinctiveness, Naia is a long-lost sister of all American Indians. Future studies of her nuclear DNA are sure to provide a fuller picture of her relationships to living groups in both America and eastern Asia.

–Brad Lepper

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A Legacy of Impeccable Scholarship

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channels in the Egyptian Sahara revealed by the NASA Shuttle Imaging Radar. Their test excavations showed that beneath a featureless sand sheet lay ancient river channels filled with current-bedded sands similar to channel sands 8 km away, where Middle Paleolithic artifacts had been found. Artifacts greater than 100,000 years old were evidence of less arid periods of the hyperarid Sahara. Until 2001, Haynes made annual winter trips to continue this work.

For 40 years beginning in the 1960s, Haynes addressed many similar research patterns. His study of microstratigraphy and careful application of radiocarbon dating, particularly the AMS method, clarified artifact chronologies. At the Mill Iron bone bed, Haynes's analysis of Goshen artifacts challenged accepted knowledge concerning their age and typological relationships between Goshen artifacts of the Great Plains and Plainview artifacts located farther south. His work at the Clovis site found that the Clovis-Folsom transition was unexpectedly brief, and his new research in this area further solidified his own findings from earlier research in 1964.

The Clovis Drought Hypothesis

Using microstratigraphic observations and his broad view of trends in depositional and erosional cycles, Haynes was able to draw inferences about climate changes. Work during the 1990s at Clovis, Miami, Lindenmeier, Hell Gap, and Lange-Ferguson, combined with his San Pedro Valley project and data from other regions, led him to form the Clovis Drought Hypothesis. In it he argues that Clovis sites at Blackwater Draw in New Mexico and Murray Springs in Arizona dried up during the Clovis era; after the Clovis period ended, water tables rose once again. His article, "Geochronological and paleohydrological evidence for a Clovis-age drought in North America and its bearing on extinction," appeared in *Quaternary Research* in 1991.

Recently Haynes has returned to sites explored decades earlier by himself and other scientists to apply new techniques and compare the results with earlier conclusions. Some of these locations are the sites where Haynes launched his career a half century earlier (Clovis, Lindenmeier, Sandia Cave), others involve new work at more-recent important Paleoindian sites (Dent, Folsom, Miami, and Hell Gap).

Black Mats

Haynes's article "Younger Dryas 'black mats' and the Rancholabrean termination in North America" in the January 2008 *Proceedings of the National Academy of Sciences* draws on data from 97 geoarchaeological sites that date to the Pleistocene-Holocene transition. Haynes finds that about two thirds of the

sites contain a rich organic layer, or "black mat," which he interprets as a stratigraphic manifestation of the Younger Dryas cooling episode. These mats cover the Clovis-age landscape in which the last remnants of the terminal-Pleistocene megafauna are found. Stratigraphical and chronological evidence has convinced Haynes that the megafauna extinction was catastrophic, much too sudden and extensive to have been caused solely by either human predation or climate change. Although not all black mat layers are alike, Haynes determined that they all signify a relatively moist condition compared with that existing before and after they were deposited. Black mats, he concludes, are manifestations of Younger Dryas climate, which witnessed a rise in local water tables. They represent the end of the Allerød warm period and the abrupt beginning of the Younger Dryas, which coincided with the extinction of megafauna and the last evidence of the Clovis culture.

Battlefield geology

In an interesting sidelight to Haynes's geoarchaeological research, he studied the 1873 battlefields along the Yellowstone River in Montana and analyzed the stratigraphy of Deep Ravine at the 1876 Custer Battlefield National Monument. He investigated and mapped river terraces and alluvium to determine how both the U. S. Cavalry and the Indians used terrain geomorphology in combat. His study also found that some of the battlefield has been lost to river action. "I eagerly accepted the invitation to investigate the Custer site," Haynes says, "because one of my hobbies is the development of the breech-loading Springfield carbine that figured so prominently in the Indian wars."

The Haynes personal touch

Vance Haynes wrote extensively on the method and theory of geoarchaeology, but he preferred to go into the field and get his hands dirty. There were so few individuals that shared his unique background in geoarchaeology (a term not yet coined when he began to practice it) that opportunities to apply his skills abounded. His expertise in both the earth sciences and archaeology, an awe-inspiring record of published works, and the history of his investigations into fundamental issues concerning the peopling of the Americas have inspired generations of students. His refusal to relax his stringent standards has more than once stirred up controversy, which Haynes customarily meets by cordially agreeing to disagree.

"Besides the intellectual stimulation of his research," says geoarchaeologist Vance T. Holliday, who assumed Haynes's position in Anthropology and Geosciences at the University of Arizona when he retired in 2002, "Haynes has inspired us by being remarkably generous in sharing his time, talents, and ideas. There are few stratified Paleoindian sites on the Great Plains he hasn't visited, few kinds of radiocarbon samples he

hasn't worked with, and few aspects of Plains Paleoindian chronology and typology he hasn't addressed. I have always been particularly amazed by his ability to get along with so many different personalities."

Former students help take the measure of C. Vance Haynes and his impact on First American studies. "Anyone who had the privilege of taking a class with Vance, particularly Quaternary geology," says anthropologist Bruce Huckell of the University of New Mexico, "will remember being presented at the beginning of the course with T. C. Chamberlin's classic article on the method of multiple working hypotheses. Its philosophical resonance with Vance became apparent on field trips to alluvial exposures and archaeological sites, and clearly underlay his approach to understanding both the geological past and the human past. He always encouraged his students to think in terms of multiple working hypotheses whenever they were trying to make sense of the past."

VANCE HOLLIDAY

Haynes guiding a tour at the Murray Springs site, Arizona, 2006.

University of Oklahoma anthropologist Bonnie Pitblado attests to Haynes's unswerving devotion to ideals. "Vance always modeled a combination of impeccable scholarship with genuine respect for the work of others," she remembers. "In a field rife with contention, I never heard him take potshots at even those who vilified him for the sky-high standards to which he holds all scientists . . . himself included."

Haynes's long career in the geosciences and anthropology at the University of Arizona continued until 1999, when he technically retired. Today at age 87 he maintains an office at the university and continues his research. In the 2000s he has produced many substantive publications, including his contribution to a comprehensive multi-author study on the Murray Springs Clovis site in southeastern Arizona published by the University of Arizona in 2007.

In his career Haynes has amassed a jaw-dropping list of honors. He was the first recipient of the prestigious Fryxell Award of the Society of American Archaeology in 1978. In 1984 he became the second recipient of the Archaeological Geology Award of the Geological Society of America. He was granted a Guggenheim fellowship in 1980 and a Smithsonian Senior Fellowship in 1987. In 1990 he was elected a member of the National Academy of Sciences. He received the Medal of Merit of the Egyptian Geological Survey in 1996, and in 2002 he was presented with the Distinguished Career Award of the American Quaternary Association. These accolades testify to the remarkable breadth of scholarship his long career has brought to the Paleo world.

"Seeing the success of my students," says Haynes, "has made it all worthwhile."

– Martha Deeringer