MAMMOTH TRUMPET

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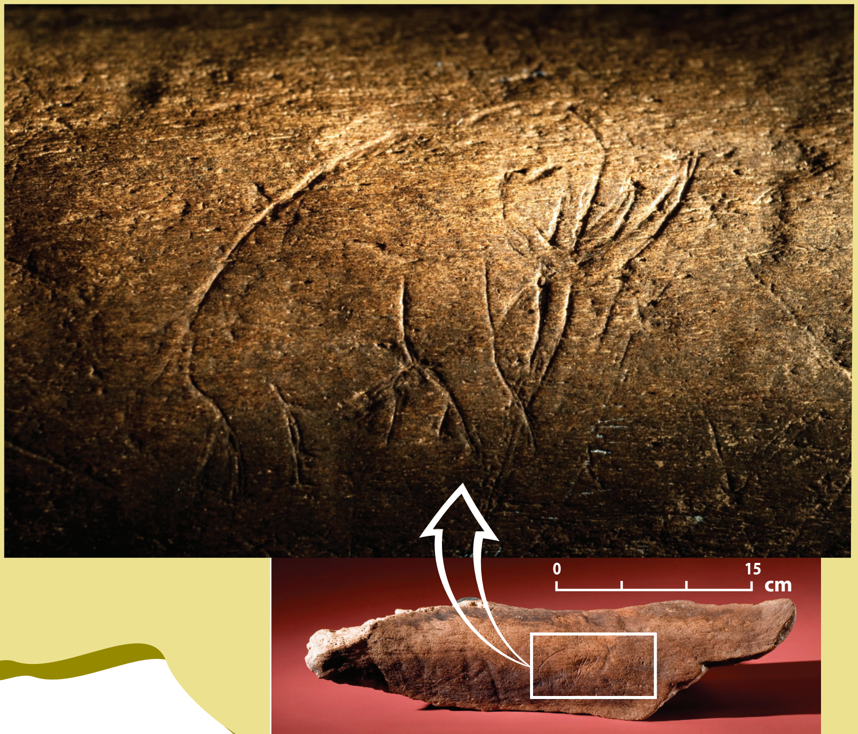
Mammoth Engraved on Bone from Florida



BOTH: CHIP CLARK, SMITHSONIAN NMNH

A **FOSSIL BONE** from Vero Beach, Florida, bears a remarkable engraving of a mammoth. Is this evidence of the earliest art in the Americas or an elaborate forgery? A team of scientists led by Barbara Purdy, Emerita Professor of Anthropology at the University of Florida, has conducted a thorough forensic investigation of the bone and its engraving. They conclude that the artifact "likely represents one of the first verified Paleoindian representations of a proboscidean in the Western Hemisphere."

INSIDE

Discovery of the bone

Sometime in 2006 or 2007, Vero Beach resident James Kennedy was out looking for fossils at an undisclosed location in northern Vero Beach, Florida. Among the specimens he collected on that otherwise unremarkable day was a scrap of fossil bone from some large Ice Age animal. In February 2009, while cleaning this seemingly unexceptional chunk of bone, Kennedy says he discovered that it was engraved with a small image of a mammoth. The engraving is a stunningly accurate depiction of a mammoth reminiscent of artistic styles of the European Upper Paleolithic. If proven to be authentic, this small bone would be the only image of a mammoth on portable art in the Americas. Moreover, it would be an important piece of evidence supporting the hypothesized relationship between Paleoindians and the Paleolithic cultures of the Old World.

Kennedy shared his discovery with Barbara Purdy at the University of Florida. Purdy assembled a team of specialists to subject the bone and its amazing engraving to a variety of tests to determine its authenticity. The team includes Kevin S. Jones, John J. Mecholsky, and Gerald Bourne from the Department of Materials Science and Engineering at the University of Florida (UF); Richard C. Hulbert, Jr. and Bruce J. MacFadden from the Florida Museum of Natural History at UF; Krista L. Church from the Department of Anthropology at the University of Texas; Michael W. Warren with the Department of Anthropology at UF; Thomas F. Jorstad from the Department of Paleobiology at the Smithsonian Institution; Dennis J. Stanford from the Department of Anthropology at the Smithsonian; and Melvin J. Wachowiak, and Robert J. Speakman with the Smithsonian's Museum Conservation Institute. Their paper was published online in July by the Journal of Archaeological Science.

The bone

The bone is a fragment, nearly 16 inches long and 4 inches wide, of a long bone from a large mammal. Based on the curvature of the bone, which indicates its original size, Purdy and her team conclude it's most likely from a mammoth or a mastodon, or possibly a giant ground sloth. The bone is highly mineralized, the original organic content of the bone having been largely replaced by inorganic minerals. This means it probably no longer contains intact DNA that could be used to identify the species. It also means it cannot be radiocarbon dated.

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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

The bone can, however, be dated reliably to the Pleistocene Epoch because it comes from a land animal larger than anything alive in Florida during the Holocene. As for the engraving, the anatomical accuracy indicates the artist was familiar with the appearance of a living mammoth.

KEVIN JONES

Bourne at the computer, Mecholsky looking over his shoulder, and Jones in the foreground when first handling the engraved bone

The engraving

The image of the mammoth, only about three inches long by almost two inches high, according to Purdy and her coauthors most likely represents a mammoth because of its "shortened, high-domed skull and longer forelimbs than hind limbs." Mastodons lack the high-domed skull, and their forelimbs and hind limbs are about the same size. A geometric design of "diamond pattern/cross hatched lines" appears to frame the mammoth engraving. It is most clearly evident on the left side of the mammoth.

Authenticating the bone

The late Carl Sagan famously quipped that "extraordinary claims require extraordinary evidence." The claim that the Vero Beach mammoth engraving is the "earliest art in the Americas" is definitely an extraordinary claim. Purdy and her coauthors having made extraordinary efforts to determine whether it might be a forgery, many on the team are convinced their results verify its authenticity.

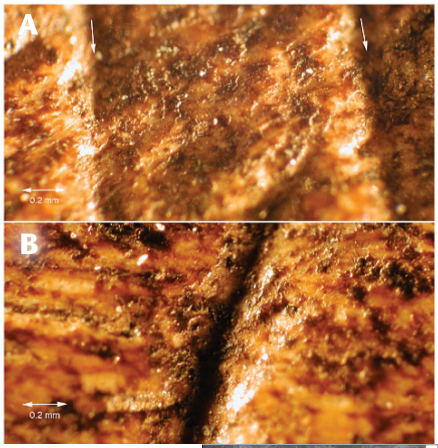
The team measured relative amounts of rare earth elements (REE) of the engraved bone and compared these with bones of extinct Pleistocene mammals from the Vero Beach site in the collections of the Florida Museum of Natural History. First of all, the REE levels in the engraved bone are consistent with those in fossil bone, which are greater by two orders of magnitude or more than in modern bone. Second, each site has a unique "fingerprint," a distinct proportion of rare earth elements; the proportion of elements in the engraved bone closely matches that in fossil bones known to have come from Vero Beach. Third, individual layers of the site can also be identified by their unique proportions of various elements, and the chemical composition of the engraved bone matches that of bones from those strata that have yielded most of the fossils of extinct Pleistocene mammals.

Authenticating the engraving

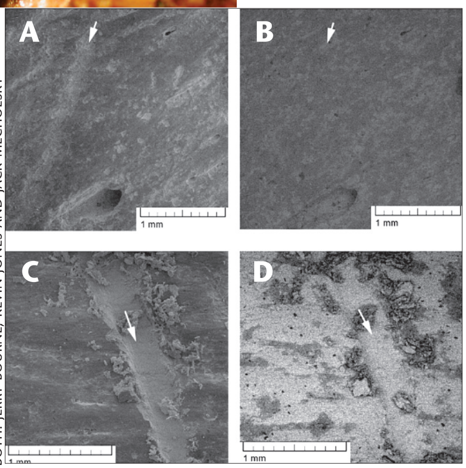
Having established rather conclusively that the engraved bone is Pleistocene in age and that it comes from the vicinity of the Vero Beach site, the next logical question concerns the engraving itself. Was it carved into a fresh bone by Paleoindians, or did someone recently engrave it into a fossil bone?

The study of the engraving began with a simple examination using an optical microscope. Purdy and colleagues describe the margins of the engravings as "smoothed and rounded," and the trough of the cuts "shows the same coloration and environmental inclusions as the rest of the bone." These observations are consistent with the interpretation that the engraving has suffered the same degree of weathering as the rest of the bone and therefore is as ancient as the bone itself.

The research team also examined the engraving using scanning electron microscopy (SEM). Comparing under extremely high magnification the engraved marks with a test incision made on the same bone fragment with a scratch made with a razor blade yields the most convincing evidence that the engraving is ancient. First of all, the scratch is bordered by a ragged "debris field" of material that has been gouged out of the bone but still adheres to the surface of the bone. In contrast, the



◀ Magnified views of mammoth engraving: **A**, two inscribed lines (mammoth trunk) showing that the coloration is the same inside the lines as on the surface; **B**, inscribed line (upper front leg) showing the smooth edges.

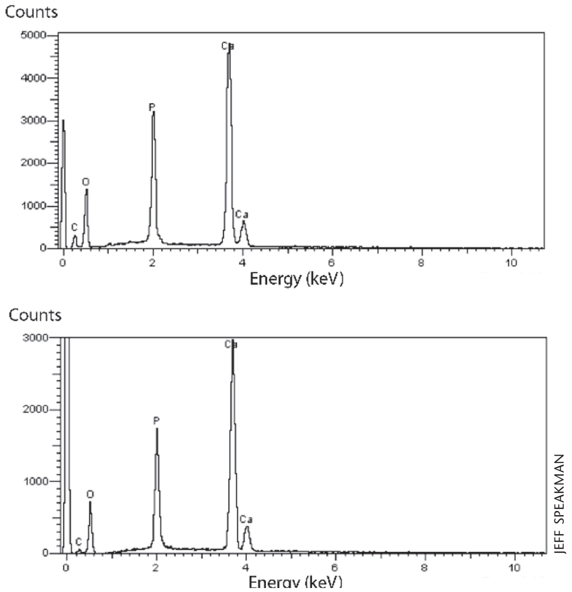


BOTH: JERRY BOURNE, KEVIN JONES AND JACK MECHOLSKY

▼ Secondary electron SEM images of fossil bone fragment: **A**, tusk region of incised image; **B**, backscattered electron SEM image of the same region, showing identical backscattered contrast inside the incision as in surrounding material; **C**, secondary image of intentional scratch made by authors on the surface showing debris field and rough edges; **D**, backscattered image of the same region, showing a clear difference in the backscattered contrast inside the scratch compared with surrounding material (note the lack of dark contrast inside scratch).

incised lines of the engraving are shallower and show “no sign of a debris field.” This could indicate that geochemical or physical erosion over millennia had scoured away particles that would have been present when the engraving was made.

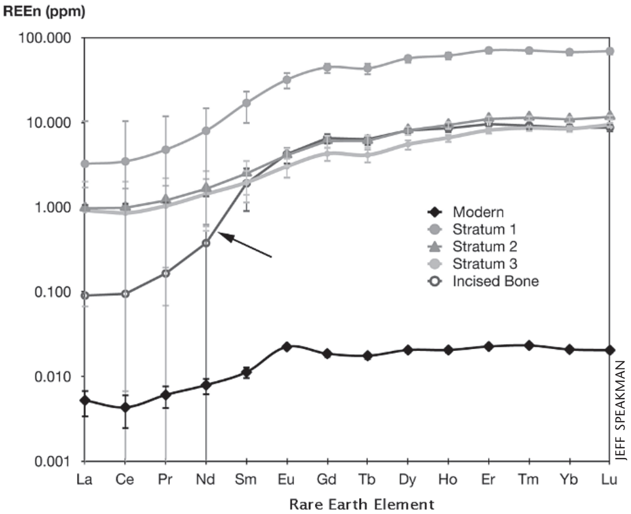
By detecting backscattered electrons reflected from the bone surface, SEM can extract data about variations in the elemental composition of the sample. In the backscattered image, the engraving marks are barely visible, thereby indicating that the elemental composition of the material at the bottom of the groove is consistent with the surrounding surface. Purdy and her coauthors conclude that “it appears that the mineralization occurred across the indentations caused by the scribing.” In other words, they interpret the evidence as a strong indication that the bone at “the bottom of the incised line and the surrounding materials aged at the same time in the same environment.”



EDS spectra confirming that no polymer was used to coat the surface of the incised bone: A, engraved bone from Vero Beach; B, comparison proboscidean bone from Vero Beach site.

Purdy and her team then used energy dispersive x-ray spectroscopy (EDS) to test the hypothesis that the SEM evidence was a result of a forger’s cutting the design into a fossil bone and then coating the specimen with a substance that would make the inside of the engraving appear to be the same as the fossil’s surface. The EDS results showed that the bone surface was “consistent with mineralized bone” and not some chemical coating. Moreover, the surface composition was identical to that of another mineralized bone from the Vero Beach area.

Finally, after subjecting a cast and mold of the bone to reflectance transformation imaging, the authors of the report found “no evidence that the engraving was made recently.” An important unexpected result of this procedure, however, was the discovery of additional geometric engravings that frame the mammoth image. The “diamond pattern/cross hatched lines” extend to the edges of the bone fragment but don’t continue past the rounded broken edge, which suggests to Purdy and her colleagues that “the engraving occurred before the bone broke” and would have extended onto the missing portion of the bone.



Rare earth element (REE) concentrations of the incised bone compared with average values by stratum at the Old Vero site (8-IR-9).

Paleoamerican art or modern forgery?

Purdy and her team acknowledge that, in spite of the evidence of authenticity so far accumulated, “there exists the possibility that the incised bone is a forgery.” The engraving could have been cut into a fossil bone fragment by a modern artist who then used some unknown chemical or physical means to soften the contours of the engraving to make them appear ancient. The research team concludes, however, that on the basis of the studies conducted so far, “all scientific evidence is consistent with the incisions mineralizing simultaneously with the surrounding bone surface.”

There have been other claims for Paleolithic engravings of mammoths or mastodons in North America. All of these, however, were subsequently proven to be forgeries. In 1976, the journal *Science* reported that a reevaluation of the Holly Oak pendant suggested that it was an authentic engraving of a mammoth on a fossil whelk shell. Eventually, however, radiocarbon dating of the shell showed it to be a 19th-century fraud.

There are a variety of rock art images claimed by some experts to be authentic representations of mammoths, mastodons, or other Ice Age megafauna (**MT 25-2,** “Paleolithic art in North America?”). If the Vero Beach engraving proves to be genuine, it might not be a unique example of Paleoamerican artistry, but it would be the only known image of a mammoth depicted on Paleoamerican portable, or mobiliary, art.

In the future, additional study of the Vero Beach site or applying new methods of analysis to the specimen may remove any doubt about the antiquity of the engraving. The opportunity for additional studies of the specimen, however, will depend on the outcome of an upcoming auction of the specimen. If it doesn’t end up in a museum, it may no longer be accessible to the scientists. Ironically, the Web site advertising the auction cites the conclusions of Purdy and her team as proof of authenticity.

Potential significance of the discovery

If the Vero Beach mammoth engraving is authentic, how would it affect our understanding of the Paleoamerican past?

First of all, Purdy and the colleagues point out that in 1916,

E. H. Sellards claimed that human skeletal remains had been found "in apparent association" with the bones of Ice Age megafauna at Vero Beach, but these claims were disputed. If the Vero Beach engraving is genuine, then it suggests that Sellards's claims should be reconsidered.

It is the similarity of the Vero Beach mammoth engraving to the artistic styles and subjects of the Old World Upper Paleolithic that has the most far-reaching implications. Purdy and her team offer the tantalizing possibility that this similarity might indicate "a more direct Ice Age connection between North America and Europe." This would, of course, be supporting evidence for the theory of Dennis Stanford, another member of the research team, that the Americas were peopled, in part, by the European Paleolithic Solutrean culture (**MT 17-1,** "Immigrants from the Other Side?").

On the other hand, Kenneth Feder, archaeologist from Central Connecticut State University and author of the book *Frauds, Myths, and Mysteries: Science and Pseudoscience in Archaeology,* suggests that the similarity between the Vero Beach mammoth engraving and Old World examples might have a more prosaic explanation. If it turns out that the engraving is a modern forgery, the Old World Upper Paleolithic depictions are the most obvious models that a forger would copy, just as they were for the forger of the Holly Oak engraving.

To their credit, Purdy and colleagues have stated their intention to undertake future investigations of the Vero Beach site that "will provide additional data to address this important question."

The greatest obstacle to authenticating the Vero Beach mammoth engraving is the absence of a verifiable archaeological context. Even though the bone has been confirmed to be from the area of the Vero Beach site and, moreover, from the layers yielding the richest trove of Pleistocene fossils, the circumstances of its discovery and subsequent history as well as the precise location of its discovery site remain uncertain.

After reviewing the Holly Oak pendant and two other 19th-century frauds involving engravings of mammoths or mastodons on artifacts, the late Herbert Kraft concluded that "unless excavated under controlled conditions and irrefutable circumstances, we probably ought seriously to question and carefully examine every inscribed gorget, pendant, or tablet." Purdy and her colleagues have indeed carefully examined the Vero Beach engraving, and the results of an array of splendid tests performed on the specimen lend considerable weight to the hypothesis that the artifact is authentic. Nevertheless, the analyses don't dispel questions surrounding the context and circumstances of its discovery.

Future investigations of the site and specimen may answer the fascinating questions raised by Kennedy's intriguing discovery. If new analytical techniques yield more definitive results or if additional fieldwork should turn up additional examples of Paleoamerican art in solid context, the Vero Beach mammoth engraving will be recognized as the early American masterpiece it appears to be.

–Bradley Lepper

JEFF GAGE

In Powell Hall at the Florida Museum of Natural History August 2011 *(left–right)* Bruce MacFadden, Barbara Purdy (holding a cast of the incised bone), and Richard Hulbert. Not shown is team member Michael Warren.

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Suggested Readings

Alpert, B. O. 2010 A context for the Vero Beach Engraved Mammoth or Mastodon. Paper presented at the "Pleistocene art of the Americas" symposium, IFRAO Congress, September 2010; available online at http://www.ifraoariege2010.fr/docs/Articles/Alpert-Amerique.pdf

Feder, K. 2010 *Frauds, Myths, and Mysteries: Science and Pseudoscience in Archaeology,* 7th edition. McGraw-Hill, New York.

Kraft, H. C. 1996 Mammoth Frauds in Archaeology. *Bulletin of the Archaeological Society of New Jersey* 51:1–11.

Purdy, B. A., K. S. Jones, J. J. Mecholsky, G. Bourne, R. C. Hulbert, Jr., B. J. MacFadden, K. L. Church, and M. W. Warren 2010 Earliest Art in the Americas: Incised Image of a Mammoth on a Mineralized Extinct Animal Bone from the Old Vero Site (8-Ir-9), Florida. Paper presented at the Pleistocene Art of the Americas symposium, IFRAO Congress, September 2010; available online at http://www.ifraoariege2010.fr/docs/Articles/Purdy_et_al-Amerique.pdf

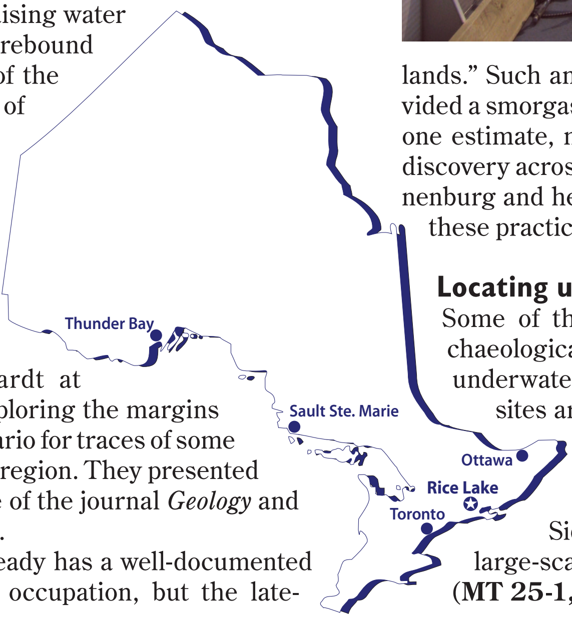
Purdy, B. A., K. S. Jones, J. J. Mecholsky, G. Bourne, R. C. Hulbert, Jr., B. J. MacFadden, K. L. Church, M. W. Warren, T. F. Jorstad, D. J. Stanford, Melvin J. Wachowiak, and Robert J. Speakman 2011 Earliest art in the Americas: Incised Image of a Proboscidean on a Mineralized Extinct Animal Bone from Vero Beach, Florida. *Journal of Archaeological Science,* in press.

GEOARCHAEOLOGISTS from McMaster University in Hamilton, Ontario, are using the smallest clues to track the footsteps of ancient Americans across the now submerged landscapes of the Great Lakes. Recovering "microdebitage," the microscopic residue of stone tool production, from soil cores promises to reveal otherwise undetectable locations of Paleoindian and early-Archaic sites now submerged along America's coastlines. Moreover, this technique may answer important questions about the routes by which people entered the New World.

Microdebitage Analysis Makes Big Contribution to Archaeology

Water where they once walked

The Ice Age arrival of Paleoamericans in this hemisphere coincided with a period of lowered sea levels, with the result that much evidence of the peopling of America now lies beneath the ocean on the submerged continental shelves. In the continental interiors, lake levels also have fluctuated with the sometimes competing rhythms of melting ice sheets, which pumped meltwater into lake basins raising water levels, and with the isostatic rebound of the land with the lifting of the weight of many cubic miles of glacial ice that resulted in lower water levels for some lake margins. Using coring equipment and advanced analytical methods, geoarchaeologist Elizabeth Sonnenburg and her geoscientist colleagues Joseph Boyce and Eduard Reinhardt at McMaster University are exploring the margins of Rice Lake in southern Ontario for traces of some of the earliest peoples in this region. They presented their results in the July issue of the journal *Geology* and in Sonnenburg's dissertation.



The Rice Lake region already has a well-documented record of early-Paleoindian occupation, but the late-Paleoindian through the middle-Archaic cultures are poorly represented. One of the reasons for this gap in the archaeological record is that this period coincided with a major lowstand of Lake Ontario, when its waters were more than 100 m below the present level. According to Drs. Sonnenburg, Boyce, and Reinhardt, at that time "more than half of the area of the modern lakebed . . . was exposed lake plain with extensive coastal wetlands." Such an environment rich with game would have provided a smorgasbord for early-Holocene hunter-gatherers—by one estimate, more than 1,000 prehistoric sites are awaiting discovery across this submerged landscape. The problem Sonnenburg and her team are tackling is how to locate and study these practically inaccessible sites.

Taking core samples at the McIntyre site *(left–right)* Sonnenburg, Reinhardt, and Boyce.

ALL PHOTOS: ELIZABETH SONNENBURG

Locating underwater sites

Some of the challenges to discovering underwater archaeological sites are obvious. First of all, besides being underwater, the scatters of stone tools that constitute early sites are also likely to be buried under lake sediment whose depth increases with age. To try to use soil cores to recover individual artifacts from underwater sites is doomed to failure. Side-scan sonar has been successful in locating large-scale built structures exposed on lake bottoms (**MT 25-1,** "Finding Traces of Early Hunters beneath the

Great Lakes"), but it can't reveal traces of small artifact scatters even if they lie exposed on the lake bottom.

The solution Sonnenburg and her colleagues have hit on to overcome these challenges is to look for the smallest but most common artifacts found in every Stone Age archaeological site: microdebitage. The bits of stone that constitute microdebitage are produced in huge quantities when stone tools are made. According to Knut Fladmark, Simon Fraser University archaeologist and pioneer of microdebitage analysis, more than a *million* pieces of microdebitage can result from making a single stone tool. Microdebitage often isn't collected in terrestrial archaeological surveys because the effort required to recover and analyze prodigious quantities outweighs the benefits. Yet these same disadvantages of dealing with microdebitage on terrestrial sites make it a supremely useful tool for locating submerged sites.

Reinhardt and grad student Gillian Krezoski retrieving samples from cores.

Sonnenburg and her team selected a small lagoon on the western side of Rice Lake as the focus for their investigation. The McIntyre site, a known multicomponent archaeological site, is situated around the banks of the lagoon, and the team thought it likely that occupations corresponding to periods of lower lake levels extended onto the formerly dry and exposed lake bottom. Although the McIntyre site is predominantly a late-Archaic site, there are also Paleoindian and early- and middle-Archaic occupations that would have been coeval with the lower lake levels.

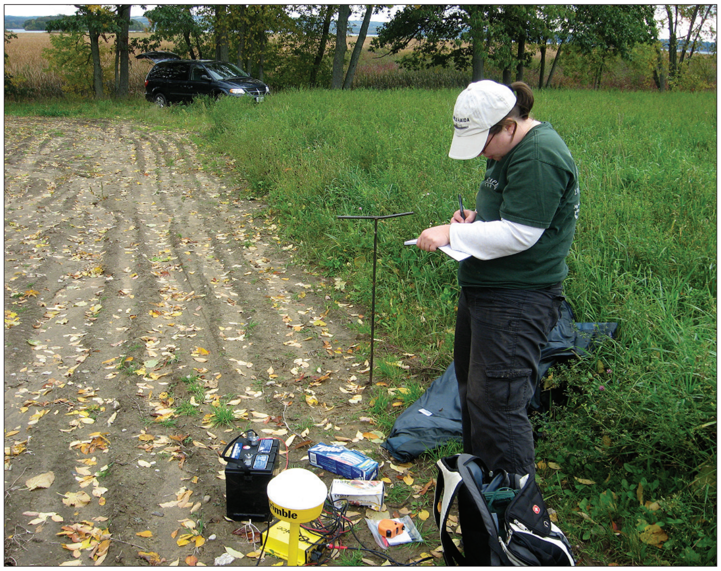
Reconstructing Paleoenvironments

In addition to microdebitage, sediment cores also contain important clues to the paleoenvironments of the late Pleistocene and early Holocene. By correlating this information with recovered microdebitage, Sonnenburg and her colleagues get a clearer picture of late-Paleoindian and early-Archaic patterns of land use.

In one core, Sonnenburg's team made a laser-diffraction analysis of particle size on sediment samples taken at 1-cm intervals and a microfossil analysis at 5-cm intervals. In particular, the team looked for testate amoebae, single-celled organisms that build shells, or tests, that can be preserved in sediments for millennia. Because different species lived in different environments, they are "sensitive indicators of changes in lake environment . . . and water levels." Based on the kinds of mineral particles, the size of the grains, and the varieties of testate amoebae, the team identified six stratigraphic layers. The lowest two levels included mud and sand from ancient Lake Iroquois. Next was a layer of peaty mud 10–40 cm thick with lots of plant matter and assorted amoebae typical of soils in a wetland environment. This layer was dated using AMS C-14 dating of seeds and wood fragments to between 9480 and 8760 RCYBP. Overlying this was marl with mollusks and amoebae characteristic of an open-water lake environment. Finally, the uppermost layers consisted of a 1- to 3-m-thick sequence of highly organic mud and peat.

Recovering and identifying microdebitage

The team extracted a total of five soil cores, each about 7 cm in diameter, from the lagoon. Each core was mapped, recorded, and sampled to test for the presence of microdebitage as well the paleoenvironmental indicators. To search for microdebitage, the team extracted 20 g of sediment at 5-cm intervals along the first core and at somewhat greater intervals in the other cores. The team then examined particles from each of these samples using scanning electron microscopy (SEM) to identify the presence of microdebitage.



Sonnenburg augering at the McIntyre land site.

Sonnenburg and her coauthors use four criteria to distinguish microdebitage from ordinary particles of stone: angularity, geometry, presence of conchoidal fractures, and relative grain size.

Sedimentary particles in most environments tend to have rounded edges due to weathering, erosion, and tumbling against other particles in water or wind. Microdebitage is distinguished by sharp, angular edges as long as it hasn't been subjected to these erosive forces.

Particles subjected to natural weathering and erosion tend to have spheroidal or blocky shapes. Microdebitage, on the other hand, tends to look like ordinary debitage but on a much smaller scale. Sonnenburg and her co-authors characterize microdebitage as "flat or blade-like grains with triangular, subrectangular, [or] trapezoidal shapes."

An identifying characteristic of ordinary debitage is the presence of conchoidal (shell-like) fractures and flake scars. The microdebitage from flint and other toolstones displays many of the same features including scars from previous flakes on the dorsal (outside) face of the microflake and ripple marks on the ventral (inside) face.

Grad student Gillian Krezoski taking auger samples on a land site.

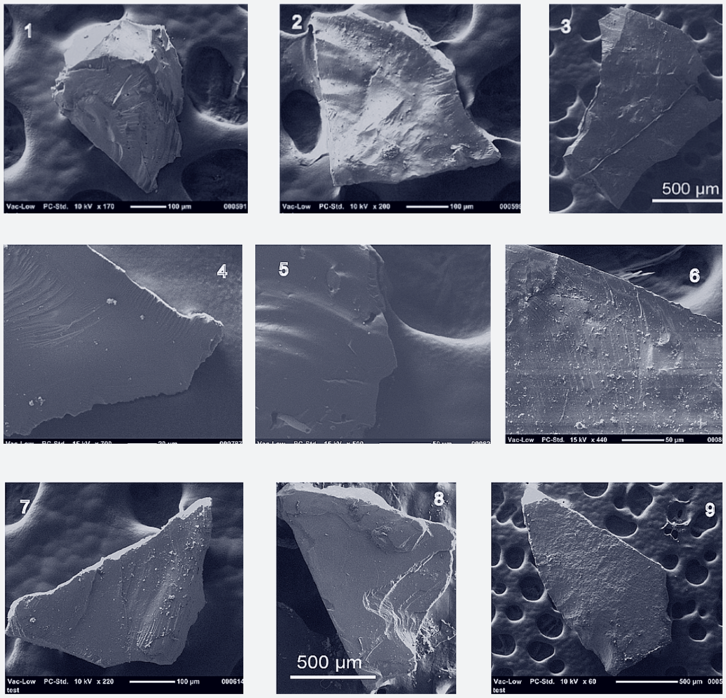
Finally, microdebitage particles, though small, tend to be larger than ordinary sediment particles—at least in the sediment samples Sonnenburg's team studied.

It isn't always possible to distinguish microdebitage from naturally produced stone chips. Certain kinds of sediments make it hard to distinguish macrodebitage, or even simple stone tools, from naturally produced objects. But by using all these criteria and taking into account the sedimentary context, microdebitage analysis holds much promise for archaeology.

SEM images of microdebitage and sediment particles

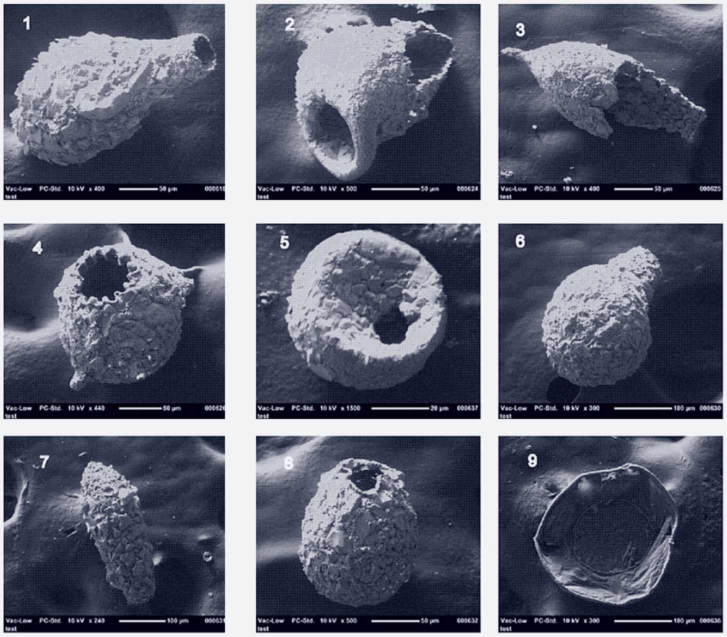
1 Microdebitage from McIntyre site
2 microdebitage from RIL* 10
3 experimental obsidian microdebitage
4 microdebitage, showing feathered edges and unidirectional striations
5 microdebitage, showing thinned edge and unidirectional conchoidal fractures
6 microdebitage, showing thinned edge and unidirectional striations
7–9 naturally occurring angular quartz grains, RIL 10

*RIL indicates Rice Lake provenance



Thecamoebian SEM images

1 *Difflugia oblonga 'oblonga'*
2 *Centropyxis constricta 'aerophila'*
3 *Difflugia proteiformis 'proteiformis'*
4 *Difflugia corona*
5 *Centropyxis aculeata 'discoides'*
6 *Lagenodifflugia vas*
7 *Difflugia oblonga 'linearis'*
8 *Cucurbitella tricuspis*
9 *Arcella vulgaris*



Results

Sonnenburg and her colleagues recovered a total of 155 quartz microdebitage fragments from three cores taken from Rice Lake. Examination with a scanning electron microscope confirmed that the microdebitage matched all the criteria that distinguish by-products of stone tool production.

In each core, the microdebitage was found in a layer of peaty mud with abundant plant material, the same layer that produced the early-Holocene radiocarbon dates and the paleoenvironmental data indicating a wetland environment. They interpret these results as "evidence for primary deposition of lithics at tool-making sites."

Since several of the cores were extracted just offshore from a known archaeological site, it's possible the microdebitage recovered in the cores was washed or blown into the lake from the adjacent land surface. Sonnenburg and her team reject this interpretation, however, because the microdebitage has not been rounded by erosion. In addition, one of the cores taken closest to the terrestrial site had no microdebitage. Sonnenburg and her colleagues argue that these facts are "consistent with localized scattering of lithics at individual toolmaking sites, as opposed to wider dispersal of lithic fragments by fluvial or eolian processes."

Rice Lake survey boat with GPS and sonar equipment attached.

The fact that the recovered sample consisted only of quartz with no flint might seem odd, since most large stone tools recovered at sites in southern Ontario are made from exotic cherts, but Sonnenburg and co-authors note that quartz and quartzite were the favored raw material at many Ontario late-Paleoindian and early-Archaic sites. The radiocarbon dates for the peaty layer in which the quartz microdebitage was found are early Archaic in age, so we would expect to find a preponderance of quartz tool production at these sites.

Discovering ancient occupations on submerged landscapes

Sonnenburg, Boyce, and Reinhardt's research "represents the first use of microdebitage to locate a submerged prehistoric site in the eastern Great Lakes." They suggest that the clusters of quartz microdebitage they identified in their coring "could represent a logistical camp on the periphery of a main encampment"; the main encampment would be the documented terrestrial site on the margins of the lagoon. Alternatively, they propose that these microlithics represent the by-products of tools "manufactured or sharpened on the spot during a hunting-gathering foray" by groups exploiting the locally available quartzite cobbles.

Regardless of the specific interpretation of the site, Sonnenburg and co-authors have demonstrated that "microdebitage analysis is a viable approach for exploration for submerged prehistoric sites." The method requires only a conventional light microscope to initially identify microdebitage in lake sediments, although SEM microscopy may be necessary for making more definitive analysis. No special extraction techniques are required, and the search for microdebitage needn't hinder the conventional use of soil cores for analyzing paleoenvironmental data such as microfossils, including pollen, and particle size.

Microdebitage analysis offers great potential as a method for locating underwater archaeological sites. Given the importance of America's submerged coastlines for evaluating various theories for how Paleoamericans first migrated into this hemisphere, this technique may become increasingly important in First Americans studies. It's ironic that the humblest by-products of stone tool manufacture, rather than the spectacular projectile points themselves that have dominated archaeological research for decades, may be the most important clues for solving one of the biggest problems in American archaeology. MT

–Bradley Lepper

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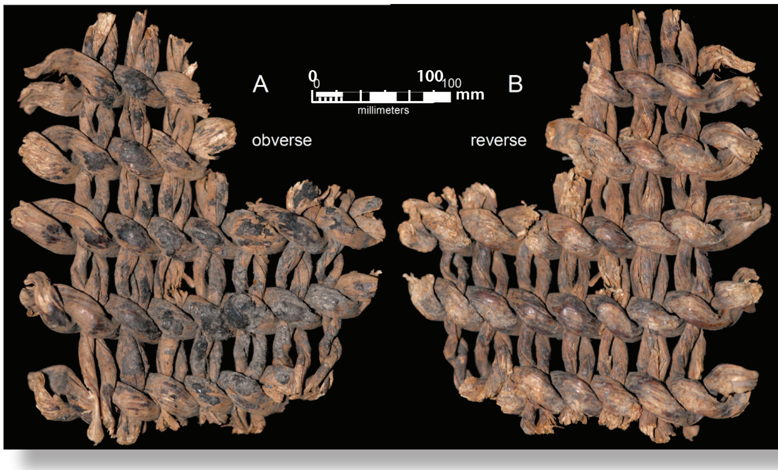
Suggested Readings

Fladmark, K. 1982 Microdebitage Analysis: Initial Considerations. *Journal of Archaeological Science* 9:205–20.

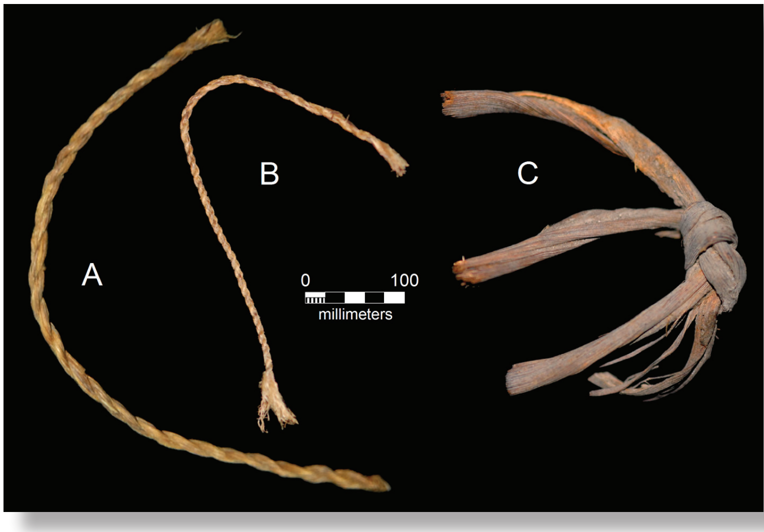
Sonnenburg, E. P., J. I. Boyce, and E. G. Reinhardt 2011 Quartz Flakes in Lakes: Microdebitage Evidence for Submerged Great Lakes Prehistoric (Late Paleoindian–Early Archaic) Tool-making Sites. *Geology* 39:631–34.

The obverse and reverse sides of a fragment of a twined mat or basket container AMS dated to about 11,200 CALYBP. Black grimy residue *(left)* and wear from use *(right)* are visible.



The FIBER of Their Being

Direct Dating Fiber Artifacts



BOTH: PHIL GEIB AND EDWARD A. JOLIE

AMS-dated cordage from Complex II of Guitarrero Cave. **A**, 2-ply cord of medium diameter. **B**, 2-ply cord of small diameter. **C**, two twisted leaves (probably Bromeliaceae) tied in a square knot.

Part I: Dating We Can Trust

THERE WAS A TIME when fiber artifacts from the ancient Americas were forgotten or ignored. Stone tools took precedence because of their sheer numbers and because of the emphasis on pursuing ancient hunting methods. The fact that fiber artifacts are so vulnerable to the effects of time further obscured their value. On rare occasions when remnants were found, too often it was by archaeologists who had little experience in handling, preserving, and analyzing fragile materials. It's no wonder it took us so long to discover that what we were finding was archaeological gold in fiber form.

Today we recognize that fiber artifacts are diamonds in the rough. Really, really fragile diamonds, which if handled with respect offer otherwise unattainable insight into the lives of the people that made and used them. Entwined in these artifacts is a glimpse of a culture on a truly personal level because every movement of the maker's hands is manifest in the visible record. The real value to the archaeologist lies in another domain: Fiber artifacts have the ability to date a site with more certainty than any other materials.

James Adovasio and Edward Jolie of Mercyhurst College, Phil Geib of the University of New Mexico, and Thomas F. Lynch from the Brazos Valley Museum have taken their refined techniques for dating fiber artifacts to low latitudes and high elevations. High in the Andes lies a site that's a rare find, for it contains not one or two, but dozens of fiber artifacts. Previous radiocarbon dates were old, for skeptics unbelievably old, and the stratigraphy of the site is on shaky ground at best. Could it possibly be as old as originally dated? Now we have the means to find out.

Strands of time

What makes dating fiber artifacts better than dating anything else? Perhaps the real question to ask is, What can be wrong with dating other objects? The answer is a lack of certainty. We've come to trust our ability to date wood and charcoal, but though we may be confident in the dating methods, the wood or charcoal itself is another matter. Dr. Lynch was keen to point this out 25 years ago (**MT 3-3**, "Linking Two Americas"). Today Dr. Jolie iterates Lynch's message, that though wood is datable it's also reusable. We have no way of knowing that the wood used by early peoples hadn't sat nicely preserved somewhere for a few hundred years before they used it, thereby skewing our dates and distorting our timeline. Nor can we always tell if the charcoal we find isn't the result of natural burning, nature's way of housekeeping. There's a good chance dates made on charcoal from occupation sites are on the money, but there's still an uncomfortable measure of doubt that these objects were actually associated with humans. What we need is something that was the unmistakable product of human presence, an artifact with an ironclad guarantee.

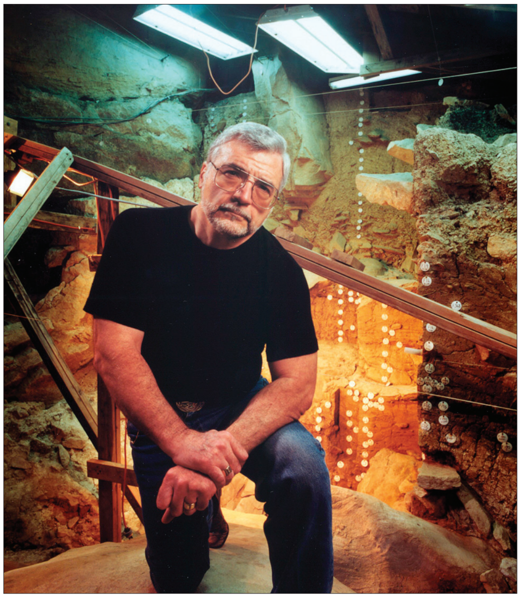
Human remains as a substitute for artifacts spring readily to mind. They don't, however, spring readily from the earliest sites in North and South America. Lacking the remains of people, we can rely on objects that we are absolutely certain belonged to them. Fiber artifacts fall exactly in that category. "Since textiles are of indubitable human manufacture," Dr. Adovasio explains, "by dating them, you have established a minimum age for the presence of humans at any locality from which they derive." Oddly enough, the very perishable nature of fiber artifacts makes them perfect for dating. We can be certain that ancient people weren't making garments, ropes, mats, or bags out of centuries-old plant fiber because this simply isn't possible.

When archaeologists recognized the value of fiber artifacts from the Old and New World as datable material, they were eager to obtain ages for them. As dates on ancient cordage and textiles started to roll in, we discovered that human ability to craft usable products from plant fiber is more ancient then we had formerly supposed. The oldest by a comfortable margin, though not directly dated, are from the Pavlov I and Dolni Vestonice I and II sites in the Czech Republic, which have produced both textiles and cordage dating to 26,300–29,300 RCYBP. The next runner-up doesn't appear until many millennia later, around 19,300 RCYBP on the Sea of Galilee. Around 17,000 radiocarbon years ago a few sites start to crop up in Ukraine, Moldova, and France. Asia doesn't join the game until about 13,500 RCYBP, and neither Africa nor Australia has anything to offer in this early timeframe.

GWEN SAUL

Jolie in the lab.

The New World has surprises of its own to offer. Meadowcroft Rockshelter in Pennsylvania, which principal investigator Dr. Adovasio has for years offered as evidence for pre-Clovis human presence in North America, has something that may top all but the oldest textiles and cordage in the world. Retrieved from the lowest levels of the site was a piece of bark that appears to have been deliberately cut. When dated it returned a mind-boggling age of 19,600 ± 2400 RCYBP, which Adovasio labels as tentative. Until its age is confirmed or refuted, the honor of the oldest known fiber artifacts in the New World is held by cordage from the Monte Verde site in Chile, which was wrapped around wooden stakes; those stakes have been soundly dated between 13,563 ± 250 and 11,790 ± 200 RCYBP. Meadowcroft next reports in with not mere cordage, but sophisticated basketry. Layers above and below the plaited fibers date it between 12,800 ± 870 and 11,300 ± 700 RCYBP.



MERCYHUST COLLEGE

Adovasio at Meadowcroft Rockshelter, ca. 2000.

Securely dated fiber artifacts dating to the Pleistocene have been found at the Hiscock site in New York, Danger Cave in Utah, and Fort Rock Cave in Oregon. All have yielded cordage dating to around 11,000 RCYBP.

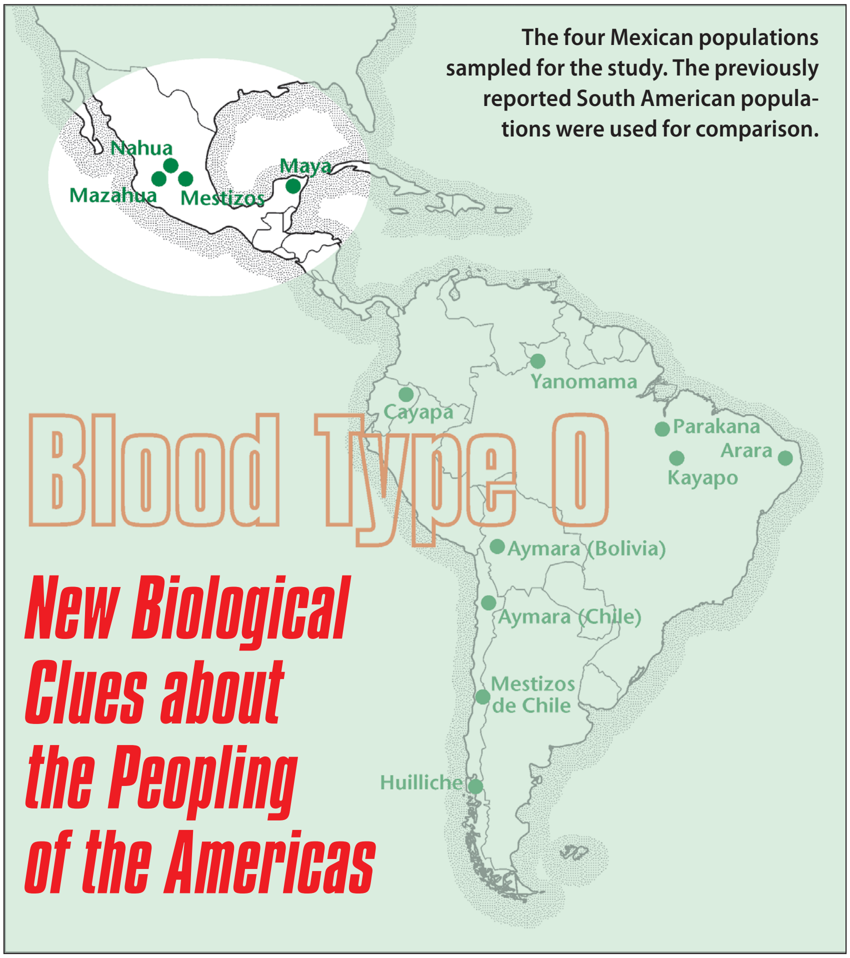
New methods untie the archaeologist's hands

Perishable fibers from the Fort Rock Cave site were directly dated, not simply associated with other dated objects. Like wood and charcoal, artifacts made from plant remains can be dated directly. Though direct dates are unquestionably desirable, the method for obtaining them in the recent past undeniably wasn't, for early radiocarbon-dating technology required reducing an entire speci-

continued on page 20

Blood Type O

New Biological Clues about the Peopling of the Americas



The four Mexican populations sampled for the study. The previously reported South American populations were used for comparison.

WHEN IT COMES TO UNDERSTANDING human prehistory, the disciplines that tend to spring to mind first are those based in the solid Earth beneath our feet: geology, archaeology, paleontology, and related sciences. And admittedly, that's where we've derived most of what we already know about our pre-literate ancestors. So it's easy to forget that clues to important questions about human origins can be found not just beneath our feet, but *within* them as well. As our comprehension of the life sciences has evolved, we've learned to use even the tiniest biological indicators—particularly biochemical and genetic data—to fine-tune the stories told by the physical evidence.

That's precisely what one team of Mexican researchers did recently in a landmark study that appeared in the May 2010 issue of the *American Journal of Physical Anthropology.* As Benito Estrada-Mena of the Universidad Nacional Autónoma de México (UNAM) and ten colleagues demonstrated in their paper, "Blood Group O Alleles in Native Americans: Implications in the Peopling of the Americas," even something as ordinary as a blood cell can tell extraordinary stories about the makeup and history of the First Americans.

Circulatory clues

Because human blood chemistry is well understood in biomedical circles, it's an excellent avenue for investigating genetic variation at the molecular level. In particular, blood antigen groups offer intriguing clues. Except for a few rare variants, human blood is characterized by three such groups, designated A, B, and O, which can combine in various ways to form blood types A, B, AB, and O. The three gene varieties (or alleles, to use the biological term) differ only at the molecular level, encoding for enzymes that produce specific antigens—"antibody generators"—on the surfaces of many types of cells, including red blood cells. These antigens are always either A or B. Typically, they each produce antibodies to attack the other—though oddly enough, people with blood type AB don't produce either type of antibody. Blood cells with the non-functional O-allele lack surface antigens of either type.

As it happens, O is also the most common allele, appearing in 61%–98% of individuals worldwide depending on the population. Note that these numbers don't represent the percentage of people with blood *type* O, but simply those with an O-allele in their blood makeup. Because most genes are expressed in pairs (one per parent), many people who present as blood types A or B actually have a recessive O-allele that can be passed on to their children. This ubiquity helps make O-alleles excellent markers for tracking biological kinship and, through logical deduction and inference, other characteristics of a population that aren't immediately obvious—such as where their ancestors came from, and what might have befallen them along the way.

O-alleles in the Americas

Dr. Estrada-Mena and his colleagues tested DNA from the blood cells of 180 type O individuals belonging to four Mexican cultural groups, looking for inherited antigen mutations and comparing their results with those derived from other studies of South American and Asian populations. The three Native American groups were selected for two primary reasons: accessibility, and, according to Estrada-Mena, "because each of them corresponds to a different Mesoamerican language family." The 37 Nahua tested speak a Uto-Aztecan language, the 50 Mazahua speak an Oto-Manguean language, and the 50 Maya speak Mayan; in terms of sheer numbers, these three language families are the most widely spoken in Mesoamerica. Furthermore, the Nahua, Mazahua, and Maya "constitute groups that represent distinct socio-cultural entities," notes Alejandro García Carrancá of the Instituto Nacional de Cancerología, one of the paper's co-authors. The researchers also included 43 Mexican-Mestizos, people of mixed European and Native American ancestry, as a control group.

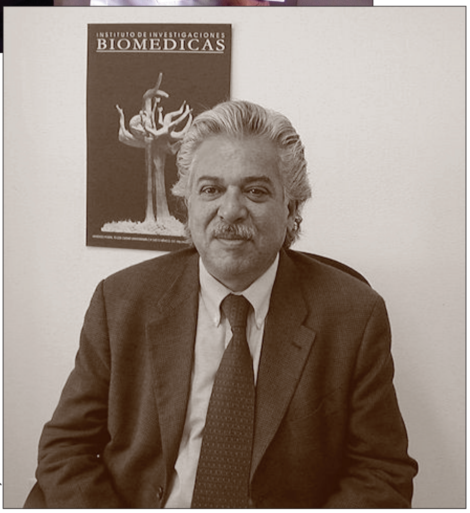
The team chose the O blood group for a simple reason: It's nearly universal among Native American cultures, especially those south of Canada. The Aleut-Eskimos of Alaska and western Canada do express A- and B-alleles in their populations, but only in small percentages. Moving farther east, the Na-Dene peoples of Canada and the northern U.S., as well as more southerly offshoots like the Apache and Navajo, express the A-allele occasionally, but the B-allele is almost entirely absent. In the rest of the Americas, O reigns supreme. This was especially true before the European invasion of the New World and the subsequent blending of cultures and biology.

It's hard to say what may have eliminated the A- and B-alleles from the vast majority of Native American populations, though it's possible that epidemic and endemic diseases killed off most of the individuals bearing those alleles at some point. According to a recent proposal, a one-two punch of selective bacterial and viral infections, keyed to blood antigens, might have done the job. Those without the affected antigens would have been immune and would have survived to become the ancestors of nearly all Native Americans going forward. In fact, this event may have occurred comparatively recently. As Estrada-Mena points out, "Smallpox was introduced in the Americas following European contact and was devastating to the Native Americans, who had never been exposed to it. A-allele individuals may be most susceptible to smallpox, because a molecule like the A-antigen may be present in the smallpox virus." He also cites syphilis as a possible allele-eliminating disease among the Native Americans.

Alternatively, sheer random chance may have eliminated nearly all the people carrying the A- and B-alleles by the process known as genetic drift. This is especially likely to have occurred if the relatively small group that initially dispersed south into the New World included very few members carrying those alleles. This phenomenon, known as the founder effect, occurs when a small group from a larger population establishes a new, isolated population. A net loss of genetic variation results, since the new population inevitably lacks the diversity of the larger group.


BENITO ESTRADA-MENA

◀ Benito Estrada-Mena of UNAM, lead author of the study.



ALEJANDRO GARCÍA CARRANCÁ

▼ Alejandro García Carrancá of the Instituto Nacional de Cancerología, coauthor of the study.

Blood will tell

Genetic analysis of the blood samples collected by Estrada-Mena et al. revealed that all their study groups are closely related, possibly as a result of being mutual descendants of what García Carrancá calls a "major component of a single polymorphic founding population." The Mexican-Mestizo group showed the least similarity to the others, which isn't surprising given their partial European ancestry. Comparison with other groups in Central and South America also revealed close genetic affinities.

It's tempting to assume that North American populations would be more genetically diverse than their Mesoamerican cousins, given that North America would have been colonized first under the standard north-to-south migration model; but incomplete data make such an assumption unwarranted. Both Estrada-Mena and García Carrancá discourage assuming that the O-allele variant frequencies observed in Central and South America are similar for North America; they may not be, if North American populations have become genetically differentiated in some way or are only peripherally related to the founding group that colonized Central and South America.

Speaking of allele variants: Although the O-allele is non-functional, it does come in a number of flavors or "haplotypes." Estrada-Mena et al. identified seven different haplotypes in their test subjects, some of them quite rare. They focused, however, on three most common, O^{1}, O^{1V}, and $O^{1V(G542A)}$, all of which appear in every Native American population sampled thus far. The G542A variant is of particular interest because it's almost exclusively Native American.

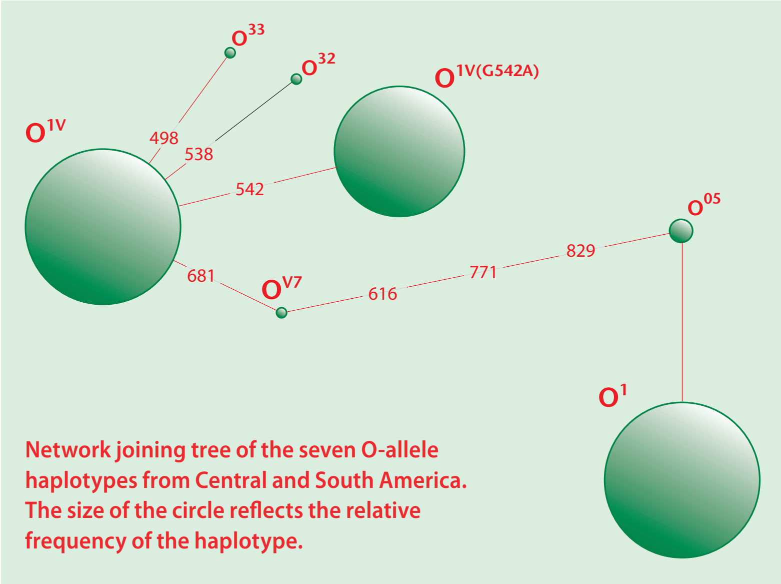
Almost being the operative term here, because a tiny percentage of people in Europe and the Middle East also bear the G542A variant. Estrada-Mena et al. suggest that G542A arrived there via gene flow from Latin America; that is, that the Old World individuals bearing the mutation must have had at least one Latin American ancestor with Native American heritage. This seems reasonable, considering the


ALEJANDRO GARCÍA CARRANCÁ

The Mazahua group sampled for the study.

consistent interaction between the Iberian Peninsula and the New World from the late 15th century onward.

G542A, because it is unique, can serve as an Ancestry Informative Marker for Native American heritage. Its very uniqueness and ubiquity also suggest certain implications about the origins of the First Americans. What it all boils down to is this: Asian populations, especially Southeast Asian populations, bear a demonstrable common ancestry with all Native American groups. However, while the O^{1V} haplotype is common in Asia, the G542A mutation of O^{1V} is entirely absent in sampled Asian populations. It's possible that $O^{1V(G542A)}$ does in fact occur in Asian populations that have yet to be sampled, or that it originated in Asia and became locally extinct. However, a simpler explanation is that $O^{1V\ (G542A)}$ was a mutation that appeared spontaneously in an isolated group sometime *after* the ancestors of modern Native Americans left Asia, but *before* they spread into the New World. That would better explain why all Native American populations bear the mutation, while it's mysteriously absent in Asia.



Network joining tree of the seven O-allele haplotypes from Central and South America. The size of the circle reflects the relative frequency of the haplotype.

BENITO ESTRADA-MENA

A refined New World population model

Interestingly, the distribution of blood group alleles, both in the current study and others, lends credence to a long-held theory of human immigration to the New World. Put very simply, the three-wave model states that first the Amerinds (First Americans) arrived and spread south, followed much later by the Na-Dene, who stayed primarily in the north, and then, just a few thousand years ago, the Aleut-Eskimos and their close relatives. The timing of the three waves remains uncertain, and in fact some researchers (including evolutionary biologists) aren't certain there were three distinct waves at all. In any case, a three-wave model seems roughly consistent with the blood-group evidence; it may even offer yet another explanation of why Eskimo-Aleut populations retain the A and B blood groups, and why the Na-Dene still have some A-alleles in their bloodlines.

If indeed the three-wave model is accurate, then given what we now know, those three waves probably didn't originate directly from Asia. It's more likely that the founding population from which all three in-migrations emerged was sequestered for millennia in Beringia, the wide, dry land bridge region stretching from eastern Siberia to western North America that was exposed after global sea levels dropped during the Last Glacial Maximum. "There are indications suggesting a clear Beringian standstill, where a founding population paused in Beringia long enough for specific mutations to accumulate," says García Carrancá (**MT 25-3,** "An Archaeological Feast: Digging into Owl Ridge"). This population bottleneck may have lasted 10,000 years or more.

Basically, it appears that Beringian populations were cut off from Asian populations for a good long time. One of the mutations that later appeared in the genome, the G542A mutation of the O^{1V} haplotype, had plenty of time to become distributed throughout the Beringian populations, but apparently didn't diffuse back west. This suggests that a significant geographic barrier stood in the way—doubtless the new Bering Sea, which drowned central Beringia as the world warmed and the ice sheets melted. Eventually, part of the sequestered population moved south in the first great wave of migration, with the others venturing into northern North America much later on.

Consider, for a moment, what life would have been like for hundreds of generations of Beringians, hemmed in on all sides by insurmountable barriers, both geographic and climatic, with at most a few individuals coming in from the west at irregular intervals. With limited access to new genes, specific adaptations and mutations were able to accumulate in the Beringian population; not to dangerous levels, because the population was large enough to prevent that, but to a point where they would be detectable by the science of their descendants a thousand generations later. Then, suddenly, one of those insurmountable barriers was lifted; an ice-free corridor, or perhaps a Pacific coastal route, was opened to those willing to quest south.

Out of that hotbed of evolutionary change, the ancestors of nearly all modern Native Americans emerged, and went forth to claim their New World.

–Floyd Largent

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The author uses an experimentally produced flake to cut through fresh horse hide, fat, and muscle.

ASHLEY SMALLWOOD

What It Means to Be Clovis

Part IV: Non-biface Lithic Tools

PREVIOUSLY IN THIS SERIES, we reviewed the characteristics of Clovis bifacial tools, particularly hafted projectile points, and how they were produced. Thanks to timely experimenting and use-wear research, we understand that these deadly spear points were used as both projectiles and knives. All in all, the Clovis point was a versatile tool that gave lots of bang for the buck in terms of function, adaptability, and long-term use.

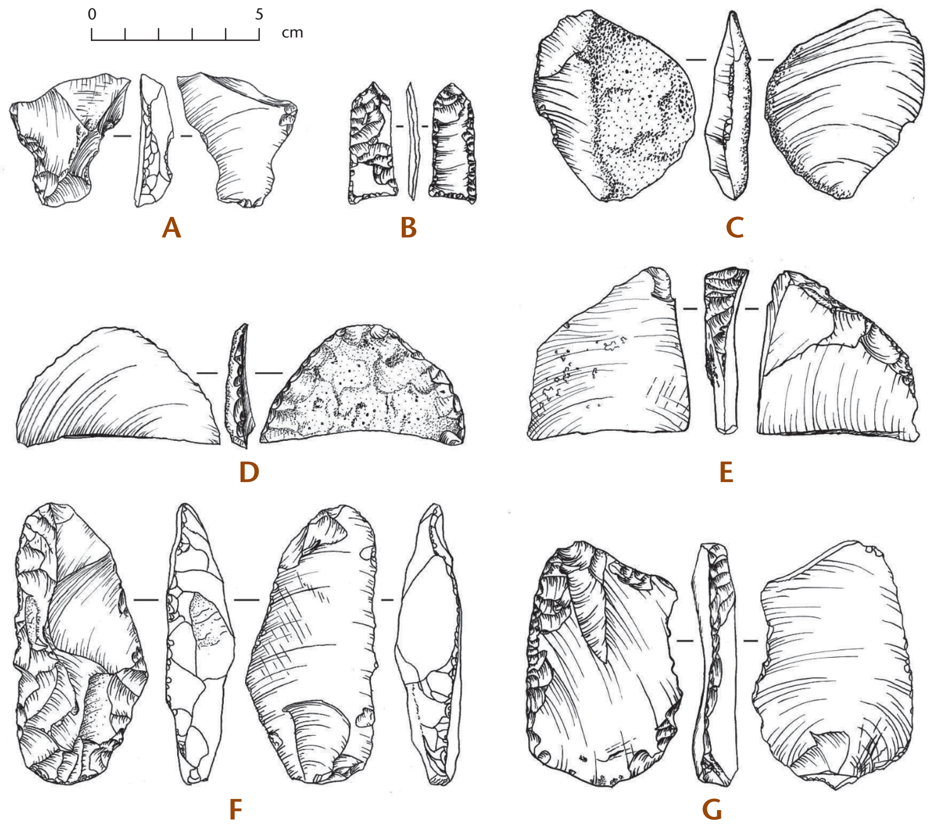
But there were other components in the Clovis lithic toolkit. These less glamorous but equally useful tools carry a number of monikers and often are referred to as ***flake tools*** or ***utilized flakes.*** As the name implies, they were made from flakes—often from flaking debris. But they also were made from blades and other intentional knapping products. Sometimes little effort was put into altering their form before use—just pick up a flake, use its sharp edge to complete the task at hand (e.g., cutting meat), and discard it. Other flake tools got a little more attention before being put to use—the flake or blade edges were shaped so the tool was suitable for a specific task (e.g., a narrow projection formed to drill wood). They may even be hafted.

Flake and blade tools show up as frequently as projectile points at Clovis sites all over the country. Logically, different types of flake tools—or different proportions of certain types—are found at different types of sites.

CHARLOTTE DONALD PEVNY

Close-up of the flake the author used to cut fresh hide. The left margin of the flake, an acute edge ideal for cutting, remained sharp during the course of the experiment. Tool analysis and experiments like these help researchers understand how Clovis tools were used and how patterns of wear develop.

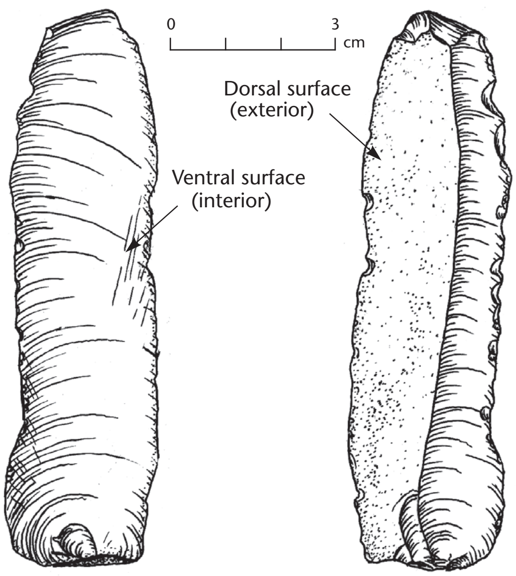
For example, endscrapers are found at all sorts of Clovis sites, out west at the Murray Springs site in Arizona, back east at the Shawnee Minisink site in Pennsylvania, and at sites in between like the Gault site in Texas. The endscrapers from these three sites look very similar. They are made on slightly curved flakes with lateral margins that expand toward the distal end of the flake, and the bit end is steep with patterned invasive flaking. The hafting element of these endscrapers may or may not have been modified, apparently at the toolmaker's option—there's more variation within the assemblage from Shawnee Minisink than among specimens from the three sites!



JOSH KEENE

Modified Clovis flakes. These examples have been modified by retouching the edge or through use. Tools **A**, **D**, **E** and **F** were used to scrape hard materials such as wood. Tools **C** and **G** were used to cut softer substances like hide or meat. Tool **B** is a small projectile point made from a flake; the original surfaces of the flake can still be seen on both sides of this point.

How do the three groups of tools differ? Well, first off, only a handful of endscrapers were recovered from Murray Springs. The final count's not in from Gault, but only 10 were recovered from Excavation Area 8 at the site. Compare this with 126 endscrapers identified at Shawnee Minisink! Second, the three sites served different functions for Clovis inhabitants: Murray Springs is a kill and associated camp, Gault is a quarry/camp, and Shawnee Minisink is a camp associated with plant and piscine remains. Though we still aren't certain what materials were being "scraped" at Murray Springs and Shawnee Minisink, we know the endscrapers from Gault Excavation Area 8 were used on hard materials like wood or bone. The sheer number of endscrapers at Shawnee Minisink suggests bulk processing, whatever the resource.



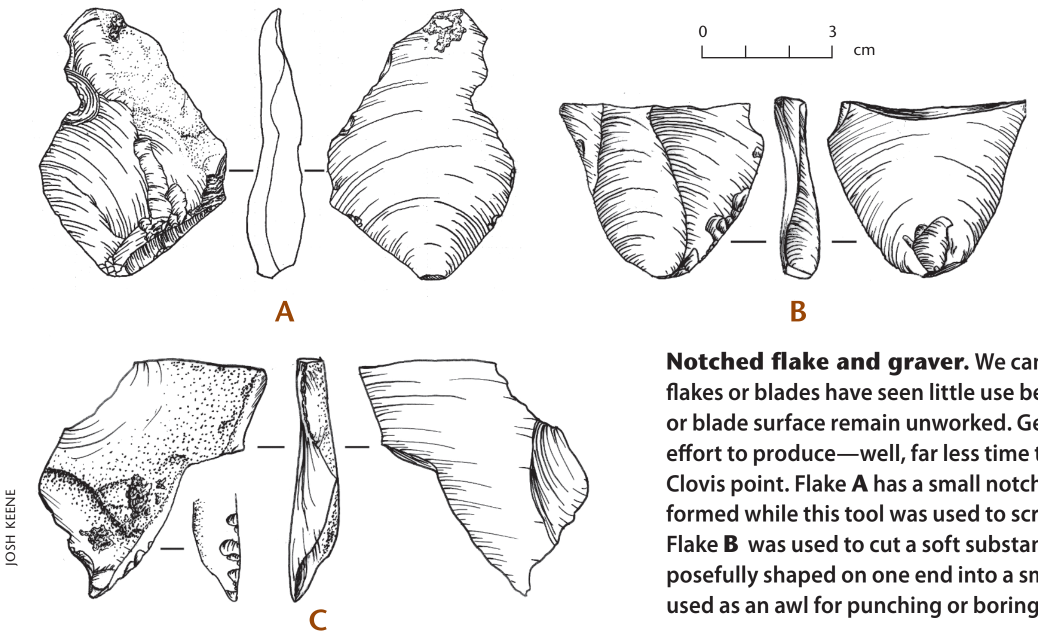
JOSH KEENE

Blade tool. This blade was modified through use alone and not retouched prior to use. Only the dorsal (exterior) surface of the blade shows small flake removals along the right lateral margin. Modification along the edge mimics the same type of use wear observed experimentally while whittling wood. The near absence of flaking on the interior surface of this blade, the acute angle of the edge, the pattern of flake removals, and location of polish and edge rounding match those observed on experimental replicates.

When does one "utilize" a flake?

Twenty years ago Joan Gero (Professor Emerita at American University and Research Fellow at the Museum of Natural History Smithsonian) asked this question when investigating the reasons for the bias then existing in lithic technological research toward more formal artifact types such as projectile points and knives. Much of the research on Clovis flake tools in the last 15 years has helped lessen that bias. The relevance of this question, however, is perhaps best appreciated at the analytical level—when you're trying to identify as a tool something that's only been minimally used! That is, How can the analyst identify a tool that requires little or no effort to produce?

Flake tools defy classifying because they're of random form. They are manufactured and used, then discarded after a short use life. Lewis Binford describes these tools as situational gear used in response to immediate circumstances. They can be secondarily modified either by intentionally flaking an edge, referred to as ***retouching,*** or simply by wear suffered in use. Some of these tools, like endscrapers, might be described as more formal or curated—that is, more effort is invested in making or maintaining them. Endscrapers are hafted and well maintained. Typically they are only discarded when "exhausted," that is, when the convex scraping edge, or bit, has been repeatedly resharpened until the bit is straight and no longer useful for scraping.



Notched flake and graver. We can tell that in many instances these flakes or blades have seen little use because portions of the original flake or blade surface remain unworked. Generally these tools require little or no effort to produce—well, far less time to make and maintain than, let's say, a Clovis point. Flake **A** has a small notch on the left-hand margin that probably formed while this tool was used to scrape a hard substance such as wood. Flake **B** was used to cut a soft substance, perhaps meat. Flake **C** was purposefully shaped on one end into a small projection, which may have been used as an awl for punching or boring holes in soft materials like hide.

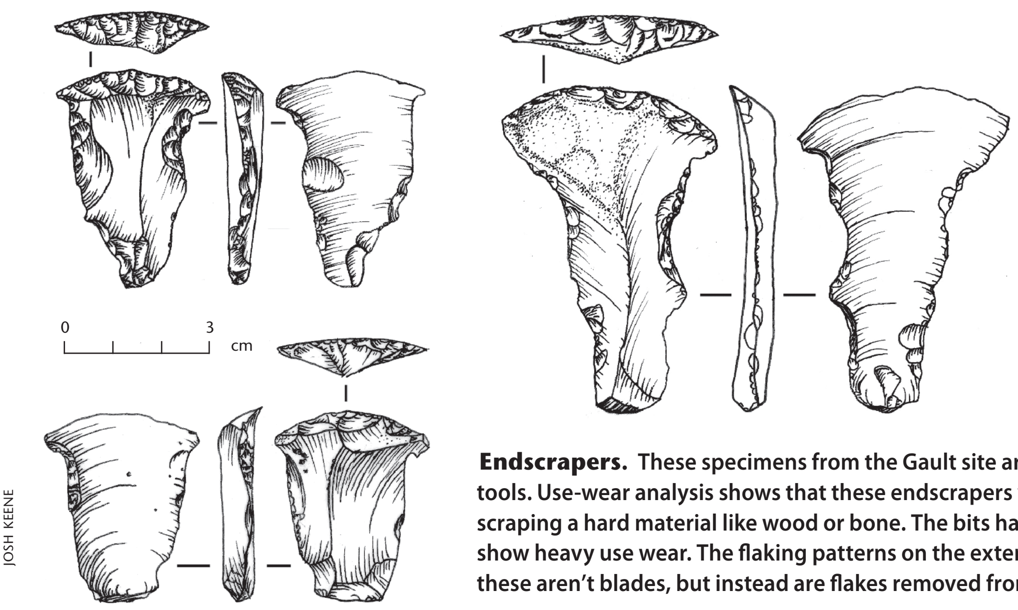
What complicates the analyst's task with flake tools isn't necessarily the amount of production involved in making the tool, it's frequently the lack thereof. Just when you think of crying "Use Wear to the Rescue," you realize you're analyzing one of the trickiest artifact classes of all. (I write this from experience!) Perversely from the analyst's point of view, microwear traces don't have time to accrue when a tool is only used for a brief period, and any wear that has developed may disappear in subsequent use and resharpening. What's more, events at a site can damage flakes and blades in a way that makes them look like tools. Yikes!

What's in a name? What we call a flake . . .

Flake and blade tools are called all sorts of things, depending on the researcher's perspective. That is, if referred to as blade or flake tools, the emphasis is on their origin, e.g., their original form. If their edges are described as convex, concave, or straight, then the emphasis is on the shape of the utilized edge. Sometimes they are referred to as unifacial tools, or unifaces, to describe which surface of the flake or blade has been modified. Flake and blade tools are by definition unifacial or unifacially retouched; the ventral or interior surface of the flake usually remains intact, and any modification of the tool occurs to the exterior surface of the flake or blade. Otherwise they would be bifaces.

And of course, this group of tools can be identified by names that describe their use in terms of motion (cutting, scraping, or boring tools) or function (knives, scrapers, spokeshaves, gravers, drills, etc.). These names are most appropriate for tools that have undergone use-wear analysis; nevertheless the images these terms evoke make them universally recognized descriptors and a handy heuristic device.

Some researchers simply use the catch-all phrase "edge modified," which takes into account both modification through use and retouch, and damage that occurs after the



Endscrapers. These specimens from the Gault site are excellent examples of curated flake tools. Use-wear analysis shows that these endscrapers were hafted for extra leverage when scraping a hard material like wood or bone. The bits have been extensively resharpened and show heavy use wear. The flaking patterns on the exterior surfaces of these tools suggest that these aren't blades, but instead are flakes removed from bifaces.

MAMMOTH TRUMPET

Volume 27 ■ Number 1

Clovis Core Efficiency Experiment

ONE OF THE MAJOR QUESTIONS archaeologists are still wrestling with is, How mobile were Clovis bands? Understanding the organization of Clovis core technology can help answer this question.

Toolstone is an exhaustable, yet heavy resource. Away from quarries, mobile hunter-gatherers faced decisions regarding the amount of stone to carry and how to conserve stone. Archaeologists have traditionally assumed that bifacial and blade cores are two of the most efficient ways to transport stone and produce useable flake blanks for tools. This assumption has reinforced the idea that highly mobile Clovis bands, who relied heavily on bifacial and blade cores, were concerned with efficiently transporting and conserving stone as they rapidly moved across the landscape. However, a series of recent core reduction efficiency experiments are reshaping our understanding of Clovis technological organization.

Jennings with experimental cores and blades shown below.

Building on the work of Mary Prasciunas and Metin Eren, Charlotte Pevny, Bill Dickens, and I experimentally reduced multiple types of cores to determine the best way to conserve stone. From these cores, we collected and quantified all flakes that could have served as useable blanks for flake tools. When we compared the production efficiency of bifacial, blade, and informal cores, we were surprised to discover that informal cores

Texas A&M doctoral student Tom Jennings analyzing experimental cores and "useable" flakes.

UNLESS NOTED, PHOTOS: ASHLEY SMALLWOOD

Exhausted bifacial core *(upper)* and wedge-shaped blade core *(lower)* with some of the "useable" flakes produced by each.

tool has been discarded at a site. To analyze this class of tools requires intimate knowledge of the context at the site before excavation and the "chain of evidence" after the artifact was recovered, including what happens to it in the lab and during analysis, because flakes and blades can be damaged in ways that mimic cultural use.

The when and why of curating tools

Finally, a flake tool can be described according to the effort put into making and maintaining the tool. Words like "formal" and "informal" or "curated" and "expedient" describe how folks organized their technology. Lewis Binford explored the continuum between curated and expedient over 30 years ago. At one end of the spectrum, there are ***expedient tools,*** that is, flake or blade tools that serve immediate needs. They are quickly made, briefly used, and discarded. Tongue in cheek, I refer to these kinds of tools as "the plastic knives and forks of the prehistoric world" (**MT 20-2,** "Assault on Gault"). At the opposite end of the spectrum are ***curated tools.*** More effort is invested in making and maintaining them. Frequently they serve multiple purposes, are transported to different locations, and may be recycled for other purposes at the end of their use life.

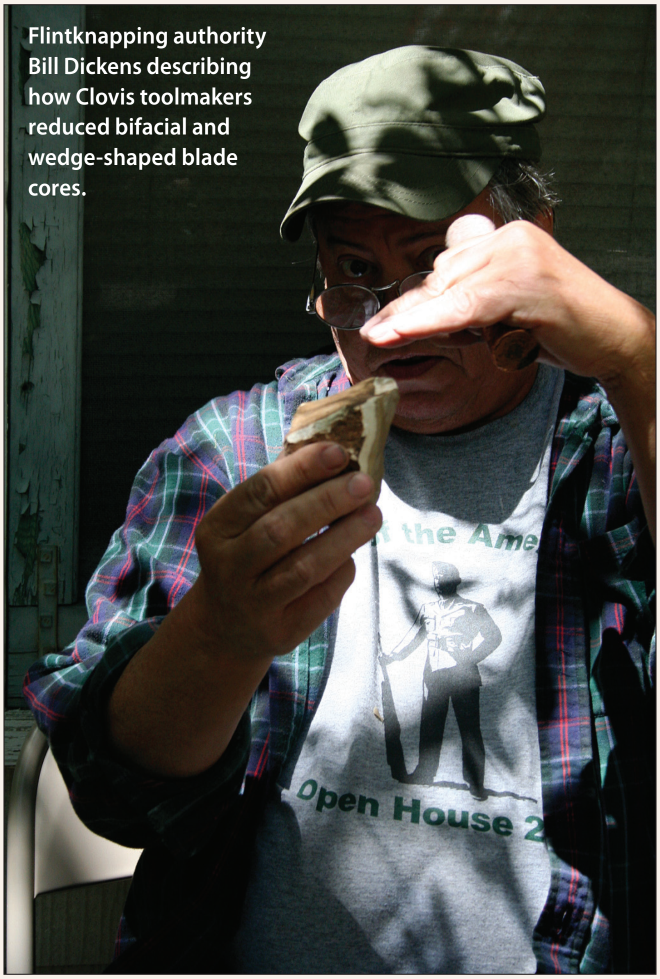
Binford includes this activity—curating tools—under the rubric of acquiring subsistence resources and mobility. Movin' and eatin', that's what hunter-gatherers do. For this they need a lithic technology that's portable, dependable, and easily maintained. For instance, hunters put time and effort into shaping and resharpening the edges of dull projectile points. Robin Torrance suggests that tool curation figures as a factor in "time-stress," what a time-and-motion specialist would call "scheduling conflict," to describe the problems involved in prioritizing necessary activities. A hunter-gatherer in the span of a day must effectively and efficiently execute a number of tasks while at the same time exploiting multiple resources that may not be in close proximity to each other. Torrance suggests that an experienced hunter-gatherer would make and maintain curated tools in advance of upcoming activities, like hunting. Game isn't always predictable, but you can control the "when and how" of the tools you'll need to take it down.

For Douglas Bamforth, tools are curated as dictated by the availability of raw material. Faced with a shortage of toolstone and no outcrops or quarries on the horizon, the hunter-gatherer by necessity must pay attention to maintaining tools and recycling spent ones. Under more favorable circumstances, where raw material is plentiful and there is no need to conserve toolstone, spent tools would likely be simply discarded. In this situation you'd expect to find a profusion of expedient tools.

Each of these researchers may be correct, depending on the archaeology. Of course, there's no reason why these three hypotheses have to be mutually exclusive. It's just a question of what's more advantageous in the paleo-circumstance at hand: investing minimal effort into making a tool for immediate use, or laboring to make a tool with a longer use life?

Flake tools vs. blade tools

There's a lot of variation in the "flake tool" category. Study and use-

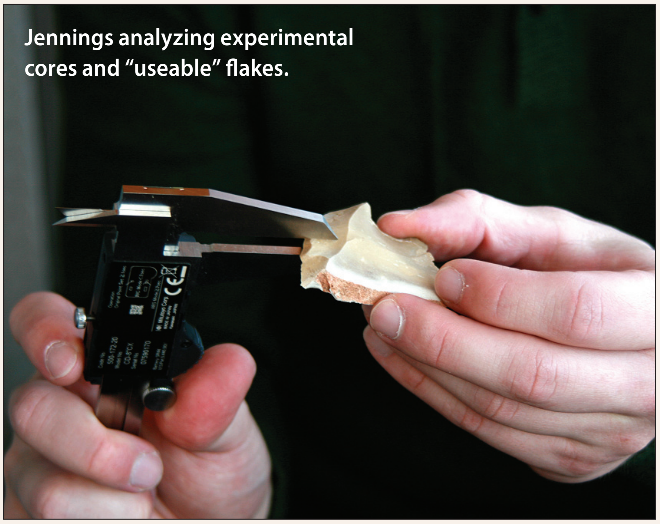


Flintknapping authority Bill Dickens describing how Clovis toolmakers reduced bifacial and wedge-shaped blade cores.

CHARLOTTE DONALD PEVNY

were the most efficient way to transport stone and produce useable blanks for flake tools. This led us to conclude that Clovis groups were not solely concerned with conserving stone and that factors other than mobility must have led them to rely so heavily on bifacial and blade cores.

–Tom Jennings



Jennings analyzing experimental cores and "useable" flakes.

wear analysis of these tools may help identify regional differences between Clovis groups across North America—differences that aren't discernible in bifaces. The same types of tools, made for a particular use, are made from both blades and flakes. Some of these tools are made for hunting and to process kills. Others are used to work wood for making handles or hafts for tools. Some are used to gather plant materials for making baskets. Use-wear analyses conducted by Marilyn Shoberg (the Gault Project at Texas State) conclude that Clovis unifacial tools recovered from Gault were used to process food (e.g., to cut meat), as well as to whittle wood, cut grasses or reeds, and work bone. Her analyses also suggest that many smaller tools were hafted to provide a better grip and increased leverage during use.

Although biface thinning flakes were commonly used as tools, especially for endscrapers, don't think for a second that Clovis folks were just "farming" debris left over from making points. Far from it. Take, for instance, the Clovis blade. The shape and size of each blade are intentional. Clovis blades don't conform to a standard template like machine-made products from a factory. Nonetheless each blade had to meet certain criteria. Look how many *rejected* blades were recovered from Excavation Area 8 at the Gault site—over 200! These blades were discarded because they didn't make the grade. Other blades, however, made the cut and were certainly put to good use in a host of different duties. On the Southern Plains, blades were a dependable source of sharp edges ideal for cutting, scraping, and boring tasks.

–Charlotte Pevny

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Suggested Readings

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The Fiber of Their Being

continued from page 11

men to ash, a sacrifice many archaeologists were unwilling to make. Especially considering, as Jolie points out, the chance that a smaller item might fail to provide a sufficient sample for dating. *Poof!* went a treasure.

As is often the course with archaeology, sometimes the wisest course of action is to put it back on the shelf and wait for technology to catch up. What's a few decades compared with millennia that have already elapsed? Today technology has progressed to the point where only a minute sample from a fiber artifact has to be sacrificed to obtain a radiocarbon date. Archaeologists everywhere are returning to their shelves and dusting off textiles and other previously untouchable organic artifacts.

–K. Hill

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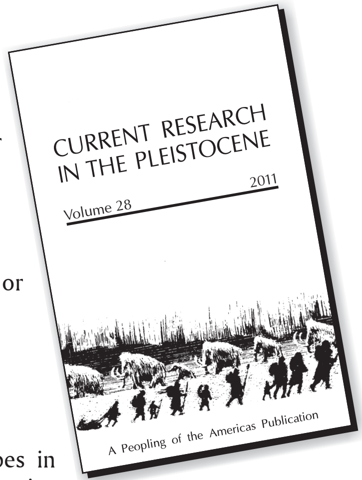

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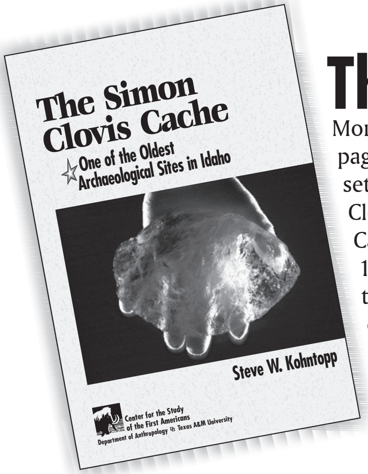

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Method and Theory for Investigating the Peopling of the Americas, edited by Robson Bonnichsen and D. Gentry Steele, is the first of four volumes to come out of the first World Summit Conference on the peopling of the Americas. Included are general sections on methods, geoarchaeology, biological approaches, linguistic approaches, material culture, discussions and conclusions. 1994. 264 pages. Hardback, ISBN 0912933-09-7; paperback, ISBN 0912933-11-9.
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