MAMMOTH TRUMPET

Center for the Study of the First Americans
355 Weniger Hall, Oregon State University
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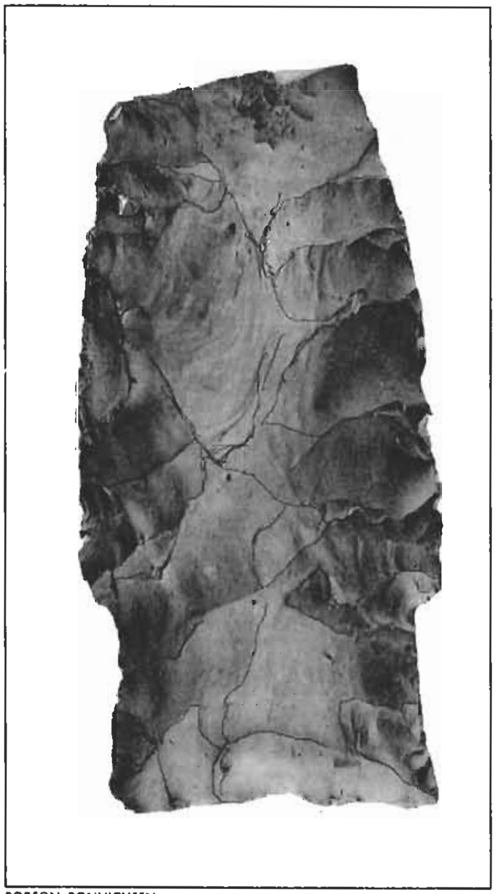
Two Innovations in Analysis



ROBSON BONNICHSEN

DAVID S. WHITLEY

Investigations of stone tools—such as this Cody point from southwest Montana—and investigations of rock art—such as this petroglyph from eastern California—might seem very different, but as two reports in this issue verify, the analyses can have similar goals and approaches. In both cases, researchers are analyzing the thought processes of prehistoric artisans. **See articles on page 1 and 6.**

The Center for the Study of the First Americans fosters research and public interest in the Peopling of the Americas. The **Center**, an integral part of **Oregon State University**, promotes interdisciplinary scholarly dialogue among physical, biological and social scientists. The **Mammoth Trumpet**, news magazine of the **Center**, seeks to involve you in the late Pleistocene by reporting on developments in all pertinent sciences.

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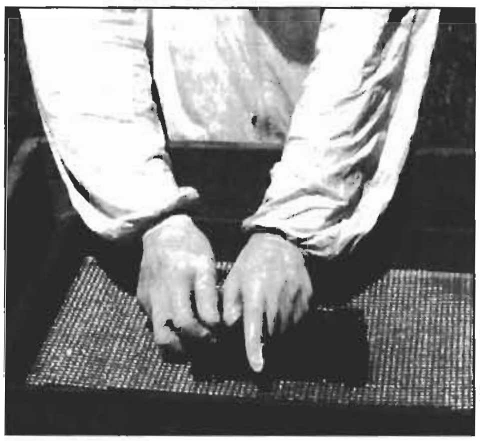

WALTER BIRKBY

Hands that work the screens during molecular-archaeology field work must wear rubber gloves.

NEW FOCUS: MOLECULAR ARCHAEOLOGY

CSFA, Earthwatch to Open 5-Year Project at 3 Sites

Answers to questions about the peopling of the Americas have thus far proved elusive. Until now, most of the focus has been on trying to explain how the migration took place, but Robson Bonnichsen says that scientists have developed techniques that for the first time can provide information about who these people were.

"We're trying to understand the context of the past, who lived there, and how these people adapted to that context," Dr. Bonnichsen, Professor of Anthropology at Oregon State University and Director of the **Center for the Study of the First Americans,** said in a recent interview.

This summer the **Center for the Study of the First Americans** will coordinate four teams of Earthwatch volunteers who will work alongside archaeologists in excavating sites in three states with the goal of obtaining ancient animal and human hairs that have potential to yield DNA that can be used to characterize early Paleo-American populations.

Bonnichsen will head the CSFA/ Earthwatch endeavor in this first year of what is to be a five-year molecular archaeology project. Bonnichsen expects that the team is likely to find human and animal hair,

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FRAME ANALYSIS AIDS STUDY OF STONE TOOLS

Replacing Pigeonholes With Careful Descriptions

Stone tools survive the rigors of time better than most other vestiges of ancient cultures, so it is not surprising that names given to types of lithic projectiles are used to describe cultural complexes of the tool makers. Thus, a single name, which often derives from the archaeological site where a distinctive tool was discovered, is extended to a specific type of tool, a cultural complex, the human population associated with it, a cultural period, and even a particu-

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INSIDE

CSFA Probes Oregon Pleistocene Fauna Site

The first phase of an investigation of an Oregon site rich in remains of Pleistocene animals began in mid-February with core drilling.

Alison T. Stenger, project leader of the investigation sponsored by the **Center for the Study of the First Americans,** the City of Woodburn, and Woodburn School District, outlined project objectives. The coring phase of the project seeks to develop a soil profile of the site to be able to understand how animal bones got there; to determine the extent and depth of the bone-bearing stratum; and to get in situ samples for analysis including radiocarbon dating, study of pollen, and recovery of hairs, seeds, and other organic matter.

Armed with this knowledge of the site, the team will proceed to the second phase of the project—test excavations that will verify whether the site has significant scientific potential. If it proves an important site, city officials expect a long-term, full-scale archaeological excavation that could lead to establishing an exhibition center to display natural and cultural history of Oregon's Willamette Valley. The site is less than a mile and a half from Interstate 5 in Woodburn on property owned by the city and school district.

The Willamette Valley was formed after the uplift of the volcanic Cascade Mountains in Miocene and Pliocene time sent sediments into a Pacific Coast bay that had been created by the formation of the volcanic Coast Range in Eocene time. Relatively little is known about the Willamette Valley's history through the Pleistocene, although it is known to have been periodically inundated by floods caused by the spilling of vast ice-dammed lakes in the Rockies and Great Basin.

During installation of a sewer line in 1987, a crew found large bones of extinct animals and summoned scientists. Paleontologist William Orr of the University of Oregon subsequently identified bones of mammoth, ground sloth, horse, bison, mastodon, bear, and wolf. Stenger, of the Institute for Archaeological Studies in Portland, says a crucial question is how those animals got there. They may have been victims of a big flood, which would have turned the entire Willamette Valley into a temporary lake. Or they may have become trapped in a bog, perhaps at a watering place during summer drought.

Stenger hopes the February coring will allow the **CSFA** team to place excavation units in the most strategic part of the site, a grassy field near Woodburn High School. The cores provided initial indication of stratigraphy that might be expected in stream-channel deposits. Stenger was especially excited by one discovery from more than three and a half meters down. "Within the dark, slightly reddish brown peat were what appear to be seeds of red, black and amber colors," she said. Pollen and seeds should give the scientific team much information about the environment of the ancient Willamette Valley.

CRP 12 Available

If you do not receive Volume 12 of *Current Research in the Pleistocene* within a few weeks of placing your order, please let us know. Pre-publication orders of the journal were mailed in January. The 1995 issue of the **CSFA**'s timely annual journal of research notes contains 21 papers on archaeology as well as papers on lithic studies, methodology, physical anthropology, taphonomy, and paleoenvironments. There also is a brief discussion of the Native American Graves Protection and Repatriation Act. Meanwhile, papers for the 1996 issue are being refereed by the editors. Our streamlined production process promises to have *CRP* Vol. 13 printed and distributed on schedule this fall. See order form on the wrapper of this **Mammoth Trumpet.**

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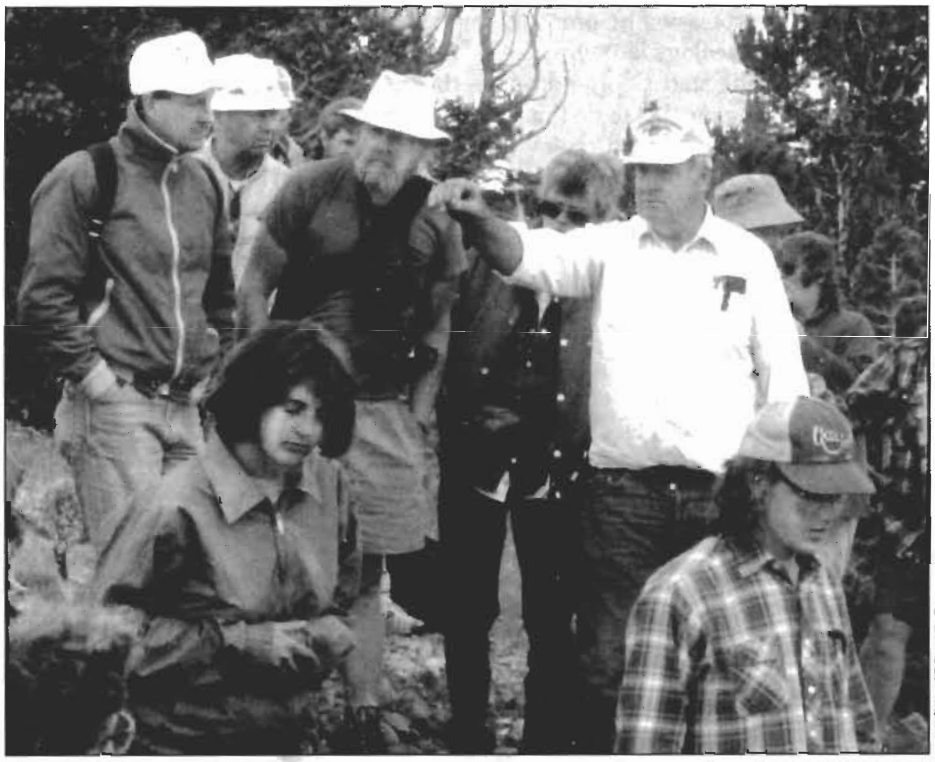
The Frison Effect

A Career That Has Illuminated Plains Archaeology



George Frison explains bighorn sheep trapping to Wyoming Archaeological Society members at a sheep trap above the Lookingbill site near Dubois, Wyo., in 1993.

RENOWNED SCIENTISTS often are known for the laws they promulgate: George Simon Ohm and his Ohm's Law of electrical resistance, for example, or Charles Darwin and the Darwinian Theory of species evolution. Nor is any debate of chipped-stone technology complete without discussing the Frison Effect, which describes the changes that occur on the edges of stone tools when they are sharpened. Frison's principles have provided a better understanding of variation in tool assemblages, and thus afforded a better understanding of the technological organization of stone-tool users throughout the world. Perhaps more significant has been Frison's discerning comprehension of High Plains hunters and their prey.

The Frison Effect was but one contribution of George Carr Frison, now Professor Emeritus at the University of Wyoming, who retired his university position last December after more than 40 years of research and teaching. Frison was honored for his accomplishments by a session at the 53rd Annual Plains Anthropology Conference in Laramie last October.

Dennis Stanford, chairman of the Department of Anthropology at the Smithsonian Institution in Washington, D.C., credits the former rancher and hunting guide with "putting Wyoming archaeology on the map." Frison, says Stanford, a colleague since they were undergraduates together, brought an exceptional pragmatic clarity to the analysis of the subsistence of prehistoric people of the High Plains. "He has had a tremendous impact on Plains archaeology."

Stanford cited the importance of Frison's many books and other publications, especially *Prehistoric Hunters of the High Plains,* which Stanford calls a landmark publication, as well as monographs on many archaeological sites, especially those interpreting prehistoric bison and antelope kills and sheep traps.

Frison is known to colleagues as a tremendously hard worker and a man of intense concentration in the field—one who might not notice falling snow or blazing sun as he examined ancient bone beds in archaeological sites, and one who thinks nothing of driving his pickup truck hundreds of miles a day inspecting archaeological sites. "What George brought to the field that few people do was his pragmatic way of looking at sites from his experiences as a rancher and hunting guide," said Stanford. "He knows animals and he knows how to hunt animals and how to predict the way animals will react in various situations." His knowledge gave him a really good insight in interpreting bone-bed sites.

Born Nov. 11, 1924, in Worland, Wyo., Frison first attended the University of Wyoming in 1942. However, World War II intervened and Frison served with the U.S. Navy in the South Pacific until 1946. Following discharge, he worked the family ranch near Tensleep, Wyo., until he returned to the university in 1962 to complete his bachelor's degree in anthropology. "He learned how to *think* before he got to graduate school," said a longtime colleague. As a Woodrow Wilson Fellow, Frison then went to the University of Michigan, where he raced through a master's degree in one year. He finished a doctorate in an incredible two years with a dissertation titled *Archeological Evidence of Crow Indians in Northern Wyoming: A Study of Late Prehistoric Buffalo Economy.* After receiving his Ph.D. in 1967, Frison became head of the Anthropology Department at the

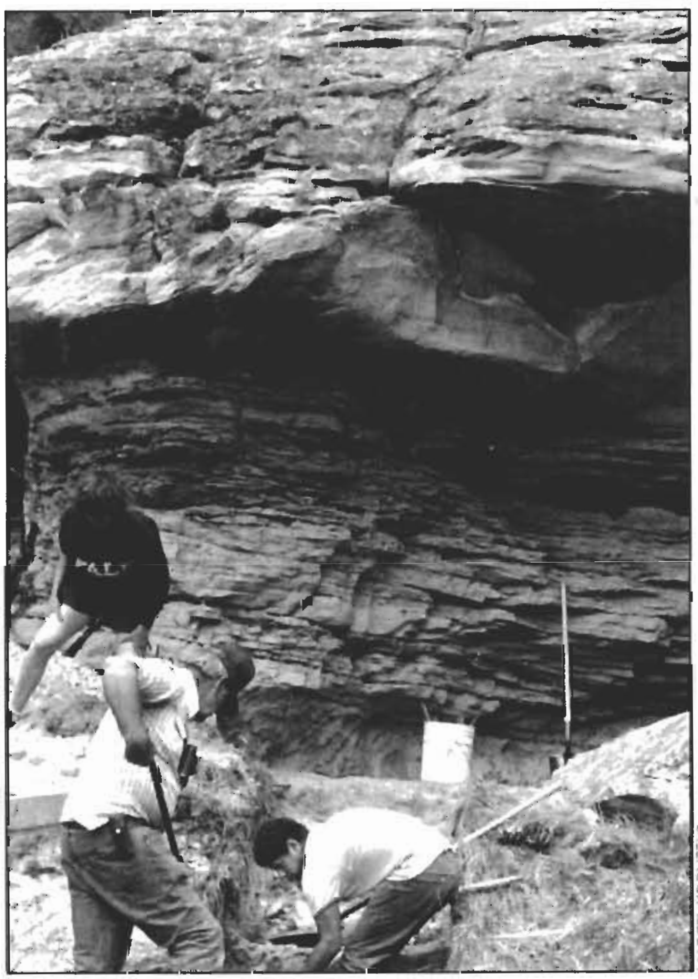
University of Wyoming. As if that weren't enough, he became Wyoming State Archaeologist the same year, a job he performed until 1984 when it became a full-time job.

More than 70 students have graduated with a master's degree from the University of Wyoming's anthropology department during Frison's tenure.

Charles A. Reher, professor of anthropology at the university, was one of Frison's first graduate students. Frison spurred Reher into the profession by promptly putting him to work in the school's archaeology lab.

"Right from the start George gave me the appropriate role model by showing me that to do this archaeology business you had to work long hours and travel long distances, and really invest a lot of yourself into it or else it wasn't being done right," Reher said in a telephone interview. "He really helped me get my professional start. There is no person I admire more, and for all of the right reasons."

Reher also recalled an episode that illustrates Frison's illustrious ability to concentrate. At a field site in the late 1960s, Frison was hunkered over troweling a bison bone bed when snow started falling—a not-uncommon occurrence on the High Plains. "We watched a half-inch or more of snow build up on his back before he even noticed it was snowing," Reher said. "He was on his hands and knees and was so concentrated on what he was doing that he didn't even notice it. That's how he is."



During excavation at a rockshelter at Keyhole Reservoir in 1984, Frison prys up a large slab of rock that has fallen from the roof.

From 1967 to 1994, Frison excavated nearly a dozen bison bone beds ranging in age from Paleoindian to Protohistoric. He reported his findings with dozens of articles and books. For example, he has been author, coauthor, editor, or coeditor of six books detailing sites such as Casper, Hanson, Agate Basin, Colby, Horner, and Mill Iron. His book *Prehistoric Hunters of the High Plains* provides a synthetic overview of northwest Plains prehistory. He also has left his mark on such sites as Medicine Lodge Creek, Laddie Creek, Southsider, Lookingbill, and a number of Plains rockshelters. His work on those sites has provided a better view of Paleoindian traditions.

In addition, he has written more than 70 other professional articles, and has presented scientific papers at more than 60 regional, national and international meetings. More than $1 million in grants from agencies such as the National Science Foundation, National Endowment for the Humanities, National Geographic Society, and the National Park Service have supported his research.

Throughout his career, Frison has served on numerous boards and committees. He was president of the Society for American Archaeology from 1983 to 1985. In 1972 he was named a Fellow of the American Academy of Science. Other awards have included the 1985 George Duke Humphrey Distinguished Faculty Award, and a 1993 Arts and Sciences College Outstanding Alumni Award. He also has received awards for outstanding contributions to Plains archaeology and the Plains Anthropologist Distinguished Service Award.

There is no question that Frison's work has been significant, according to Marcel J. Kornfeld, another University of Wyoming anthropologist, who explained that perhaps the foremost implication of Frison's research involves his systemic and ecological view of Plains prehistory.

"He sees humans adapting as people acting within their environment," Kornfeld said. Frison discerns that prehistoric people exploited the resources in the context of their particular environments, be it a mountain, foothill or plains environment.

Stanford explains that Frison brought a uniquely singular, pragmatic way of looking at things to his field research. "This came from his experience as a rancher and hunting guide. He knows animals, how to hunt animals and how to predict how animals would react in certain situations. That knowledge gave him a really good insight in interpreting bison and antelope kills and sheep traps."

His experimental work with stone tools produced what came to be known as the "Frison Effect," a term coined by Arthur J. Jelinek in a 1976 publication. Jelinek wrote that the Frison Effect describes "a particular situation in which restricted access to raw material has been shown to affect the ways in which tools were used, resharpened, and modified in form before being discarded." In his 1968 analysis of artifacts from the Piney Creek site, Frison traced modification, breakage and remodification of particular tools through a bison-butchering sequence—showing that the final form of a tool, or set of tools, might differ distinctly from the original one. "I suggest this phenomenon be called the Frison effect," Jelinek wrote.

Frison's interest in experimenting with chipped-stone tools

Frison conducts a 1995 tour of Wyoming Archaeological Society members and other visitors in the Black Mountain Archaeological district, Big Horn Basin, Wyo.

was twofold, according to Kornfeld. "He wanted to know how easy it is to butcher an animal with a stone tool and how stone tools might vary in how efficient they are in butchering animals." He found that simple tools, flakes for example, work well.

"A large flake with sharp edges is probably the most efficient tool for skinning a hide, it just cuts right through and makes a nice, thin cut. And the blades are quickly replaceable." Kornfeld said that in the process of his experiments, Frison learned what happens to the tool—"how quickly it dulls, and how much it can cut before it dulls, and the difference between the way certain tools cut different types of animals."

Kornfeld said that Frison has experimented with stone tools on bison and other animals. In the mid-1980s, for example, he took Clovis tools that Bruce Bradley had replicated and went to Zimbabwe where he could try them out on African elephants that authorities were culling from a particular herd (**Mammoth Trumpet** 2:3 "George Frison: Elephant Hunting").

His colleagues do not think it strange that Frison would forsake the family ranch for an archaeological career. He was bitten by the archaeological bug early, because, as a Westerner, he acquired an avocational interest in archaeology, so Frison's eventual professional involvement seemed natural. "Those of us who grew up out there, and saw the archaeological sites, were interested in the artifacts and started digging. We soon began to realize that there is a lot more to it than just the artifacts," said Stanford.

Frison's early interest in archaeology, perhaps coupled with not always seeing eye-to-eye with relatives regarding ranching, tipped his hand toward grabbing a professional archaeologist's trowel. His background as an avocational archaeologist naturally has given Frison a particular affinity with amateur archaeologists, an affinity shared by many professionals, including Kornfeld and Stanford.

"Most of the sites are found by the avocationalists," said Stanford. "They are basically our eyes and ears in the field, and as long as they are in it for the science it is great."

Stanford notes that there is still plenty of work for professional archaeologists to do, and Frison has been at the forefront of needed professional research.

"George is quite a guy," Stanford said. "He doesn't think anything of getting into his pickup and driving 900 miles to see sites. I don't know where he gets his energy." Kornfeld agrees: "George is the kind of person who might travel from Laramie to Rock Springs [210 miles away in southwest Wyoming] and then take a side trip to Mill Iron 400 miles in the other direction [in southeast Montana]."

Frison's wife, June, always accompanies him on such jaunts, and she is always with him on site excavations. Her only requirement, said Kornfeld, is that "George give me a half-hour's notice if we are going somewhere in the country and an hour if we're going abroad." Kornfeld added: "I believe she has contributed greatly to his success."

Frison has no plans to vanish from the archaeological landscape. "I look forward to emeritus status and continuing to do research in Wyoming archaeology," he said at his retirement. "I doubt very much that if I were allowed to do it again I would do it any differently." MT

–George Wisner

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Interpreting Rock Art

Neuro-Psychological Model Provides Big Advance in Scientific Analysis

MANY OF US have experienced a sense of wonder upon seeing petroglyphs or pictographs for the first time. Who made them and when? What is the meaning behind them? Until recent years the answers to these questions were elusive and caused many archaeologists to turn their attention elsewhere.

Archeologist David S. Whitley says rock-art research is at the methodological forefront of archaeology—specifically that segment of archaeology that is concerned with research on hunter-gatherers. He believes that many North American archaeologists may not be aware that in the past 15 years significant advances have been made in the interpretation of rock art, in the ability to scientifically test those interpretations, and in the ability to determine the age of rock art.

Dr. Whitley is trying in his research on rock art to bridge the gap he perceives between anthropologists and archaeologists—his was the first anthropological-archaeological doctoral dissertation on the interpretation of Native American rock art. Whitley, who received his Ph.D. from UCLA in anthropology with a specialization in archaeology, says that new anthropological-archaeological views place more weight on the ethnographic record and propose a shamanistic origin for most rock art. Further, they propose a neuro-psychological explanatory and predictive model that is supported by current scientific research on altered states of consciousness. He believes the model has the potential to apply universally to rock art sites throughout the world.

Whitley knew early on that he wanted to be an archaeologist. At age 12, he traveled to Europe with his parents. The famous upper-Paleolithic European cave sites were on his list of "must" places to visit, and seeing the art works in those caves made a lasting impression upon him.

"At that point I didn't know that it was not a common topic for research in North American archaeology." Thus, he became interested early on, "before I knew better, in a sense," he said in a telephone interview. Now principal in W & S Consultants, a cultural-resource management firm, Whitley was chief archaeologist at the Institute of Archaeology, and lecturer at UCLA's Department of Archaeology from 1983 to 1987. After that he did post-doctoral work with David Lewis-Williams at the University of the Witwatersrand, South Africa. He is an instructor in the Division of Social Sciences and Humanities of UCLA Extension.

Rock-art research, he says, has largely been marginal to mainstream archaeology. Although such distinguished archaeologists as Julian Steward, Luther Cressman, and Robert Heizer did occasional studies of pictographs or petroglyphs, their careers were dedicated to other aspects of archaeology.

New Strides in Dating

Whitley suggests that until recently, archaeologists have tended to shy away from rock-art research in part because of the difficulty of determining its age. In addition, he believes that most archaeologists view the interpretation of rock-art symbols as something that does not lend itself to scientific study. In recent years Ronald Dorn and others have developed chronometric dating techniques that include cation-ratio dating, which Whitley describes as "a bio-geochemical technique for assigning calibrated ages to the rock varnish that coats rock surfaces in many arid and semiarid regions." (The **Mammoth Trumpet** will be focusing on this and related techniques for rock-art dating in a subsequent issue.) Whitley believes that new dating methods have moved archaeologists far beyond a past reliance on stylistic and superpositional approaches to rock-art interpretation.

"When you are dealing with hunters and gatherers who don't have a very extensive artistic tradition in the material-culture record, it's very very difficult to link the art to standard cultural-historical frameworks," says Whitley.

Furthermore, North American archaeology has been oriented toward material culture, and has developed a series of techniques to analyze and study material-culture items. Rock art, on the other hand, is about symbolism, art, aesthetics, religion and ceremony. These are subjects, topics and themes that archaeologists rarely study and have no training in analyzing, he says. "Archaeology is not oriented towards this kind of a cultural artifact. It's a realm of human behavioral remains that archaeology has never dealt with before and has never developed a set of techniques for handling."

Ancient Symbolism No Less Complex

Another problem is that many archaeologists hold an evolutionary perspective in regards to hunter-gatherers that tends to assume a greater complexity as we move forward in time. Whitley believes that when one deals with symbolism in the distant past, the thinking behind it was just as complex as is modern thought. Such an outlook does not fit well within an evolutionary perspective and has led to a tendency by archaeologists to ignore rock art entirely.

In the early 1980s, David Lewis-Williams, the South African cultural anthropologist and archaeologist, turned to ethnographies to give him clues to interpreting paintings of South Africa's San people. In seeking to maintain objectivity, many anthropologists had translated and transcribed ethnographic information from cultural informants as precisely and accurately as possible. However, careful analysis revealed that these literal translations often failed to convey the true metaphorical meaning of the informant's words.

Lewis-Williams began to use what he called a "metaphoric model" in his study of ethnographies and in his attempt to understand San art. Whitley sees this model as a turning point in rock art interpretation.

"Once it is acknowledged that many ethnographic comments are expressed metaphorically, and an effort is made to decipher relevant metaphors in texts that pertain to rock art, a coherent interpretation of otherwise enigmatic ethnographic statements can be obtained," Whitley said. As an example of a North American hunter-gatherer metaphor, Whitley suggests taking a look at the word "death."

"When an informant stated that an individual had died, it was not necessarily implied that he or she was mortally deceased, in our sense of the term. Depending on context, 'death' was a metaphor used throughout the far west to indicate entering an altered state of consciousness or trance. A person who had died might be said to be in a dream or trance, and therefore in the supernatural world."

A Neuro-psychological Model

In 1988, Lewis-Williams, together with Thomas Dowson, developed a neuro-psychological model that allows scientists to test whether a particular body of art was produced as the result of the mental imagery of shamanistic experiences. The model also shows the connection between such imagery and altered states of consciousness. The information on altered states of consciousness patterns and stages is derived in part from research by scientists in other fields on modern-day individuals undergoing altered states of consciousness.

Briefly, the model is divided into three parts. The first part consists of seven different types of entoptic patterns (within or behind the eye) that are generated by the visual and nervous system of the subjects experiencing an altered state of consciousness. The second part is made up of the seven principles that guide the perception of the mental images during an altered state of consciousness such as replication, fragmentation, integration and rotation. The third part, itself divided into three parts, describes the three progressive stages of mental imagery that take place during an altered state of consciousness.

—Passage of the Rain Shaman—

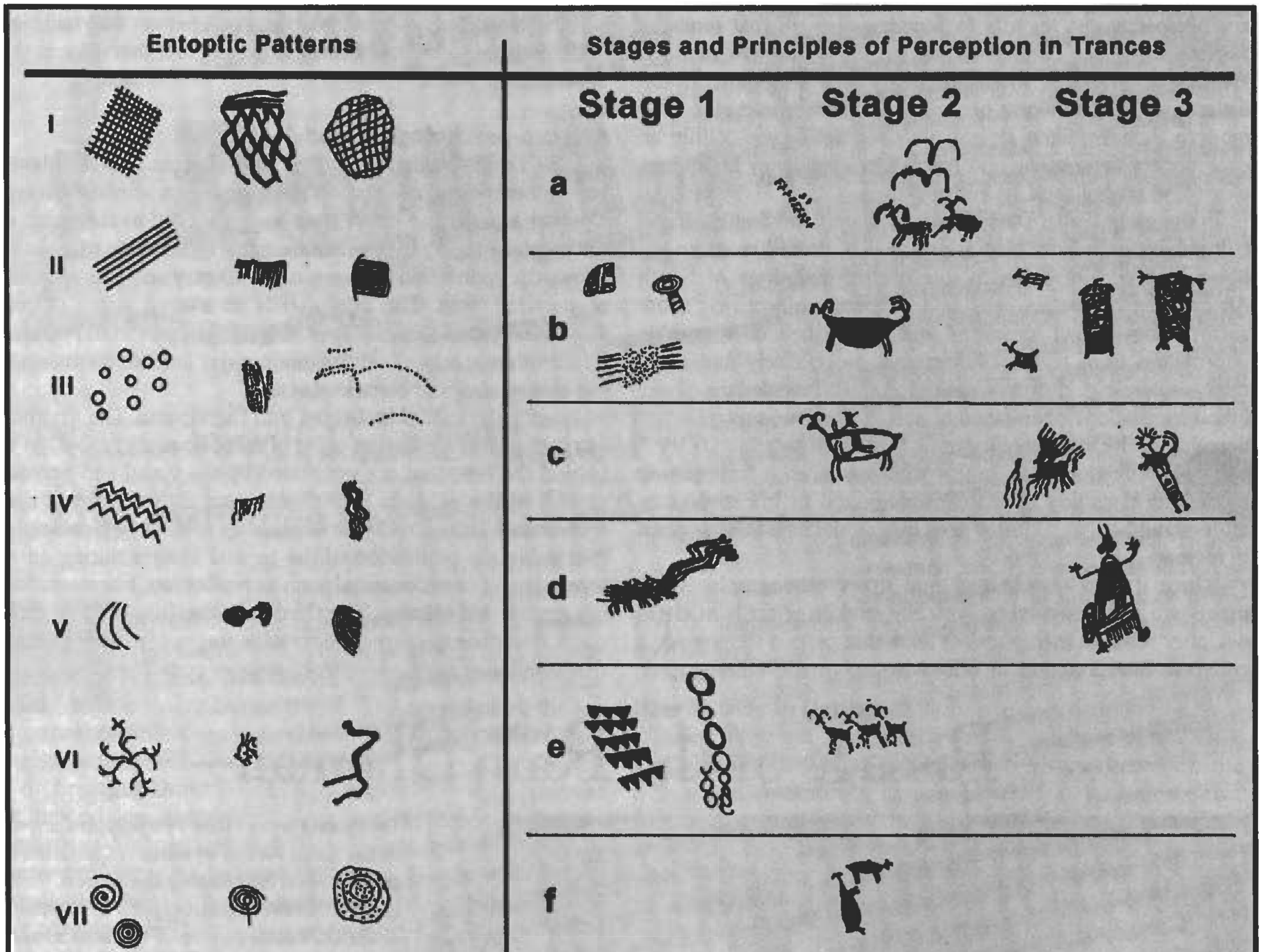
D.S. WHITLEY

This panel from Little Petroglyph Canyon in the Coso Range of eastern California is part of what is probably the largest concentration of petroglyphs in North America. Besides some of the area's many bighorn sheep, this panel includes geometric ("entoptic") patterns, a simple human figure, and a "medicine bag." Ethnographic research has shown that the concentration of petroglyphs in the Coso Range resulted because shamans traveled there from throughout the Great Basin to acquire rainmaking power; that the bighorn sheep was the specialized spirit helper of the rain shaman; and that the metaphor "killing a bighorn" (sometimes shown in the art in what have been misinterpreted as "hunting scenes") symbolized the rain shaman's entry into the supernatural world to make rain. Skin medicine bags were used by shamans for their ritual paraphernalia.

Model Provides Understanding

Whitley sees the neuro-psychological model as both predictive and explanatory. "These represent a series of common patterns, which we can expect when art is intended to portray altered states imagery, and that allows us to test cases like the European Upper Paleolithic." In other words, the model provides a structure within which aspects of shamanistic arts can be understood and/or identified, and it also specifies the kinds of art motifs one can expect to find in the imagery of altered states of consciousness.

The neuro-psychological model is concerned solely with the mental imagery of altered states of consciousness and the form



Visions and Images
Rock art research has combined ethnography, demonstrating that much of the rock art was made by shamans to depict visionary images, with neuropsychology, providing cross-cultural data on the mental imagery that results during trance states. A major advance was the development of the neuro-psychological model by South African archaeologist David Lewis-Williams and his students, depicted here using petroglyph examples from the Coso Range of eastern California. The left side shows the first component of this model, the internally generated luminous percepts, known as entoptic ("within the eye") patterns, commonly seen cross-culturally in trances. On the right side, the left column depicts the idealized patterns; the middle and right columns are Coso petroglyphs showing how the idealized patterns manifest in the art. The right side illustrates the second and third components of the model, the progressive stages of a trance (across), and the principles of perception in trance imagery (down). During Stage 1, entoptic patterns are seen alone. In Stage 2, entoptics are construed as culturally meaningful iconic forms. Then, in Stage 3, iconics and entoptics combine, or iconics are seen alone. Mental images experienced during a trance may be perceived as: (a) fragmented; (b) integrated into more complex forms; (c) superpositioned one atop another; (d) juxtaposed one against another; (e) duplicated in series; (f) rotated off a horizontal plane; or (g) simply seen alone (not shown). Examples of Coso petroglyphs are used here, illustrating how well this model accounts for aspects of this art not explained by other suggested interpretations. (After Whitley, 1996, *The Art of the Shaman*).

that they take. It focuses on visual or optical hallucinations. Whitley believes that the aural and the somatic, or bodily, effects of altered states of consciousness are equally important. His own research focuses on the somatic hallucinations of altered states of consciousness.

Examples of mental imagery include certain geometric motifs such as parallel lines, zigzags and spirals that are found at various sites throughout the world. Aural hallucinations include such things as the sound of bullroarers and flutes. Whitley says that in far western North America shamans typically used a flute or bullroarer (a slat of wood swung on a cord to produce a whirring sound) at the start of rituals to demarcate a transition from profane to sacred time. Use of certain sounds to help induce trance is another cross-cultural phenomenon.

Biological Bases of Culture

"My work is oriented towards what are essentially the themes or the subject matter of shamanic art," says Whitley, who believes he is reaching an understanding of where the biological bases of culture actually lie. He is looking at the biological bases for a series of shared shamanic themes or motifs in art that are found in many cultures.

> *The thinking behind symbolism in the distant past is as complex as modern thought.*

Somatic hallucinations, according to Whitley, include things such as the common metaphoric allusion to death in an altered state of consciousness. This is typically displayed in North American iconography as either a killed animal or a human killing an animal, with the animal being the spirit helper that the shaman received during his altered state of consciousness. Other cross-cultural somatic metaphors include flight (a metaphor for entering the supernatural world), drowning or going under water (indicating a place where there is weightlessness, difficulty breathing, changes in hearing and vision), and the metaphor of sexual intercourse (certain trance-inducing hallucinogens cause sexual arousal).

Whitley believes that research on the symbols that are associated with altered states of consciousness is producing very important information about the origin of art and the origin of religion. "Our Christian saints were heavily involved in fasting, and in isolation (which is sensory deprivation). Both of those conditions lead to altered states of consciousness. If we look at the descriptions of the visions that the saints had, they absolutely fit the pattern of the neuro-psychological model."

Traditionally, rock art has been classified on the basis of style; however, recent research is bringing this taxonomic approach into question. "The interpretation of style was taken to its logical extreme, which is that each style is culturally and chronologically specific," says Whitley. "And that's just ethnographically insupportable."

Further, he says that the stylistic chronologies for rock art around the world simply don't work. For example, chronometric dating of Great Basin rock-art styles shows that each style was being produced from the late Pleistocene down to the last 500 years, and similar associations between styles and chronologies are found in the rock art of Australia and southern Africa.

Whitley writes that "the ethnography and its implications in the neuro-psychological model alone potentially explain most of the styles defined for the far west [of North America] as manifestations of a single prehistoric culture."

When asked to what degree recent inferences from rock-art research are accepted by archaeologists, Whitley said some are hesitant. Some archaeologists, he said, think that "interpretive hypotheses concerning things like symbolism, ritual and so on are somehow less scientific and more speculative than hypotheses about technology or subsistence.

"That's just patently false. Hypotheses are hypotheses, and either they are scientific or they are not."

Whitley says that there are archaeologists who seem to believe that no knowledge is preferable to a small amount of knowledge, and who seem to prefer to say nothing rather than speculate and present only a small amount of evidence. He thinks that such archaeologists abdicate their responsibility to the public and thus create a void that invites explanations by authors such as Erich von Danikin, whose 1970s best-seller *Chariots of the Gods* proposed extra-terrestrial beings as the answer to many archaeological mysteries.

Seeking to Explain Human Behavior

Asked to explain a bit more about how he sees rock-art research as being at the forefront of archaeology, Whitley refers to developments in the disciplines of cognitive science and biopsychology. Because of the neuro-psychological model, rock-art research is able to participate in the intellectual debate going on in these other sciences. It presents a scientific explanatory model at the highest level of abstraction.

He says the goal of archaeology since the 1960s and 1970s has been to obtain true explanations of human behavior. But, says Whitley, "much of the discipline has denied that symbolism, interpretation, art, and so on are subjects that can be studied from the point of view of science. Yet, archaeologists rarely have been able to achieve true scientific explanations of technology and subsistence.

"And here we are, we've got an interpretation of art and symbolism and ritual, and we've got a scientific explanation of it!"

–Carol Ann Lysek

In addition to publications listed in **Suggested Readings,** David S. Whitley has three new books on rock art coming out this year and next. His *A Guide to Rock Art Sites: Southern California and Southern Nevada,* was published in March by Mountain Press Publishing Company of Missoula, Mont. Later this year Le Seul, Paris, and Harry N. Abrams, New York, will be bringing out his *Art of the Shaman: Rock Art of Native California.* A third new book, *Ethnography and Rock Art in Western North America,* edited by Whitley, is due from the University of New Mexico Press in 1997.

The excavation area at the northeast margin of Tolo Lake is visible in this aerial view toward the northwest. Mammoth No. 3 area is in right-center foreground. Beyond, from the left, are the water-screening area, Mammoth No. 1, and the "Ivory Coast."

Photographs courtesy of Susanne Miller

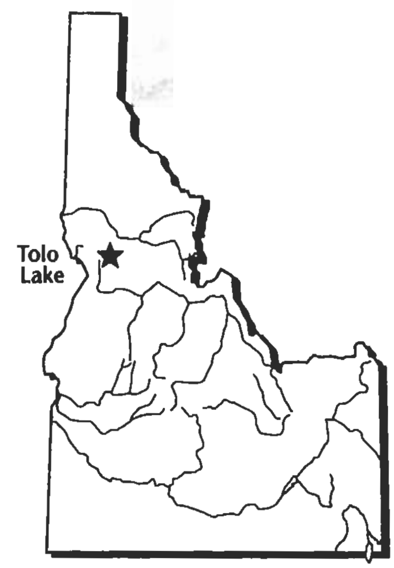
Excavation in Idaho Lake Bed Yields Mammoth, Bison Remains

Natural law seems to dictate that major archaeological and paleontological finds will be serendipitous, that they will take place late in the season during uncomfortable weather, and that they'll occur just before the end of a fiscal year and/or immediately prior to a three-day weekend. A further law of nature affirms that there is a magnetic attraction between mammoth skeletons and earth-moving equipment.

Heavy-equipment operators completing a wildlife and recreation rehabilitation project at Tolo Lake, Idaho Department of Fish and Game property five miles west of Grangeville, Idaho, made just such an unexpected discovery on Sept. 2, 1994. The lake had been drained so workers could grade away wind-borne sediment, much of which had been blown into the lake from agricultural fields. Bulldozers struck fossil bone and mammoth tusk at several spots along the northeastern margin of the lake bed.

The find was reported to the office of the State Archaeologist, and a late-season investigation was initiated to determine the nature, extent and scientific value of the discovery. What one scientist called a "paleo-SWAT team"—archaeologists, paleontologists, and volunteers—descended on the site and soon established that the Tolo Lake mammoth fossils were abundant and well preserved. The site offered an excellent opportunity to investigate these prehistoric animals and their Ice Age environment in northern Idaho. The find area was "winterized," and professionals made plans to field a major excavation.

The Tolo Lake Mammoth Project got under way in July, 1995. Field excavation was directed by Susanne Miller, Lockheed/Idaho National Engineering Laboratory, Idaho Falls, in coordination with principal investigators Robert Yohe, State Archaeologist, Idaho State Historical Society, Boise; and William A. Akersten, Curator of Paleontology, at the Idaho Museum of Natural History in Pocatello.



Goals of the 1995 project, said Miller, included recovery of mammoth fossils from three areas within the lake for scientific study and eventual museum exhibition. More than just an opportunity to obtain spectacular fossils, the Tolo Lake project was also designed to collect information from the lake sediments, chemistry, and geology, and from the fossils themselves, about the process of fossilization, the natural history of mammoths, and the Ice Age environment of the region.

Miller and the field workers addressed these questions through careful excavation and documentation of the mammoths (and bison fossils recovered with them), including three-dimensional recording, mapping and photography, extensive sampling and fine-mesh water screening, to determine the nature and antiquity of the fossils and sediments and to detect any possible evidence of cultural activity in association with the mammoths.

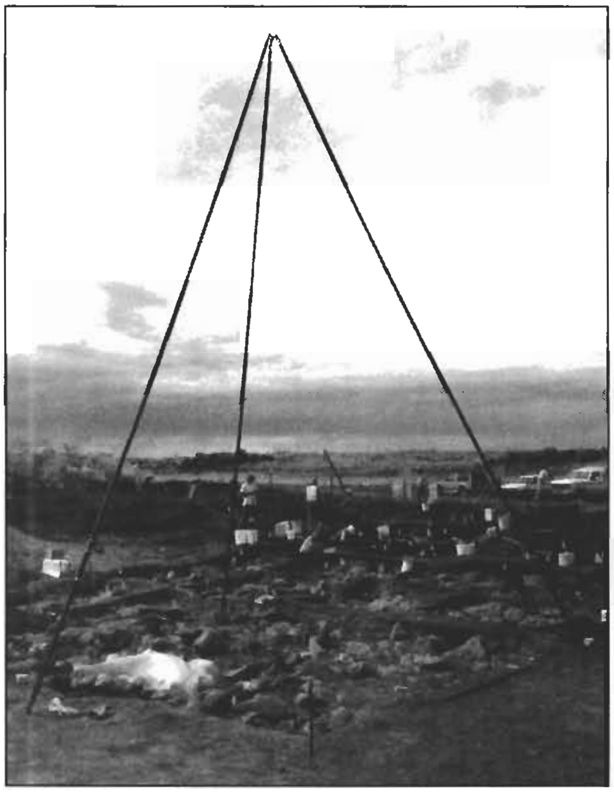
The Tolo Lake excavation focused on three spatially and, probably, temporally related deposits of exceptionally well preserved mammoth and bison fossils. One area, referred to as "Mammoth No. 1" consisted of the remains of a large adult Columbian mammoth (*Mammuthus columbi*). In life this individual, probably a male, stood about four meters high at the shoulder. It is represented by a nearly complete skeleton that was confined to a limited area and embedded in deeper lake sediments a short distance from the lake shore. Another partial mammoth skeleton was uncovered from a similar setting and depth about 100 meters away. This excavation was the focus of a University of Idaho archaeological field school directed by R. Lee Sappington.

A fossil deposit close to the complete mammoth represented a scatter of well-preserved but broken and abraded skeletal elements of an estimated seven additional mammoths and three extinct bison (*Bison antiquus*). These fossils were found in shallow lake-margin deposits, christened the "Ivory Coast," on, in, and under rocks; they offer an interesting contrast to the fate of the whole mammoth skeleton preserved just a short distance away. The spectacular preservation of the megafauna gave rise to optimism that other species critical to dating the mammoths and characterizing the paleoecology of Tolo Lake would be recovered. But in spite of continuous screen washing of tons of sediment throughout the summer, almost no vertebrate or invertebrate microfossils were recovered.

Radiocarbon dates obtained on sediments and mammoth bone so far have been anomalously young—around 4,300 to 5,000 years B.P. Contamination is suspected as the cause of recent dates. The sedimentary history and geology of Tolo Lake should provide a relative dating sequence to place the mammoth fossils in time. Results from coring done in the fall of 1994 identified some features useful to interpreting the depositional history and a possible paleomagnetic reversal. No evidence of human association with the fossils has been found.

A volunteer excavates a partial mammoth pelvis on the rocky "Ivory Coast." Seven 5-by-5-meter blocks in 2½-by-2½-meter subsections were opened on this beach area of Tolo Lake.

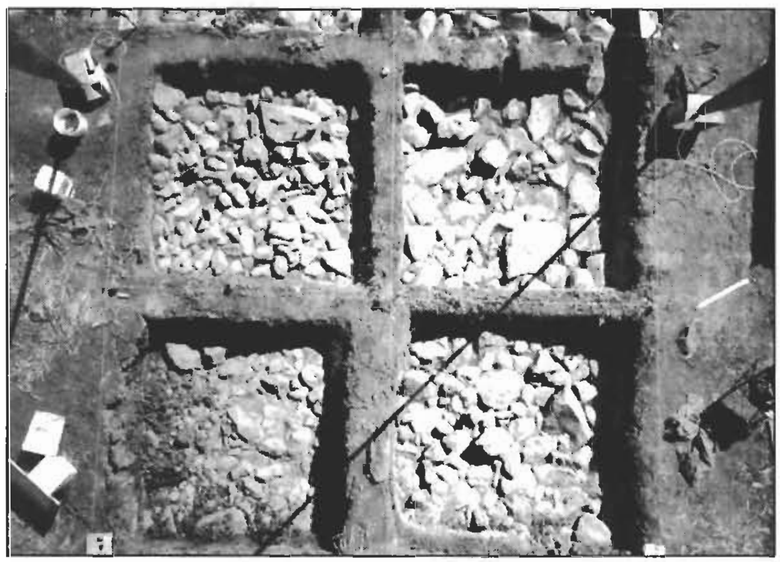
More than 400 individual fossils (totalling more than 6,000 pounds, and including the ubiquitous plaster jackets required to protect many of the larger specimens, especially tusks) were recovered from Tolo Lake during the three-month field season. Miller said they represent just a fraction of the total fossils scientists suspect are in the lake bed. All fossils will be prepared and housed at the Idaho Museum of Natural History on the



(Above left) **A jacketed tusk is lifted from the "Ivory Coast" area.**

(Above) **Team members prepare the top jacket of a scapula of Mammoth No. 1.**

(Left) **A custom-made tripod eight meters tall helped map the site's rocks and bones and made possible overhead photos such as the one** *(below)* **of a 5-by-5-meter block of the "Ivory Coast."**



Idaho State University campus in Pocatello.

The Tolo Lake project experienced firsthand the keen interest of the public in fossils and in the subjects of history, archaeology and paleontology. (One of several Tolo Lake T-shirts, the "Tolassic Park" version, probably expresses this interest accurately: "There hasn't been this much excitement in Grangeville, Idaho, in 10,000 years.") People were eager for the opportunity to visit a working dig, see newly exposed fossils in their natural setting, ask questions and share in the excitement and techniques of recovering the large bones. The Tolo Lake project met this enthusiasm in several ways.

More than 200 volunteers from several states were trained and supervised by the Tolo Lake staff and participated in the excavation as diggers throughout the summer. Recovery of fossils, and the scientific investigation at Tolo Lake were made possible by invaluable contributions from scientific specialists representing the Idaho State Historical Society, State Historic Preservation Office, Idaho Museum of Natural History, Idaho State University, and the University of Idaho. Donations of labor, materials, and logistical support came from volunteers, state and federal agencies and their personnel, citizens of Idaho County and the community of Grangeville, and private companies. Agencies included the Idaho Department of Fish and Game, the U.S. Soil Conservation Service, Nez Perce National Forest, U.S. Bureau of Land Management, Idaho County Historical Society, Nez Perce National Historic Park, Friends of Tolo Lake, Prairie Land and Timber Co., Nez Perce Tribe, and the Grangeville Chamber of Commerce.

Tolo Lake staff and volunteers conducted tours for several thousand visitors throughout the summer and 1,400 schoolchildren during the first two weeks in September. The Tolo Lake excavation received extensive media attention through newspaper articles and radio and television coverage, and even went onto the Internet. Details of the Tolo Lake dig and information about the science and methods of paleontology and archaeology, the Ice Age and extinct animals, and related topics can be found in an interactive educational home page at this Internet address: http://viper.idbsu.edu:80/bsuradio/mammoth/. The home page was developed at Boise State University.

For now, the Tolo Lake excavation area has been covered and the lake allowed to refill. Contingency plans for future access and excavation are being made, depending on funding and the results of scientific analysis over the next one or two years. Cooperating scientists will continue to investigate the many questions raised by the Tolo Lake project through additional field and laboratory work.

A paleo-SWAT team descended on the Tolo Lake site.

Miller says Tolo Lake offers a rare glimpse of one type of taphonomic situation, a North American lakeside where large bones have been well preserved in a death assemblage reminiscent of African water-hole settings. Although additional field work at Tolo Lake in the near future is uncertain, analysis of the information gained during the 1994 and 1995 field seasons will be conducted by the team.

Signs decorate temporary fencing put around the excavation area.

Yohe will continue to serve as "mammoth master," says Miller, coordinating the scientific, logistical, publishing and public-relations work, as well as contributing to the geochronological and paleontological studies. Akersten and Miller will lead the analysis of the paleontology, osteology, taxonomy and taphonomy of the mammoths and bison.

Several scientists from the University of Idaho participated in the field work and will continue investigations into the mysteries of Tolo Lake. Sappington is working on the taphonomy of Mammoth No. 3 and archaeology of the lake basin; Bill Rember is studying soils and sediments, geochemistry, invertebrate paleontology, and palynology. In addition, the team will pursue options for further paleoenvironmental research, which will include additional coring, remote sensing, and chemical analysis of the sediments and fossils.

Mammoth Trumpet readers who would like more details about the involvement of volunteers and donors, about the accommodation of the public, or about media interest in a project such as the "Tolo Lake Experience," may contact

Susanne Miller
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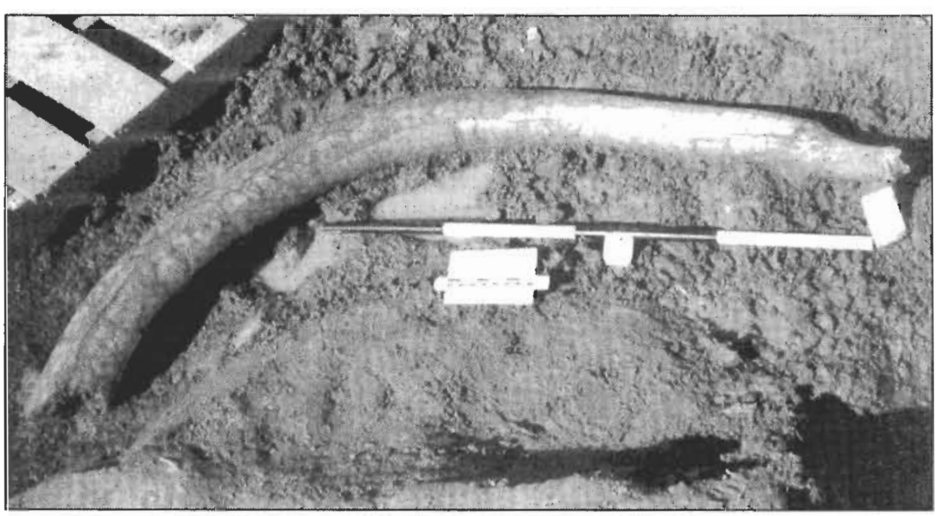
P.O. Box 1625, MS 2091
Idaho Falls, ID 83415
208-525-0062 (sk1@inel.gov)

or

Robert Yohe
Idaho State Archaeologist
Idaho State Historical Society
210 Main St.
Boise, ID 83702
208-334-3847 (rmyohe@aol.com)

Other principal coordinators are William Akersten of the Idaho Museum of Natural History in Pocatello; R. Lee Sappington of the University of Idaho in Moscow; and Carmelita Spencer of the Idaho County Historical Society in Grangeville.



One of ten mammoth tusks recovered during the Tolo Lake project.

Beringia Center Hires Paleontologist

The Yukon government's Heritage Branch has hired a senior paleontologist for the new Beringia Interpretive Center. He is John Storer, currently Curator of Earth Sciences at the Royal Saskatchewan Museum in Regina. Storer began work in Whitehorse on Feb. 1.

"The Beringia Interpretive Center will be a major new tourism heritage attraction for Whitehorse and the Yukon," said Tourism Minister Doug Phillips. "Attracting an individual of Dr. Storer's stature will ensure that the program is successfully implemented and becomes a 'must-see' attraction contributing to increased visitor expenditures in the territory."

Storer will play a key role in the exhibit planning process for the Beringia facility. Along with Yukon archaeologist Dr. Ruth Gotthardt, he will cochair a scientific and First Nations advisory body which will provide the information to be used by exhibit planners to form the basis for interactive exhibits in the new center. Storer received his B.A. in biology from Amherst College in 1966 and his Ph.D. in zoology (vertebrate paleontology) from the University of Toronto in 1971.

COMING CONFERENCES

April 10–14 Society for American Archaeology's 61th Annual Meeting, New Orleans.
Contact: SAA, 900 Second St. NE #12, Washington, D.C. 20002; 202-789-8200.

April 11–13 American Association of Physical Anthropologists 65th Annual Meeting, Durham, NC.
Contact: Matt Cartmill, Duke U. Med. Center, Durham, NC 27710; 919-684-8034; Matt_cartmill@whistle.cellbio.duke.edu.

April 22–26 Eighth International Conference on Luminescence and Electron Spin Resonance Dating, Canberra, Australia.
Contact: Judy Papps, Quaternary Dating Research Centre, ANH, RSPAS, Australian National University, Canberry, ACT 0200, Australia; 61-6-249-4764; fax 61-6-249-0315.

April 25–26 Geology and Geochemistry in Archaeology/Spring 1966 Meeting of the Mineralogical Society, Milton Keynes, UK.
Contact: Olwen Williams-Thorpe, Dept. of Earth Sciences, The Open University, Milton Keynes MK7 6AA, UK; 01908 655147; fax 01908 655151; o.williams-thorpe@open.ac.jk.

May 20–24 International Symposium on Archaeometry, Urbana-Champaign.
Contact: Sarah Wisseman, ATAM Program, University of Illinois, 116 Observatory, 901 S. Mathews, Urbana IL 61801. 217-333-6629; fax 217-244-0466; wisarc@ux1.cso.uiuc.edu.

May 24–26 Third Eastern States Rock Art Conference, University of Maine at Machias.
Contact: Mark Hedden, Maine Historic Preservation Commission, 55 Capitol St., Augusta ME 04333.

SUGGESTED READINGS

ON Lithic Analysis

David E. Young and Bonnichsen, R. 1984 *Understanding Stone Tools: A Cognitive Approach.* Center for the Study of the First Americans.

Alex D. Krieger 1944 The Typological Concept. *American Antiquity* 9:271–288.

ON Rock Art

Whitley, D. S. and L. Loendorf (editors) 1994 *New Light on Old Art: Recent Advances in Hunter-Gatherer Rock Art Research.* UCLA Institute of Archaeology, Monograph 39.

Lewis-Williams, J. D., and T. A. Dowson 1988 The Signs of All Times: Entoptic Phenomena in Upper Paleolithic Art. *Current Anthropology* 29:201–245.

Whitley, D. S. 1992 Shamanism and Rock Art in Far Western North America. *Cambridge Archaeological Journal* 2:89–113.

Whitley, D. S. 1994 By the Hunter, For the Gatherer: Art, Social Relations and Subsistence Change in the Great Basin. *World Archaeology* 25:356–373.

Whitley, D. S., and R. I. Dorn 1993 New Perspectives on the Clovis vs. Pre-Clovis Controversy. *American Antiquity* 58:626–647.

ON George Frison

George C. Frison 1991 *Prehistoric Hunters of the High Plains.* Academic Press, San Diego.

G. C. Frison 1968 A Functional Analysis of Certain Chipped Stone Tools. *American Antiquity* 33:149–155.

G. C. Frison 1991 The Goshen Paleoindian Complex: New Data for Paleoindian Research. In *Clovis: Origins and Adaptations*, edited by R. Bonnichsen and K. Turnmire. pp. 133–151. Center for the Study of First Americans, Corvallis.

Arthur J. Jelinek 1976 Form, Function, and Style in Lithic Analysis. In *Cultural Change and Continuity, Essays in Honor of James Bennett Griffin*, edited by Charles E. Cleland. pp. 22–33. Academic Press, New York.

June 22–29 Ninth International Palynologic Congress, Houston.
Contact: D.J. Nichols, U.S. Geological Survey. fax 303-236-5690; dnichols@greenwood.cr.usgs.gov.

Sept. 30–Oct. 3 Sixth International Conference on Ground Penetrating Radar, Sendai, Japan.
Contact: Motoyuki Sato, Dept. of Resources Engineering, Faculty of Engineering, Tohoku University, Sendai 980-77, Japan. 81 (22) 217-7399; fax 81 (22) 217-7401; gpr96@earth.tohoku.ac.jp; URL: http://www.earth.tohoku.ac.jp/gpr96.html. Abstract deadline April 5.

Oct. 26–29 Eastern States Archaeological Federation, Wilmington, DE
Contact: Faye L. Stocum, Delaware SHPO, No.15, the Green, Dover, DE 19901. 302-739-5685. Abstract deadline June 1.

Molecular Archaeology

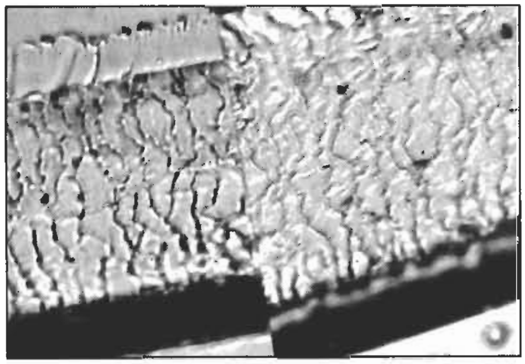
continued from page 1

seeds, small-mammal remains, plant macrofossils, fossil insects, lithic flakes, and charcoal.

Current thinking on the peopling of the Americas can be divided into two schools: those who believe Clovis people were the earliest Americans, and those who accept evidence of earlier human occupation. Scholars on both sides have generally agreed that the peopling of the Americas occurred as Asians crossed over the Bering land bridge. Bonnichsen says that even this basic hypothesis is now being questioned by some scientists.

Nevertheless, the primary debate has been about when this migration took place. The Clovis proponents believe that it happened around 12,000 years ago. The pre-Clovis adherents think it took place well before 12,000 years ago. Artifacts more than 12,000 years old are rare in the Americas, but hair of greater antiquity is preserved in many environments.

What is needed to settle the question is additional stratified sites with well-developed chronologies and unambiguous evidence that clearly demonstrates the presence of humans. Bonnichsen believes that the new molecular archaeological approach can move the debate forward by providing the needed evidence. This approach requires that scientists from a wide range of disciplines collaborate to produce the desired information.



WALTER BIRKBY

Two scale impressions (enlarged 800 times) of human hair. At the left is a sample from a living Asian person; the right sample was recovered from below a 10,500-year-old level in a cave site in Montana. The level was lateral to a 14,500-year-old date.

In previous excavations, **CSFA** researchers have discovered human and animal hairs preserved in deposits greater than 10,000 years old. Hair stylists estimate that the average person loses 200 hairs and/or hair fragments per day. This means that over a 60-year period, each person will contribute about four million hairs to the archaeological record. Since hair is the most common "artifact" that humans produce, its potential abundance at site locations can be postulated. Hair from animals can be expected to be even more abundant.

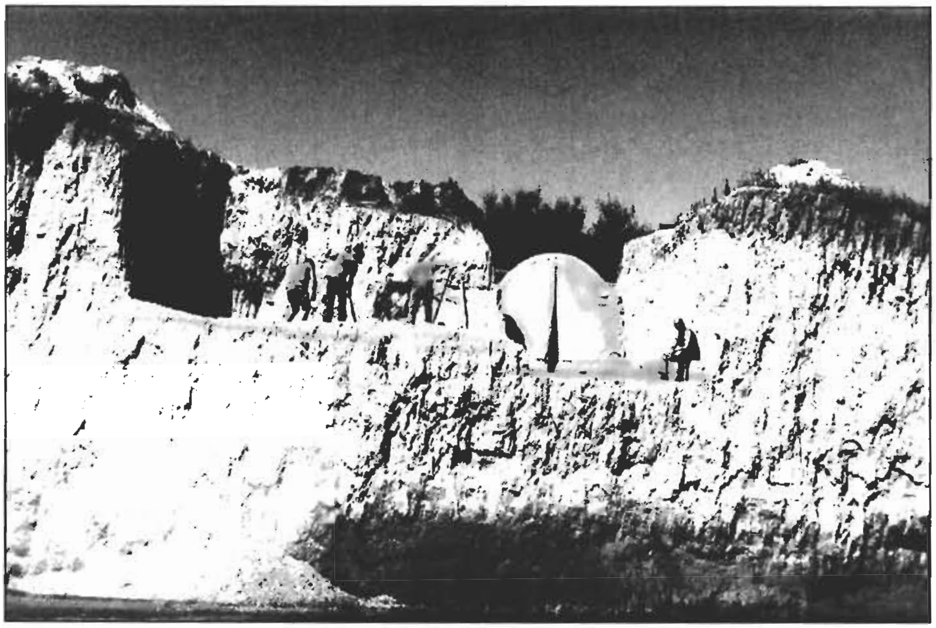
Last summer, a **CSFA**/Earthwatch team worked at developing a methodology for recovering ancient hairs. Efforts of **CSFA** researchers previously had proven that hair can routinely be recovered from many kinds of sedimentary contexts, including clay-rich sediments. Recovery is accomplished with the aid of a disaggregating agent known as sodium hexametaphosphate, which breaks down sediments in which hairs are bound.

Not only human hair, but hair from various mammals can be highly informative, says Bonnichsen. Hairs that are a minimum of 20 centimeters long can be radiocarbon dated. Further, a pilot study done last year by microbiology and agricultural chemistry scientists at Oregon State University showed that genetic material—DNA—can be isolated from hair recovered from archaeological sites and analyzed.

Bonnichsen is confident that molecular analysis will take archaeology "beyond stones and bones" and into the

ROBSON BONNICHSEN

To keep from contaminating archaeological deposits with their own hairs or DNA, workers at the 1995 Cremer-site expedition wore lab coveralls, hair nets, beard nets, and rubber gloves on the site and in the lab where Louise Dyer is pictured at work.



STEVEN R. HOLEN

One part of the 1996 CSFA/Earthwatch expedition will be at the LaSena mammoth site in loess deposits alongside a reservoir in western Nebraska.

"who" of prehistory. Molecular archaeology has the potential to yield information about human migrations and the history of human diseases as well.

This summer's research involves excavations at three different sites. The Hell Gap site is in the foothills of the Haystack Mountains, about 10 miles from Guernsey, Wyo. There a **CSFA/**Earthwatch team will join the University of Wyoming excavation being led by George Frison. Hell Gap site contains a long sequence of Paleoindian occupations.

After a month, the project will move to the La Sena site near the Medicine Creek Reservoir in Nebraska. There a **CSFA/** Earthwatch team will join with the University of Nebraska State Museum research team led by Steve Holen. Holen has found a series of sites (La Sena, Jensen, and Shaffert) that contain flaked mammoth bone that was apparently modified by humans, but there are no other diagnostic indicators for the presence of humans (**Mammoth Trumpet** 10:1 "Bones of Nebraska Mammoths Imply Early Human Presence"). The **CSFA/** Earthwatch team will collaborate with Holen's research team in a search to determine if sediments from these sites, which have been confidently dated at 18,000 and 14,000 years old, contain ancient human and animal hair, as preliminary analysis has indicated.

Next, the project moves to the Cremer site east of the Crazy Mountains in Montana, about 100 miles west of Billings, where deeply buried archaeological deposits of late-Pleistocene age were discovered during the 1995 field season. This year, the deposits will be further investigated using fine-scale recovery techniques developed during the past three field seasons.

Each of the four **CSFA/**Earthwatch teams, which may vary in size from a minimum of five to a maximum of 15 volunteers, will spend two weeks in the field. Team I will spend its two weeks at Hell Gap in Wyoming from June 16 to June 30, followed by Team II at the same site from July 6 to July 20. Team III will work at La Sena in Nebraska from July 24 until Aug. 7. Team IV will excavate the Cremer site in Montana from Aug. 11 to Aug. 25.

Beyond stones and bones and into the "who" of prehistory.

A multidisciplinary approach, which draws upon the expertise of scientists in paleo-climatology, geology, soil science, paleoecology, archaeology, microbiology, and agricultural chemistry, characterizes this project. Bonnichsen has outlined a number of objectives. The scientists want to learn more about how the sites were formed, and they will use various geoarchaeological techniques to determine that. They hope to determine the specific late-Pleistocene and Holocene history of the sites by using standard excavation, screen washing, and flotation procedures.

In addition to analyzing physical items obtained from the sites, they also plan to reconstruct, when possible, the environmental history, settlement, subsistence, and lithic procurement patterns at all three sites. The scientists also hope to develop a detailed chronological understanding of each site by using radiocarbon dating, tephrochronology (if volcanic ash is present), stratigraphy, and soils analysis. Research results recovered by the **CSFA/**Earthwatch teams will be integrated with results from previous investigations of these sites. Findings ultimately will be presented at scientific conferences and published.

To demonstrate the presence of ancient DNA, Bonnichsen said the team's researchers will work with animal hairs to begin with "so that no issue can be raised about human contamination." He is well aware of the potential for excavator contamination of ancient hair, so strict protocols have been developed to prevent it. Crew members will wear hair nets, beard masks, white coveralls and rubber gloves. Results from last year's excavation at the Cremer site show the presence of a wide range of animals.

The standard procedure for obtaining hair from sediments is to take a 50-centimeter-square column of sediment and place it in two-liter bags for chemical treatment that breaks down the bonds that hold the hairs and other light material to the soil. The treated sediments are then washed through fine screens and the hairs and other fine artifacts are separated out.

The chemical composition of hair makes it resistant to fungal and bacterial attack, says Bonnichsen. Hair has been found in dry cave sites, and it has been preserved at permafrost sites; it is also preserved in fine silts like loess and in anaerobic waterlogged deposits. "Where

Documenting a Changing World

Earthwatch, founded as a tax-exempt institution in 1971, sponsors scientists, artists, teachers, and students to assist in documenting a changing world. Earthwatch members have supported 1,523 projects in 111 countries, providing scientists with 34,000 volunteers, and $22 million in funds and equipment to solve problems on the frontiers of knowledge. Earthwatch's main office is in Watertown, Mass. It also has offices in Boston, Los Angeles, Melbourne, Australia, and Oxford, England.

Earthwatch states that its mission

is to improve human understanding of the planet, the diversity of its inhabitants, and the processes which affect the quality of life on earth. Earthwatch is an international company of citizens who have taken an interest in the quality of life on the planet. We are ageless and energetic; each is drawn by the possibility that we might be useful in finding the solutions to problems which confront humankind.

In general, contributions of cash, securities, and property donated by U.S. citizens to support scientific research projects sponsored by Earthwatch are tax-deductible. Furthermore, under certain circumstances volunteers may deduct reasonable out-of-pocket expenses for transportation to and from research sites. In the United States, Earthwatch is a public charity described by Section 501(c)(3) of the Internal Revenue Code.

Anyone wishing further information about this summer's Earthwatch projects may call Earthwatch at 617-926-8200 or the **CSFA** at 541-737-4595.

the water table has come up through time—and that's happened in a lot of places—hair is preserved very well."

Bonnichsen is a veteran Earthwatch team leader and project supervisor. He says that working with Earthwatch volunteers over the years has been an outstanding experience. "The people who come on the projects are there because they want to be there, and they bring a lot of enthusiasm and new knowledge to the project. We benefit greatly from their efforts and their contributions."

A $250 deposit reserves a place in the expedition. The full contribution of about $1,400, due 90 days prior to departure, supports the research, covering all costs to plan, mobilize, and support the expedition. This includes costs of the scientific staff, a field camp, expedition vehicles, food, accommodations, equipment, instrumentation, gasoline, and freight. Participants must pay their own transportation costs to and from the staging area. Competitive grants are available to teachers, high-school students, and artists applying for expeditions.

Bonnichsen says that Earthwatch volunteers need not have any particular experience or training. However, a background in archaeology, anthropology, geology, biology, other natural sciences, or history is always welcome, as is any excavation experience. Also, attention to detail, organizational skills and patience are always good qualities to bring to such a task.

"We provide people with an educational experience," says Bonnichsen. Evening slide presentations and field trips organized by prominent scientists participating in the project enhance the learning experience of the volunteers.

Several different types of people are attracted to a project such as this. Younger people who are considering a career in archaeology may want to see if this type of work is really for them. Teachers from the social sciences at elementary, middle, or secondary level take what they learn on the site and bring it back to their classrooms.

People who were really interested in archaeology but went into other (often more lucrative) careers want to find out how archaeology has evolved since they first studied it. Many retired people are tired of the usual tourist-type vacations. "They don't want to just spend money on a trip somewhere, they want to make a contribution to knowledge," says Bonnichsen. And a lot of people are interested in natural history in general, so they like to participate in the wide range of expeditions that Earthwatch has to offer. Also, some people are looking for fun and adventure and they just like to do interesting things.

Volunteers should be in good condition because the work is hard, but no special physical conditioning is required. "We rotate people through different jobs. Some people like to work in the field and some people like to work in the lab, but we would like everyone to have an understanding of all the tasks that are involved," says Bonnichsen.

–Carol Ann Lysek

ROBSON BONNICHSEN

The Cremer site lies in this picturesque valley on the east side of the Crazy Mountains. Here the 1995 CSFA/ Earthwatch expedition camp is visible.

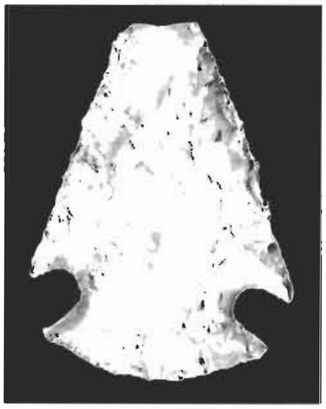
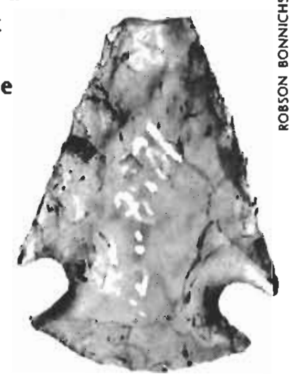


Photo (actual size) of a corner-notched point from Mammoth Meadow displays little detail.



ROBSON BONNICHSEN

Computer-enhanced image reveals detail that can be analyzed.

Stone Tools

continued from page 1

lar period of time. The result can be confusing to anyone, even those who are familiar with archaeology of the Americas.

Archaeologist Robson Bonnichsen, who as a boy taught himself how to recreate projectile points he found near his family's Idaho farm, is now using computers to arrive at a much better understanding of lithic artifacts. He calls the process "frame analysis," and stresses that it is readily available to all archaeologists. Frame analysis could break through the assumptions involved with the strings of nomenclature extensions that link artifacts with places, peoples and times, and could facilitate a better understanding of American prehistory.

The technique is an important phase in the development of the cognitive approach to anthropology, says Bonnichsen. It is a way of relating a tool maker's behavioral process to the resulting tool. Creation of a tool can be regarded as three discrete aspects: cognition, the previsualization of the tool; behavior, the process of flintknapping; and product, the tool, itself. Frame analysis seeks to isolate individual behavior patterns of the flintknapper as it provides an empirical basis for describing individual tools.

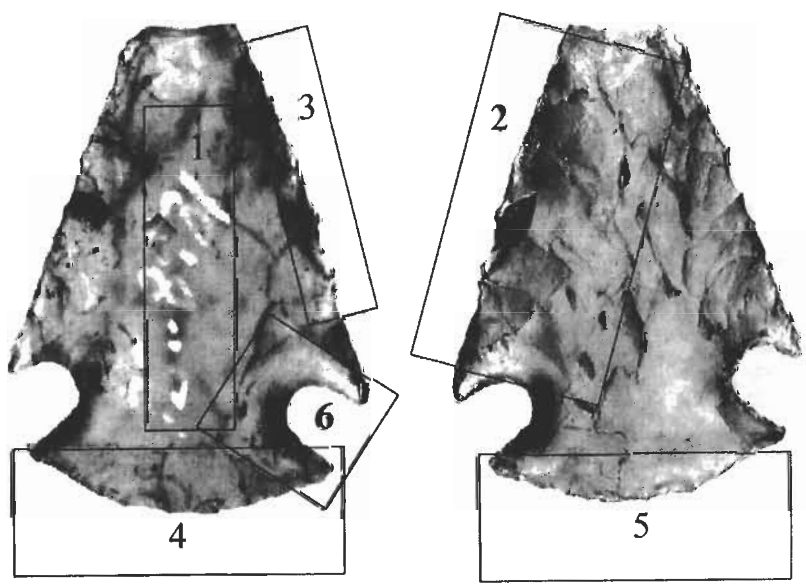
"There have been some long-standing problems in American archaeology regarding the classification and interpretation of artifacts," Dr. Bonnichsen said in a recent interview in his office at Oregon State University, where he is professor of anthropology and director of the **Center for the Study of the First Americans.** "Historically, archaeologists have created types to classify artifacts," he said, noting that archaeologist Alex D. Krieger put forward what probably remains the clearest exposition of the type concept back in 1944.

"Types were created prior to the advent of radiocarbon dating. And they were designed to isolate particular cultures in time and space." Bonnichsen says there's been a long-term circularity in the logic of classification because artifacts have been defined by the morphology, and the morphology has been looked to as an indicator of time.

The colorful names of artifact types, taken from sites where they were first found and described, are sprinkled through the pages of books on archaeology and anthropology of the Americas—Rabbit Island Stemmed, Plano, Desert Side-notched, Bitterroot, Clovis, Coquille Side-notched, Folsom, and scores of others. Archaeologists learn to recognize types that relate to their work; students are bewildered by the sheer number of types and confused by similarities. Folsom points display a distinctive form that makes them among the most widely recognized; fortuitously their type is associated with a relatively short span of time. Clovis points are thought of as an equally distinctive form, but in fact they encompass considerably more variation.

"We have a nomenclature system that characterizes archaeological cultures—in terms of projectile points—that has been based on a system of original discoveries," says Bonnichsen. "What we find when we start looking across regions is the same shapes with different names. We've got some real inconsistencies in terms of shape nomenclature."

Lithic-tool experts such as Bonnichsen have long recognized that there is a problem with typologies, but not a lot has been done about it. With experience and



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An enhanced image can be greatly enlarged for study. Numbered frames outline separate units of the flintknapper's behavior that are described in a production code for each artifact. Each production code, written in a standardized shorthand, includes a general description for each piece ("Corner notched; Sharp barb") and then goes into the descriptions of shapes and processes found in each frame (1-3 blade, 4-5 base, 6 notch, tip absent). Production codes give details for each frame including the size, shape, spacing and angle of scars.

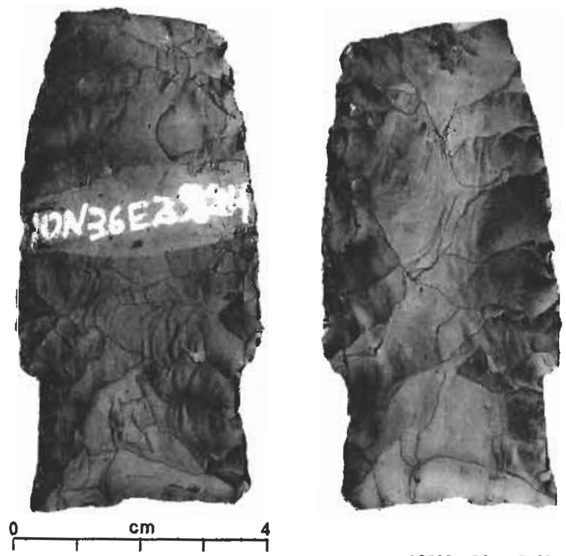
careful study, archaeologists first come to recognize general types, and then with further analysis they define variations and subtypes. "It's been a top-down, intuitive, gestalt process," says Bonnichsen. It normally requires experts to hold artifacts in their hands and examine how they were made. Experts often employ flintknapping experiments to increase their understanding of a particular type.

Bonnichsen believes any student of lithics who has a recent-model desktop computer and a few supplements available from most computer stores can take a giant leap toward better understanding of lithic artifacts with computer imaging. The key to the process is to describe the artifact carefully, rather than to classify or pigeonhole it.

To gain an understanding of an artifact, you have to be able to see it well, and that usually isn't possible from photographs published in books and journals. Views of artifacts can be greatly enhanced by computer imaging. It's a straightforward process involving a camera to capture the image, a 486 computer and an image-editing software program such as Adobe Photoshop. A high-resolution monitor is recommended.

After much experimentation with capturing artifact images with video cameras, Bonnichsen has found that images on ordinary colored slides or black-and-white negatives work better. That is important, because archaeologists already have extensive collections of slides and negatives of significant artifacts.

To prepare slides or negatives for computer analysis, a researcher needs a slide scanner. Connected to the computer, this peripheral device transforms visual images into digital ones that can be readily manipulated with image-editing software. Relatively large computer files are required to capture the original picture in high resolution. Imaging software allows dark-colored points to be made light enough to reveal every facet of every flake scar; fingernail-sized points can be enlarged to the size of huge "wealth" blades so that minute detail is visible on the computer's monitor or on a print from a laser printer. Images of artifacts of white crystal and others of black obsidian can be adjusted to look quite similar—their individual production techniques being the principal difference.



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These images of a broken Cody point made from a lusterless, dark chalcedony from the Mammoth Meadow site have been enhanced to reveal production details that are not easy to see on the actual artifact. Bonnichsen uses eight frames to analyze this point.

"You can see a lot of the production detail and even some of the use-wear detail," says Bonnichsen. "You can understand not only how the point was made but why it was discarded."

A little practice putting the software through its paces with the computer's mouse will allow anyone to produce images that are equal to or even better than the original slide. Analysis of the image, however, requires an acquired expertise in lithic technology—the computer does not do the work, but it allows a standardized, orderly evaluation.

"Using frame analysis, we place a frame around that part of an image we believe is a flake sequence or a behavioral sequence that is represented by a series of flakes."

Each image becomes not just an enhanced picture of one side of a lithic tool, but rather a series of patterns of flake scars. Beyond providing valuable information about the creation and use of the tool, the technique provides a wealth of data for use in comparing and contrasting specific artifacts. Two tools that might initially appear quite similar on the basis of outline form could well display many differences in technology that can be cataloged and described.

Bonnichsen is using the technique to analyze points from the deeply stratified Mammoth Meadow site in southwestern Montana where quarrying and tool production went on more or less continually for more than 11,000 years. The area was used by peoples of the Great Plains, Columbia Plateau and Great Basin, so the site's artifacts are revealing much cultural detail as well as presenting extraordinary challenges to analysis. Artifacts that look rather similar were discovered in strata widely separated in time, and makers of Mammoth Meadow artifacts represented cultures from a wide geographic area.

Scott Jones, one of Bonnichsen's graduate students, used frame analysis in his study of the Anzick Clovis Cache from southwestern Montana. Another graduate student, Gary Curtis, is using the technique to analyze rock art. The principle is to use image-enhancing techniques to break down a complex creation into component parts that can be understood and described.

"We're not able to reconstruct the totality of all human behavior involved in producing an artifact," Bonnichsen explained. "But we are able to classify flake scars and relate them to behaviors." The technique reveals the finishing-sequence behaviors of the flintknapper as well as breakage or wear and sharpening. "Not all parts of an artifact entail the same production procedure," he says. "We look at those procedures used to make the different design units, and we can classify points in terms of procedures."

In analyzing the many Mammoth Meadow artifacts, Bonnichsen and his team members are able to describe the individual shape attributes that distinguish one point from another in a systematic way. "Within those groups, we look to

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This broken Eden point, also from the Mammoth Meadow site, has been computer enhanced so that every flake scar is apparent. From such images, an authority on lithic artifacts can describe each step of the production process and assess use wear. The production code for this piece included seven frames.

see if we have more than one procedure used to manufacture points; conversely, we can tell if one set of technological procedures was used to make more than one style of points," he said.

"The method allows us to analyze artifacts in a comparative sense without becoming bogged down in classification. We're dealing with real data."

Bonnichsen noted that archaeologists have relied on traveling experts for lithic analysis. Authorities on artifact types have traditionally visited collections to examine artifacts and provide their impressions. Frame analysis, in contrast, will allow archaeologists to base conclusions on empirical data rather than on the impressions of experts.

More importantly for First Americans studies, frame analysis permits researchers to share and compare data without having to move artifacts from place to place. Images can be shared either on computer disk, slide or negative.

The key to making frame analysis an effective way to overcome archaeology's long-standing classification and nomenclature problems is careful definition of terms. The process requires development of what Bonnichsen calls "comparative systematics," and initially it has been a slow process. The Oregon State University researchers have looked to other disciplines, such as soil science, which has a technical nomenclature for describing all soils in a way that is universally understood within the profession. Bonnichsen and his team are following that example, by writing definitions to describe each individual characteristic of any artifact.

The process has been slow because terms are necessarily written during the analysis of a framed production sequence. "You have to write your definitions from looking at empirical reality," said Bonnichsen. "You have to work back and forth with the data all the time." While their technical vocabulary is not yet complete, the Oregon State workers are getting close. "We're defining our words so you're not tied to an individual type, but you have concepts that cut across specimens of any time. So it's like soils classification."

In the early 1960s, Bonnichsen studied with flintknapper Don Crabtree and went on to work with cognitive anthropologist David Young in relating flintknappers' behavior to the resulting tool. "It's an experimental approach that allows you to produce the missing link of the behavior that produced a given pattern." Without careful documentation, however, it's difficult to link the artifact to the experiment.

The new computer-imaging technique advances the process. Frame analysis provides a framework for doing an experiment by providing needed parameters. "We're talking about units and rules." Each frame delimits a perceived unit of an individual flintknapper's behavior. By analyzing every point the same way, each can be compared with every other point.

Though this analytical aspect of computer imaging may be its most significant scientific contribution, Bonnichsen says its beauty is that it cleans up archaeological photographs. "There's no such thing as a perfect photograph of an archaeological specimen," he notes, adding that computer software allows improvement of all photos. "You can lighten up the dark areas and you can darken the light areas, so you start to get a uniform background of what that specimen is about." Noting that archaeologists often must deal with tiny specimens, Bonnichsen said that with image enhancement "you and everybody else can see what it is."

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New Books

The Paleo-Indian of Southern St. Louis Co., Minnesota: The Reservoir Lakes Complex, by Christina Harrison, Elaine Redepenning, Christopher L. Hill, George (Rip) Rapp, Jr., Stanley E. Aschenbrenner, James K. Huber and Susan C. Mulholland. Kendall/Hunt Publishing Co., Dubuque 1995. 239 8½-by-11-inch pages, 62 figures, 22 plates and 36 tables.

This report by a team from the Archaeometry Laboratory at the University of Minnesota-Duluth examines the Paleoindian complex in an area 20 miles north of Duluth and 16 miles west of Lake Superior's north shore. The focus is the Redepenning collection of archaeological materials—801 stone implements, 218 retouched or used flakes, 14,213 pieces of debitage, and 13 copper tools and lumps of native copper. Consideration of environmental context, including faunal analysis, will await a second volume focusing on a survey and excavation. This study consists of a comprehensive analysis of a collection made at low water levels from 40 localities on sand-gravel beaches of lakes that were modified in the 1920s for hydro power.