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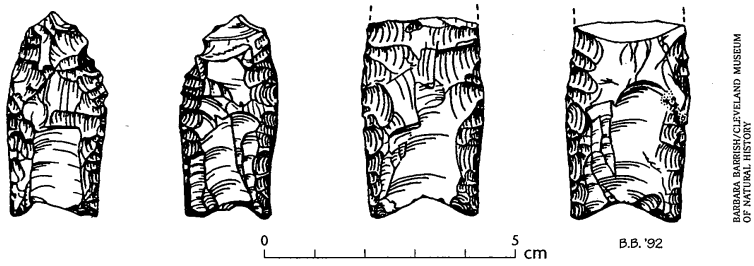

Examples of Clovis points from the Paleo Crossing site near Akron, Ohio.

INVESTIGATIONS AT OHIO SITE PUSH BACK DATES FOR CLOVIS

Discovery May Be East's Earliest Structure

The 12,000-year-old Paleo Crossing site near Akron, Ohio, is one of the earliest-known human occupations in the eastern United States. Recent discoveries there include radiocarbon-dated charcoal from what may be the oldest human structure in North America. The site represents a unique record of post-glacial Ohio.

Crews of archaeologists and students under the direction of Dr. David S. Brose of the Cleveland Museum of Natural History are in their third season of excavations at the prehistoric site in Sharon Township, Medina County, Ohio. The site, about 2½ acres in extent, is part of a larger property now owned by Terri-Jon Management and Development Company. Formerly known as the old Dague Farm site, it lies on a south slope below the crest of a kame, or glacial knoll, that rises on the west side of a series of kettles, or glacial depressions. The overall site area is defined by Clovis lithic artifacts and waste flakes from the manufacture and/or use of these tools. These lithic materials were found exposed on the surface and incorporated into the upper 20 cm of plowed fields on a 75-meter-wide bench of the knoll, which slopes southeast to a former bog about 300 meters away.

While some of the projectile points are consistent with the "Gainey" style, many are "Clovis," perhaps the earliest Paleoindian manifestation of the Great Lakes region, presumed to have developed as long ago as 12,500 years.

Avocational archaeologist Jim Remington, who first alerted the museum's archaeologists to the existence of the Clovis site, previously recovered less-ancient projectiles from a small area of the field's plowed topsoil at the high point of the knoll, about 100 m northwest of the bench. His discoveries were four heavy Kirk corner-notched serrated points of dense black Upper Mercer flint. These Kirk points are identical to those found in earlier Cleveland Museum excavations by Brose at a 9,240 ± 160 B.P. level of the Squaw Rockshelter site, 30 miles northeast of the Paleo Crossing site.

Owner Protects Property

Since discovery of the Clovis site in the early summer of 1990, the owner has protected the property from any ground-disturbing development, allowing the Cleveland Museum, under the direction of Brose, its chief curator of archaeology, to perform three intensive surface surveys of the fields in which each piece was plotted. During the summers of 1991 and 1992, Cleveland Museum archaeologists conducted additional piece-plotted collections of the area west of the ridge that defines the limit of surface distributions of Clovis artifacts found over the past years. The investigators found no evidence of Paleoindian occupation west of that baseline and no evidence of other periods of occupation in higher areas of the property.

Down the slope on a level gravel bench, the crew discovered complete and fragmentary Gainey and Clovis style points and debitage representing a vari-

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A Federal Policy for Archaeology

Public lands, especially in the West, harbor most of United States' archaeological sites. Thus the federal government's policies toward America's archaeological heritage is critical to all who are interested in the quest for the first Americans. The Secretary of the Interior, the steward responsible for the greatest number of archaeological sites on public lands, recently issued what is titled "A National Strategy for Federal Archaeology."

"The number of archaeological sites from bygone times never increases; it is only reduced, by modern development, by looting, and even by the very best of archaeological research," says the policy statement, signed by Secretary Manuel Lujan Jr. "It is important that we make the most of the sites that we have left,

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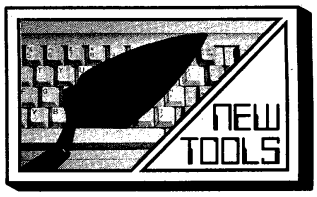
ARCHAEOLOGY HAS ADOPTED COMPUTERS

Sophisticated Methods Reveal Hidden Answers

When you think of an archaeologist's tools, do you think of brushes, trowels, plumb lines, and buckets? Perhaps you also think of cameras, microscopes, and laboratory instruments like radiocarbon dating equipment. And, if you haven't already added computers to your list, now is the time to do so. In the last 10 to 15 years, archaeologists have used computers in increasingly powerful and sophisticated ways.

A recent round of interviews with archaeologists at the Smithsonian Institution in Washington, D.C., the Center for Advanced Spatial Technologies at the University of Arkansas in Fayetteville, Ark., and the



Illinois State Museum in Springfield, Ill., has revealed a wide range of exciting new uses for computers in archaeological research. Archaeologists are using data bases, geographic information systems, CAT scanners, ground sensing equipment, satellites, and three-dimensional visualization technology to advance their understanding of the past.

Geographic Information Systems

Data-base technology is making it possible for archaeologists to synthesize masses of data that no individual person, or team of people, could possibly handle. In seconds, a data base can compare data drawn from hundreds of sites. With appropriate mapping and plotting capabilities, a computer can create maps and charts that illustrate patterns of information that would be extremely difficult, if not impossible, to infer from many pages of raw data.

Dr. Russell Graham, a vertebrate paleontologist at the Illinois State Museum, has been working with Dr. Ernest Lundelius of the University of Texas to develop a massive automated data base. "It's a pretty

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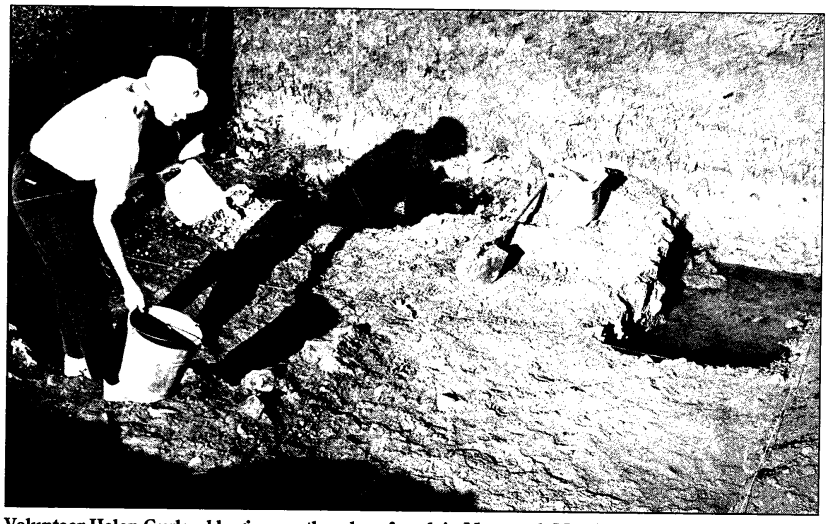
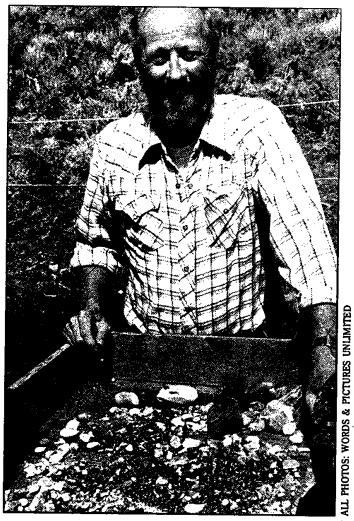


Volunteer Helen Gurland begins another day of work in Mammoth Meadow I where water stands in a corner already excavated below the water table.

Volunteer Mallory Siegel examines the fine screen at the outflow of a floatation tub while her husband Edward stirs the muddy water. Screening the water catches hair that might have escaped notice.



Principal investigator Robson Bonnichsen checks a screen of lithic debris that has been washed in a floatation tub. Drying with the rocks is a filter screen that may hold hair samples.

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Montana Site Proving Rich In Old Hair

As Complexity Increases, Plans Proceed for 1993

MAMMOTH MEADOW, MONT.—The seventh season of investigation has proven this high-altitude site in southwestern Montana even more complex and interesting than Robson Bonnichsen, principal investigator, had expected. As of this early August writing, the site is continuing to produce an abundance of artifacts from below what had been considered the oldest level.

Even more interesting is the abundance of hair being discovered from the lowest levels.

Analysis of this season's discoveries is only beginning, but it is clear that human utilization of this rich resource site dates back to before 11,000 years ago. The record of hair already identified establishes the presence of a wide variety of mammals including mammoth, bison, bear, caribou, ancient horse, human, and many smaller mammals. This season's discoveries may lengthen the list. The hair, most recovered from below the 9,000-year-old Cody level, offers great promise for dating and genetic analysis.

Project leaders, including archaeologist Bonnichsen, geologists Joanne and Morton Turner, and soil scientist Marvin T. Beatty, are already making plans to return to the site during the summer of 1993. They expect to continue and broaden the multi-disciplinary investigation of this site, which lies near a rich source of tool-grade chalcedony along a small stream near the 7,000-foot level a few miles east of the Continental Divide. The area was used as a quarry by people from both the Great Basin and the Plains. These early miners left behind millions—perhaps billions—of flakes as they processed the raw material. Bonnichsen believes the chalcedony was shaped into pre-forms at the site before it was exported.

Investigations this summer were conducted in two large units several meters apart. Excavation has proceeded down through an interesting but puzzling layer of cobbles, clay and cultural materials that formerly was seen as the floor of the site's lowest

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Center Has New Books in Production

The Center for the Study of the First Americans is in the process of publishing new books in its Peopling of the Americas series.

The first, scheduled for publication later this year, is *Method and Theory for Investigating the Peopling of the Americas* edited by Robson Bonnichsen, Oregon State University archaeologist, and D. Gentry Steele, Texas A & M University physical anthropologist.

Combining expertise from a variety of disciplines, *Method and Theory* is composed of the work of 23 authors whose 17 papers are grouped into general sections on methods, biological approaches, linguistic approaches, material culture, geoarchaeology, discussions and conclusions. It grew out of presentations presented at the 1989 World Summit on the Peopling of the Americas.

Methods chapters are "Accelerator C-14 Dating of Human Fossil Skeletons" by T. W. Stafford; "Radiocarbon Dating of Bone by Accelerator Mass Spectrometry" by R. E. Taylor; and "An Application of Nitrocellulose Membrane for the Identification of Bio Residues on Artifactual Material" by D. C. Hyland, J. M. Tersak, J. M. Adovasio, and M. I. Siegel.

The four chapters on biological approaches are "Researching Paleoindian Human Skeletal Remains," by Steele; "Non-metric Traits of the Skull Help Reconstruct Prehistory in Northwest North America" by N. S. Ossenberg; "Relating Eurasian and American Population through Morphology" by C. G. Turner; and "Modeling Ancient Population Relationships from Modern Population Genetics," by E. J. E. Szathmary.

Linguistic chapters are "Linguistic Evidence for the Peopling of the Americas," by Merritt Ruhlen; "The History and Classifications of Indian Language: What Are the Implications for the Peopling of the Americas?" by Ives Goddard and L. Campbell; and "Comments to Remarks by Goddard," by A. R. Taylor.

A chapter on material culture studies, "Exploring the Cognitive Approach" is by David Young, Bonnichsen, J. Tomenchuk, D. Douglas, J. McMahon, and Lise Swartz. A chapter, "Geoarchaeology: Definitions and Implementation," is by W. R. Farrand.

Svante Pääbo provides comments on the chapters by Turner and Szathmary, and Jane Kelley provides a discussion of the Method and Theory symposium. The editors provide a final chapter of conclusions.

A new book scheduled for publication early in 1993 is *Archaeological Research at Six Cave or Rockshelter Sites in Interior Bahia, Brazil*, by Alan L. Bryan and Ruth Gruhn of the University of Alberta. After an introduction to archaeology in the region, Bryan and Gruhn have separate chapters detailing stratigraphy and artifacts of Toca dos Buzios, Toca de Manoel Latao, Abrigo da Lesma, Abrigo do Pilao, Toca do Cosmos and Toca do Gameleira. Bryan provides a section on the Sambaqui at Forte Marechal Luz in the state of Santa Catarina, Brazil.

–DAH

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Paleo Crossing

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ety of non-local sources. All these Paleoindian lithic materials have been found in a 2½-acre area curving around the south and west sides of the kame upon which 1839-era farm buildings stand. In that 2½-acre area the archaeologists employed controlled plotting of Clovis artifacts within and upon the plowed surface. In the process they identified three concentrations apparently representing areas of ancient human activity. Field crews led by Barbara Barrish have conducted test excavations at these concentrations. They have discovered 24 complete and fragmentary Clovis spear points, more than 300 small, single-sided, snub-nosed scrapers, and thousands of used and unused flakes from the manufacture and use of tools.

Distant Sources

Widespread contacts or travel by the tool makers is evident by the sources of materials. Approximately 50 percent of the Paleo Crossing site's Clovis lithic materials are light gray to bluish gray Wyandotte chert, or Indiana hornstone, which outcrops 350 miles southwest of the site, beyond the Falls of the Ohio River.

Another 20 percent of the Clovis lithic materials from the Paleo Crossing site analyzed to date are cherts of the Plum Brook or Pipe Creek outcrops of Mississippian Vanport formation (a facies of the more-southerly and better-known Flint Ridge chalcedony). Plum Brook outcrops about 50 miles east and Pipe Creek about 50 miles west of the site.

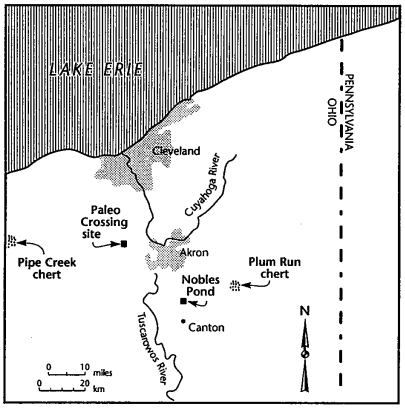
Another 15 percent of the lithic materials are an unusual variant of Upper Mercer or Zaleski flint from outcrops 50 to 70 miles south of the site. The remaining 10 percent of the site's Clovis lithic materials represent a variety of gray to tan to white cherts and flints of many lusters and compositions. Although some are from similarly colored cherts, which outcrop approximately 150 miles northeast of the site at the west end of Lake Ontario, all were likely to have been obtained from local glacial outwash deposits.

Less than 5 percent of the Clovis lithic artifacts are of Ohio Flint Ridge flint, and very little Ohio Flint Ridge debitage occurs on the surface or in the colluvial (incoherent) soils within the 2½-acre Clovis area. No materials of Ohio Flint Ridge flint were found in situ there.

Post Holes, Drain Tiles

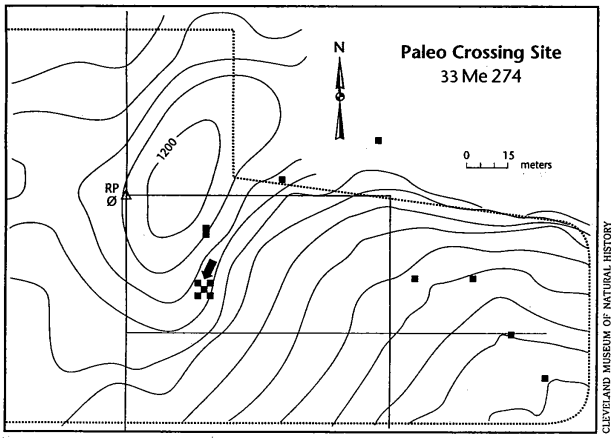
To sample portions of the Clovis site on the bench, excavation of six 2 m-by-2 m test units adjacent to areas of surface concentrations was done during the summer of 1991. One excavation unit revealed remains below the plow zone of at least two post holes in one of the activity concentrations where preliminary analyses had suggested the potential of a paleosol.

By the end of the 1991 season, Cleveland Museum crews supervised by Barbara Barrish had excavated two 1 m-by-1 m test units in the southeast corner of the field. The work demonstrated that the presence of a Clovis point fragment, which had been found in the lowest portion of the field, was due to disturbance of soils in the 1950s when drain tiles were installed and fill added. Museum archaeology crews also excavated two other series of 2 m-by-2 m test units in one of the areas of lithic concentration where no previous test units had been dug. Five checkerboarded 2 m-by-2 m test units were also dug adjacent to the areas where test units during the previous summer revealed a possible subsurface soil zone and post holes. In these test units three buried features were encountered that apparently represent subsurface cylindrical pits, about 35 cm in diameter and 50 cm in depth. These features originated in, and were sealed by, colluvial sediments washed from the kame to the north and west. Although organic staining had almost entirely diffused, the lower portion of these features was refilled with sediments much-less-well sorted than the surrounding matrix.



That dates the Clovis structure at the Paleo Crossing site as the earliest in North America.

Two of these pits contained small fragments of lithic debitage or charcoal, which the team recovered in 10-cm-thick zones. One pit contained, within such a matrix, the end-shock broken base of a Clovis projectile point, fluted on one face. By screening plow-zone soils from the same unit, the base of a small and serrated Kirk corner-notched point was recovered.



Map of Paleo Crossing site shows 2 m-by-2 m test units from 1991. Arrow locates the location of the post hole associated with Clovis horizon dated at 12,250 ± 100 years B.P.

Three Samples Dated

In November 1991 the museum sent three samples of charcoal recovered from the unscreened soils taken during the course of excavation to the University of Arizona's National Science Foundation Accelerator Mass Spectrographic Radiocarbon Facility for dating. The charcoal sample (AA8250) from one of the three post holes, which the museum investigators believed to be associated with the Clovis horizon of the site, was dated to 12,250 ± 100 B.P. That dates the Clovis structure at the Paleo Crossing site as the earliest in North America. [Proponents of the conventional late-entry theory for the peopling of the Americas have held that the first people arrived in North America about 11,500 years ago. –*Ed.*]

The museum sent two samples from the cylindrical pit that contained the Clovis point base. One sample (AA8251) of partially charred organic fragments, which came from a thin lens in the wall at the bottom of the pit, was dated to 13,100 ± 100 B.P. It may well represent the leafmold and forest litter on the surface of the post-glacial landform before occupation.

The third radiocarbon sample (AA8252) consisted of charcoal flecks in a thin colluvial lens below the plow-zone at the upper part of this same cylindrical pit, stratigraphically overlying the level containing the Clovis spear-point base. This sample was dated to 9,230 ± 80 B.P. It appears to represent colluvial sediments (slope wash) on the surface of the pit, originating from the Kirk phase occupation on the upper portion of the kame, long after Paleoindians left the site.

In all, the Paleo Crossing site appears like a much smaller, earlier, but far richer version of previously found, plowed-down sites such as the Gainey site in southern Michigan or the Nobles Pond site, about 35 miles farther east in Ohio. The 12,000-year-old Paleo Crossing site is among only a handful of partially intact Paleoindian-period occupations in the eastern United States, and it is the only one to have evidence of any structure.

As a preliminary step in archaeological site conservation, the owner of the Paleo Crossing site agreed to have the Cleveland Museum of Natural History nominate the site to the National Register of Historic Places. The owner is allowing the museum to excavate this season and in 1993.

Proposed Investigations

A site of such significance requires careful and well-supported investigation that involves several years. During the 1992 season, the museum's continuing excavations of the site involve detailed pedological and geomorphological studies and appropriate controls. Recovery of a pollen core from a nearby bog area is to be implemented this year if time and funding permit.

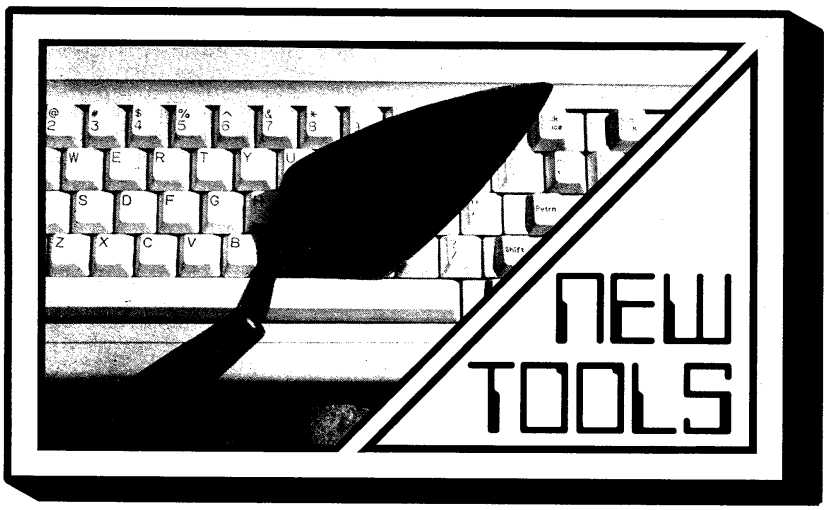
Accurate and rapid mapping of all prehistoric remains exposed at the site will in time be accomplished with a computerized laser theodolite "total data station." These data will be linked to GIS/CADD software for additional computer analyses of archaeological and geomorphological site surfaces and artifact distributions.

Chronological control of archaeological data is essential for understanding this early period of prehistory. Fine control is especially needed to discuss possible interactions among groups of peoples or to understand changes in environmental-human interactions in this recently deglaciated region of Ohio. Not only will we attempt to confirm the precise dating of this oldest occupation in the state with a suite of radiometric dates, we will attempt dating with materials other than wood charcoal and we will cross-check dating results by using several laboratories.

The analysis and interpretation of results from the current field season will take place in the museum's laboratories into the spring of 1993. The museum is exploring a variety of "paleo-forensic" methods reported to be capable of revealing the nature of organic residues on lithic artifacts. Further analysis of lithic material sources is to involve specialized laboratories and experts throughout the region.

Research based on the results of geomorphological, paleoecological and archaeological analyses will be designed to maximize the return of critical data while preserving for the future as much of this unique site as possible. Next spring the museum plans to prepare proposals for funding additional investigations, and for interpretive publications.

–David Brose & Barbara Barrish



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interesting program," Graham says. "We call it FAUNMAP, and it's for mapping the distribution of North American mammal species for the last 40,000 years." In the last year and a half, Graham and Lundelius and their team have entered data from most of the sites in the western United States; they are now working on eastern sites. Well over 1,700 sites have been encoded in the computer, and Graham anticipates at least 2,500 altogether. Using the relational data base Paradox, made by Borland, on an IBM PC-compatible computer, they encode information about each site: its age, cultural associations, geographic location, depositional systems, and species of mammals.

As with all computer systems, the results are only as good as the quality of the data that are entered. Fourteen collaborative scientists from the United States and Canada provide Graham's team with access to scientific literature containing useful data and also serve to check quality control. Three criteria are used to select the data that are entered:

1. The data must contain good locational information for each site so that it can be mapped; the site must be identified by at least the county in which it is found.
2. The site must be associated with an absolute date, have clear stratigraphic dating information, or have a strong cultural association to date from.
3. The site must have a voucher specimen in a public institution.

Data captured on the personal computer can be transported over an Ethernet network to a Geographic Information System on an IBM 6000 minicomputer. Geographic Information System, or "GIS," is an umbrella term that refers to any computer system of hardware, software, and data that can handle spatial references in a sophisticated way. On the IBM 6000, Graham uses the Arc/Info software package designed by the Environmental Systems Research Institute, in Redlands, Calif.

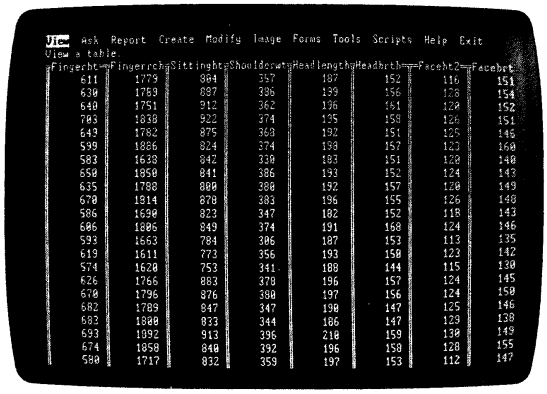
This two-part software package includes a relational data base (the "Info" segment), which contains the attribute information that has been transported from Paradox on the IBM PC.

The "Arc" segment of the program can generate maps using any of the data contained in the Info section. And, says, Graham, "The real power is in generating these maps. Some of the things we're seeing we didn't think we would see. . . . We're just really getting into it now; I think we're going to see lots of surprises before we're done with it." Arc/Info's ability to overlay different types of maps and look at spatial relationships is especially powerful, Graham says.

Graham notes that Arc can generate maps of different species through different slices of time, for example 15,000 to 20,000 years ago, 10,000 to 15,000 years ago, or at a particular span of time during the Holocene. "So we can see how individual species have moved in the past, in relationship to environmental changes."

Graham has also used the GIS to develop predictive models for paleontological sites. He explains that a predictive model is "a model you develop by taking all the information you have about the location of known paleontological sites. You look at where they are, what the relationship is to soil type, geological deposits, the nearness of streams, etc."

These data can then be used to identify how the sites relate to the physical attributes of the landscape on which they are located; for example, mammals may frequently have congregated in sheltered watering holes. "Then you take that model and apply it to an area where you know nothing about paleontological sites, and predict where sites might be with the construction of a probability map."



In seconds, a data base can compare data drawn from hundreds of sites.

From Field to Lab to Curation

Another institution making extensive use of data bases is the Center for Advanced Spatial Technologies at the University of Arkansas in Fayetteville, Arkansas. Dr. W. Fredrick Limp, director of the Center, and his staff of 26 people have been developing new uses for data bases and geographic information systems. The Center's staff has worked closely with the Arkansas Archaeological Survey, a statewide archaeological research organization, as well as other organizations.

So far, they have been using 25 UNIX work stations made by Sun Microsystems and Digital Equipment Corporation. In time, they may have to move up to more powerful systems.

Limp notes that computer applications in many fields are often afterthoughts; the researchers first perform their experiments, or make their excavations, "and then automate the results to do a particular kind of analysis. In our program, it's an integral part from field to lab to curation, as far as the whole process is concerned." Site data, artifact data, report data, and spatial information are all together on the same system.

The Center for Advanced Spatial Technology has been using data bases in four principal ways:

1. As management systems that allow archaeologists to enter data about artifacts, and then to perform detailed analysis on that data. Information about site characteristics, proveniences, and artifact characteristics is entered, and the computer can then produce reports, graphic documentation, statistical analysis, and cataloging information for curatorial facilities.
2. To collect archaeological site information. One such data base contains data about all known archaeological sites in Arkansas—23,000 sites in all.
3. To collect information on all known sites in the United States. This data is far less detailed than the Arkansas site data. So far, data has been entered from 250,000 sites in 20 states, from the Mississippi River to the Great Lakes states to the Continental Divide. The Center is examining this data in order to study changes in environment across the nation's landscape.
4. To develop, along with the National Park Service, a national archaeological data base of 110,000 archaeological reports. Archaeologists can gain access to this data from anywhere in the United States. By requesting a certain topic, an archaeologist can obtain a detailed bibliography about that topic.

The Center is also using Geographic Information System technology in combination with its data bases. For example, the Center has linked a data base with a GIS and a cartographic production system. Limp gives an example of its use: "We bring up a map of the state of Arkansas; use a mouse to draw a corridor across a portion of the state. . . . The software then goes to the data base and identifies all the archaeological sites that fall within the corridor, reports back the characteristics of the sites, and prints out a map of where they are."

The Center is also using GIS techniques to analyze Civil War sites as part of the National Park Service's American Civil War Battlefield Protection Program. Taking elevation information from aerial photos of the battlefield areas, the GIS can create a three-dimensional view of the battlefield. Then, the researchers can compare historic maps of military activities to the modern landscape, to see where various trenches might have been located. This enables the National Park Service to identify locations that should be protected by scenic easements.

CAT Scanning

Computerized axial tomography (CAT) scanners, which are commonly associated with brain imagery, have become useful tools to scientists at the Smithsonian Institution. Dr. Bruno Frohlich, a statistician at the Institution, has been using Siemens CAT scanning technology in an experimental project to create three-dimensional records of artifacts and bones in the Institution's collection.

Much of the material is going to be repatriated—returned to Native American peoples for whom the artifacts are part of their heritage. Thus, it is important for the Smithsonian to keep as accurate a record as possible of all material artifacts that will leave its collection. Frohlich has used the CAT scanner to record images of both bone and pottery.

The CAT scan creates an immensely detailed three-dimensional image. Frohlich explains, "We can display what is inside and outside of a bone; we can create a three-dimensional bone and turn it on the screen; we can do density measurements and very accurate measurements on the bone itself on the screen."

Because the CAT-scan images require a huge amount of storage space, the Smithsonian cannot make a scanned image of every artifact. Instead,

unique artifacts that need careful description are chosen for scanning.

Not only are the CAT-scan images useful records of existing artifacts; they will also be useful in determining the origins of artifacts that are studied in the future. "If there is some dispute over where material belongs, in terms of geographical distribution or tribal distribution," Frohlich says, "then maybe statistical analysis can help us document a certain specimen. By documenting material we know, then we can use statistical procedures to document material we do not know."

Thus, he says, his goal in the repatriation project is to record as much data as possible about each specimen—more data, in fact, than he now knows a use for, because it may be useful later.

Ground Sensing

Dr. Frohlich has used ground-sensing technology, or geophysical equipment, to locate archaeological sites. Since 1981, he has used this equipment in Jordan, Saudi Arabia, Egypt, Bahrain, Kuwait, and Pakistan.

In Kuwait, he used the Geonics EM-31, an electromagnetic conductivity meter made by Geonics Limited of Ontario, Canada. The Geonics EM-31 measures the ground's conductivity and produces data that can be analyzed by computer. By analyzing the conductivity of an area, scientists can begin to map the anomalies of the ground's conductivity. Working closely with geophysicists, they can distinguish anomalies created by the presence of human-made artifacts below the surface of the soil.

For example, Frohlich says, there is a difference in conductivity between ground that lies inside or outside the walls of a house, even if the walls are completely covered with additional layers of soil. By studying patterns of conductivity, archaeologists can locate sites below the surface of the ground.

Satellite Technology

The Center for Advanced Spatial Technology is also using remote sensing data gathered by satellites to define the characteristics of landscapes in which archaeological sites might be found. "The satellites aren't in fact finding archaeological sites," Limp says, "but they're finding complex relationships of soil characteristics," which can indicate likely locations for archaeological sites.

They can distinguish anomalies created by the presence of human-made artifacts below the surface of the soil.

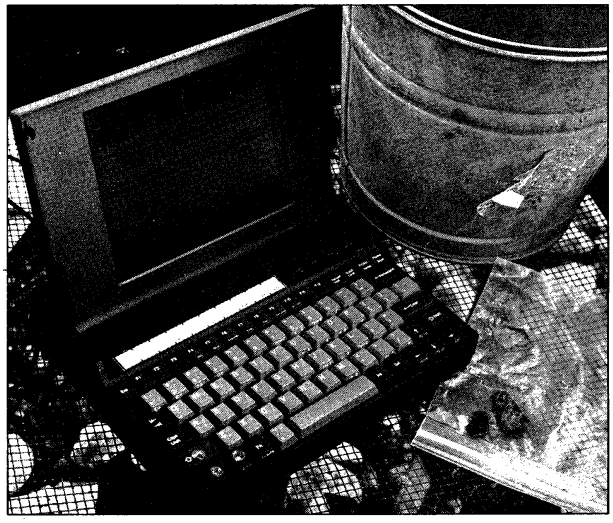
As an example, he explains that the Mississippi Valley is a convoluted geography of small sandy rises with clay around them. Many archaeological sites are located on the rises. "The satellite can't find the archaeological sites, but it does a really good job at finding the kind of vegetation that grows on those little rises." By examining satellite images of the landscape, Limp may be able to find additional archaeological sites.

Frohlich is also using satellite data to identify possible archaeological sites in southern Greenland. He explains that Viking and Norse settlers came from Iceland to southwestern Greenland and stayed about 500 years, from A.D. 1,000 to 1,400 or 1,500. Then they left or died out.

Frohlich explains that the presence or absence of settlements changes the growth pattern of grass, which satellite images can reveal. Therefore, he is going to superimpose known locations of settlement sites on a map, and then superimpose the map on a satellite image of the same region. He will study the grass growth patterns of the satellite image in the settlement areas.

"If there's a pattern in that, then we can look for similar changes in other places where we have not identified many sites yet. In that way, we can get a general idea of how many people lived there in how long a time, and then we can get into some very significant population demography."

Frohlich notes that just a few years ago, he needed a mainframe or at least a minicomputer to handle satellite data; now he can use the IDRISI software package, from Clark University, and an IBM PC or compatible to manipulate satellite data. Data processing with his personal computer is now five or six times faster than the mainframe was only five or six years ago. "What we'll be doing five or six years from now I can't tell you!" he says.



"I use it as a tool, as a shovel to move soil."

Three-Dimensional Visualization

Perhaps the most exciting use of computers in archaeology is in the area of three-dimensional visualization. This technology is closely related to what is known as virtual-reality technology. Both systems create three-dimensional images that the viewer can explore independently. However, instead of displaying the image in a headset worn by the virtual-reality user, a three-dimensional system displays the image on a computer screen.

To get an idea of what a three-dimensional visualization is like, imagine a television screen that responds to your initiative. If you want to explore the view to your left, you touch a button and the view changes to show you what is to your left. If you want to look at the ground or the sky, you can do so. You control what you look at. In a three-dimensional visualization, this is exactly what you can do.

In a joint effort with the Illinois State Museum, the Center for Advanced Spatial Technology is proposing to use three-dimensional visualization to create views of the landscape as it appeared in previous eras. Limp finds the possibilities of visualization very exciting. "With the developments in virtual reality, I'm convinced we'll have tours of the past," he says.

The Illinois State Museum and the Center for Advanced Spatial Technology hope to create such a tour of the Cahokia site, a massive archaeological site near St. Louis. This culture had 30–50,000 inhabitants at its height, and it has left behind a large complex of mounds. Limp hopes to use visualization software packages to create archaeologists' alternative visions of what this culture was like.

The task of creating a factually based representation of a past culture requires all the power of three-dimensional visualization software. "Archaeological data is enormously complex," Limp says. "Archaeology isn't really archaeology, it's psychology and biotic vegetation mapping and the mechanics of chert knapping, and species: it's basically everything—just in the past. It's an enormously complicated set of data that is interrelated. And within the last decade, really, we're beginning to see some of the automation tools that are allowing us to manipulate that data in really complex ways. Ultimately, visualization is just one way of seeing complex data."

The Impact of Computers on Research

Computers have added many new tools to the archaeologists' tool kit. The development of these tools is a great benefit to archaeologists, but it also poses one overriding danger to their research: it is all too easy for archaeologists to devote too much time to the development of the computer tools, and not enough to their actual research. As Frohlich puts it, only half jokingly, "then we are becoming computer experts instead of anthropologists."

Frohlich tries to maintain a balance between his need for computers, and his primary commitment to archaeological research: "I like to see the computer technology as a tool. It helps me manipulate data and get an overview of it. . . . But I use it as a tool, as a shovel to move soil; the shovel makes it easier for me to move the soil, and the computer makes it easier for me to look at my data. . . . I go and buy a shovel;

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UPCOMING CONFERENCES

Oct. 8–10—23rd Biennial Great Basin Anthropological Conference, Boise, Idaho.
Contact: Max Pavesic, Idaho State Historical Society, 210 Main St, Boise, ID 83702 (208) 334-3847.

Oct. 16–17—Second Gender and Archaeology Conference, Boone, N.C. Theme is "Women in the Profession—Histories, Cultural Resource Management."
Contact: Cheryl Claassen, Department of Anthropology, Appalachian State University, Boone, NC 28608 (704) 262-2295.

Oct. 21–24—Southeastern Archaeological Conference, Little Rock, Ark.
Contact: John House, P.O. Box 136, UAPB, Pine Bluff, AR 71601 (501) 535-4509.

Nov. 5–8—20th Annual Meeting of the Canadian Association for Physical Anthropology, Edmonton, Alberta.
Contact CAPA Coordinator, Department of Anthropology, 13–15 Tory Building, University of Alberta, Edmonton, Alberta, T6G-2H4 (403) 492-3879.

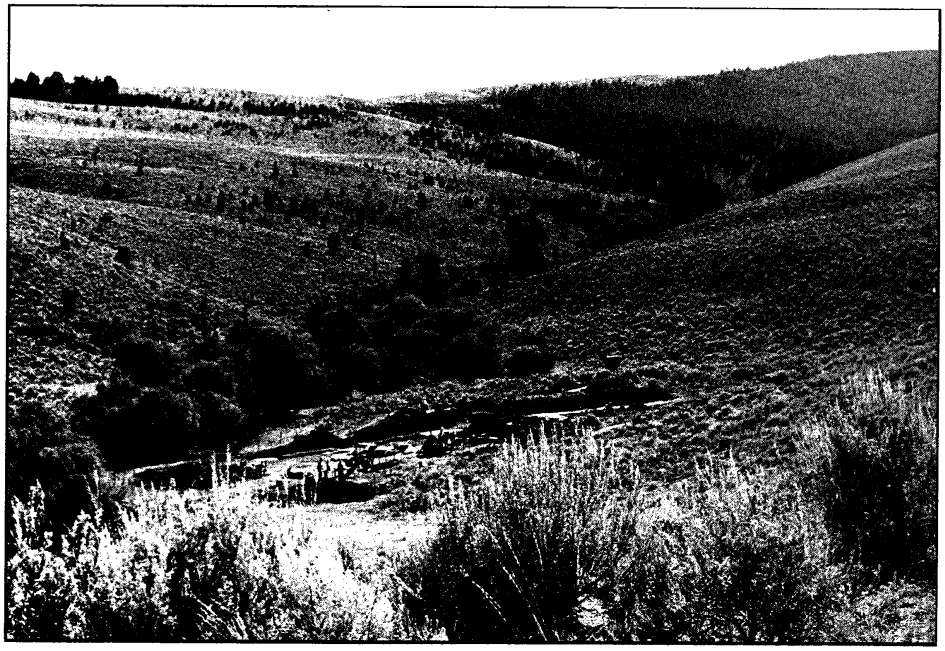
Nov. 5–8—59th Annual Meeting of the Eastern States Archaeological Federation, Pittsburgh, Pa.
Contact Richard George, Carnegie Museum Annex, 5800 Baum Blvd., Pittsburgh, PA 15206-3076 (412) 665-2600.

Nov. 12–15—25th Annual Chacmool Conference, Calgary, Alberta.
Contact: Programme Committee, Department of Archaeology, University of Calgary, 2500 University Drive N.W., Calgary, Alberta T2N 1N4.

Nov. 13–16—49th Annual Plains Anthropological Conference, Lawrence, Kan.
Contact: William Lees, Kansas State Historical Society, 120 West 10th, Topeka, KS 66612 (913) 296-2625.

Nov. 20–21—First Discovery of America, a Conference on Ohio's Early Inhabitants. The Ohio Historical Center, Columbus, Ohio. The goal of the conference is to expand understanding of the earliest human inhabitants of Ohio and the Great Lakes region.
Contact: Bill Dancy, Department of Anthropology, The Ohio State University, 245 Lord Hall, 124 West 17th Ave, Columbus, OH 43210-1364. (614) 292-9770.

Dec. 2–6—American Anthropological Association Annual Meeting. San Francisco.
Contact: American Anthropological Association, 1703 New Hampshire Ave. N.W., Washington, D.C., 20009 (202) 232-8800.



Excavated material soaks in water-softening solution.

Mammoth Meadow lies between sagebrush-covered hills and riparian habitat near the Continental Divide in southwestern Montana.

Mammoth Meadow

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level, and into a sandy layer below the present water table. Thus water pumps and generators to power them are a necessary part of the project's field equipment.

The pumps remove water from pits and also provide water to screen excavated material. Not only does water help to remove soil from still-abundant lithic artifacts, but it is also used to separate hair from the clay. After material is scooped from the pits, it is soaked in a commercial water-softening solution to break down the clay. Then it is passed through floatation tubs equipped with fine-screened outlets to catch any hair that might have been trapped in the clay and hidden from archaeologists. Waste water is caught in a holding pit and recycled as needed.

Early miners left behind millions—perhaps billions—of flakes.

Analysis of the hair will continue through the coming months. The extensive hair record is considered innovative and is potentially the most significant aspect of Mammoth Meadow.

Down through the Cody level, a previously dated and readily apparent cultural horizon that varies in depth from about a meter to more than two meters below the surface, Mammoth Meadow has produced an extensive record of bone. Below the Cody level, there is little bone but there are many samples of hair.

Hair can be identified, dated and even used as a source of genetic information. "Hair, here, is the key," says Bonnichsen, who considers the study of hair as a new subfield of archaeology. "And we have been throwing it away."

Specialists at Simon Fraser University and Penn

PENDEJO INVESTIGATION IS CONTINUING

An associate of Richard S. MacNeish, principal investigator of Pendejo Cave near Orogrande, N.M., brought faunal and fingerprint evidence from the investigation to Oregon State University early this summer to show staff members of the **Center for the Study of the First Americans.**

Dr. Donald Chrisman, an osteologist, displayed the broken leg bone of an extinct species of bison that was taken from the cave site. The bone, a humerus broken in mid-shaft, was from a layer the MacNeish team has dated to 40,000 years ago. Chrisman said the two pieces were found within a hearth approximately six inches apart, with a rock between them.

The nature of the break, apparently caused by a sharp blow to one of the strongest parts of the bone, has led Pendejo investigators to suggest that it had been purposefully broken, apparently by a human seeking to extract marrow. The bone is charred black, presumably from the low-oxygen heat of a hearth where it could have been placed to keep it from predators. Center staff members agreed that the bone, that of a *Bison antiquus*, did not seem to have been broken by natural event, such as a rock falling from the cave roof. Evidence points to a careful and deliberate break.

WORDS & PICTURES UNLIMITED

Ancient bison bone rests on tissue paper with transparent tape across the break that appears deliberately made to extract marrow.

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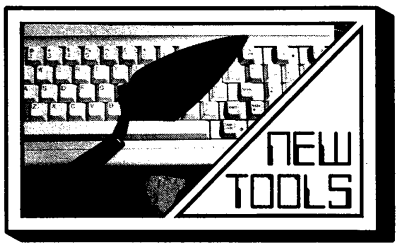
Close-up of print from 28,000 B.P. level at Pendejo.

Dr. Chrisman also displayed samples and photographs of Pendejo's now-famous clay casts of apparent human finger– or hand–prints, dated at 28,000 years ago. MacNeish and his team discovered the prints in the cave several months ago (see **Mammoth Trumpet** 7:1 *Pre-Clovis Human Prints Found in Clay*). The prints, Chrisman noted, display the distinctive ridges and also sweat glands of the people who left them. While at OSU, Chrisman also discussed the human hair, dated at 19,000 years B.P., which has been discovered at Pendejo Cave.

More recently Dr. MacNeish was the subject of a profile in the July 31 issue of *Science* spotlighting his strong disagreement with the theory that peopling of the Americas began no more than 12,000 years ago.

-DAH



continued from page 5

I do not try to make it myself. But," he adds, laughing, "sometimes I might design a better handle—something like that."

But computers' benefits to archaeologists far outweigh their dangers. Perhaps their biggest contribution has been their ability to analyze and synthesize huge amounts of data from many fields. In minutes, computers can generate charts and maps using data it would take a human lifetime to analyze and plot. As a result, computers are revealing large patterns of data that archaeologists have been unable to discern until now.

Site data, artifact data, report data, and spatial information are all together on the same system. . . . The result has been a fundamental shift in archaeologists' outlook.

The result has been a fundamental shift in archaeologists' outlook, from the recent emphasis on technical specializations to a larger, more comprehensive view of entire cultural systems. This bigger view is, paradoxically, very close to the view of the archaeologists who lived and worked a century ago. Limp explains: "When you read the way archaeologists wrote about archaeology in the late 1800s through the early 1900s, they were excited about what the people looked like, and there was a sense of almost creating a past landscape and a past life.

"Then, as archaeologists faced up to the legitimate reality of the complexity of the problem, everybody became a lithic specialist," concentrating on specific areas of technical expertise. But in viewing sites and artifacts so technically, Limp says, "we forgot that there were people. . . . While we need to focus on that very detailed analysis, maybe with the computers we have, we now have some tools to move that from an analysis to a real understanding of the real complexities of people who lived in the past. . . . That's pretty exciting."

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State University are to analyze the hair. "We don't have the animal bones, but we've got the hair," Bonnichsen explained, as he showed the site to officials of the U.S. Bureau of Land Management, the agency responsible for the area, which is extensively grazed by the cattle of a neighboring rancher. An electric fence protects the open excavation units from these modern megafauna.

Other interesting finds from the lowest levels are unusual rounded rocks that appear to be bola balls fashioned from dark, granular rock.

While recovery of the hair and lithic materials proceeds, mapping of the area's geology and study of the soils continue. Mammoth Meadows' chalcedony formed as the result of volcanic alteration of the local geology early in the Tertiary Period. For thousands of years—probably until after American explorers Meriwether Lewis and William Clark passed near here in 1805—the lustrous crystalline-like rock was quarried from these sagebrush-cloaked hills where it occurs in bands a few meters wide at or near the surface. Early miners left the slopes dotted with shallow pits, and the area's surface remains scattered with flakes of handsome tool-grade material that compel archaeologists to stoop to admire them.

The area had been known for decades to amateur collectors of lithic tools. Bonnichsen and his colleagues, including Richard Reinhart, archaeological field foreman, chose the site for their investigations in 1985 and have returned every year but one since then. The Turners have made extensive field surveys in the area. While they found that Mammoth Meadow was not glaciated in Wisconsin time, they discovered evidence of glaciation early in the Pleistocene, more than a million years ago.

This site was termed Mammoth Meadow when a piece of mammoth bone was found on the surface in 1985. Although mammoth hair has been discovered during the excavations, the site has produced no further mammoth bone or tusk.

Archaeological teams here include a number of volunteers from all across the United States. Persons interested in being part of a Mammoth Meadow expedition may write to the **Center for the Study of the First Americans** at Oregon State University to get on the mailing list for details about the 1993 field season.

–DAH

Book Clearance

The Center for the Study of the First Americans needs to reduce its stock of books and journals to make room for new titles. For a short time only, the **Center** is offering discounted prices on all its books shown below. The discounts, up to 20 percent and more in some cases, are on new titles such as *Clovis* and *Taima-Taima* as well as popular books such as *Bone Modification,* the bible of archaeological and paleontological investigations of bone. All available issues of *Current Research in the Pleistocene* also are discounted.

Orders must be received by Oct. 15 to obtain the discount.

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See other side for more publications and payment instructions

Federal Policy

continued from page 1

using wisely those that must be destroyed or damaged and preserving as many as possible so that future generations of Americans also will have access to the unique heritage information that they contain. These materials are a record of changing environments over the millennia, and of the human community's adaptations to those changes."

Secretary Lujan makes a point of calling for more public education and participation in archaeological activities. "We need more and better public education and opportunities for the public to participate legitimately in archaeological projects," he says. "The increasing popularity of State Archaeology Week celebrations, archaeological open houses and tours, available archaeological volunteer programs, even the Indiana Jones films, all demonstrate that archaeology is a topic of interest to millions of Americans." Lujan says federal and other public agencies that conduct archaeological investigations or manage archaeological sites should do more to present the results of their investigations and interpret their sites for the public. He encourages public land managers to involve the public in archaeology.

"Opportunities for public participation in federal archaeological projects should be included in the project design," says Lujan.

The Interior Secretary outlines three benefits from public involvement with archaeology projects: 1. To provide a constructive outlet for persons with a strong interest in archaeology who might otherwise engage in archaeological looting; 2. To teach people to appreciate the careful recording and detailed attention necessary in scientific archaeological field and laboratory work by having them excavate at a site or clean, sort, and catalog finds from an excavation; 3. To provide volunteer labor that can further the interpretive or management needs of public archaeological preservation and protection. He emphasized that volunteers must be properly supervised.

The National Park Service booklet *Archaeology and Education: the Classroom and Beyond* is available free of charge to help in educating the public. It includes six essays by different educators and professionals who discuss programs that successfully impart the awareness, the teaching of, participation in, and evaluation and training of teaching in archaeology. The booklet is written for a general audience and is part of a series that the Park Service is publishing.

In the federal policy statement Lujan also emphasizes that archaeological sites include a record of thousands of years of human adaptation to changing American environments.

"This record is a public trust to be understood and evaluated to help shape our present responses to changing environments," Lujan says, adding that the ancient plant and animal remains in archaeological sites identify the conditions in which people have lived, and the changes that have occurred in society, diet, and technology in response to changing climate and natural resources.

The federal policy also outlines efforts to fight looting and preserve the archaeological record in place. "We have had recent successes in this area; several federal bureaus have focused new attention on archaeological site protection. Interior bureaus and other federal agencies joined in the national effort led by the Society for American Archaeology to protect archaeological sites." The Park Service publication *Legal Background of Archaeological Resources Protection* provides an examination of legal protection to archaeological resources. It examines laws from the Antiquities Act of 1906 to the 1988 amendments to the Archaeological Resources Protection act, which were designed to help prosecute looters. Other legislation that indirectly benefits the protection of archaeological resources also is examined.

A related Park Service publication, *Site Stabilization Information Sources*, also focuses on site protection. It highlights the process of a stabilization project, which is a multi-discipline effort including archaeologists, cultural resources managers and stabilization specialists. Maximum protection to the site, with sensitivity to the area around it, is the ultimate goal. Preservation in situ is the approach of choice, and site stabilization, rather than systemic excavation, is one of the most important means to protect sites when they are threatened by adverse effects. Both publications, Technical Briefs 11 and 12, are available free of charge (adjoining box).

Lujan's policy statement stresses interagency cooperation in the exchange of information. Noting that federal and other public agencies conduct tens of thousands of archaeological investigations each year, gathering information about the presence or absence of sites and the significance of sites plus interpretations of history and prehistory, Lujan declared that the data must be available to those who need it. "Such information is of interest to more than the agency that conducts the study, but exchange of information often is hampered by bureaucratic constraints. Public agencies must work to improve archaeological information exchange at the national, State or regional, and local levels.

"One specific means of improving this exchange is the participation of public agencies in the National Archaeological Database network being established through the National Park Service," says Lujan. The new federal policy also encourages interagency meetings to discuss common archaeological challenges and opportunities.

"On average, Federal agencies that manage land have conducted investigations to inventory the archaeological sites on less than 10 percent of this public land," says Lujan. "The lack of information about where archaeological sites are located has been identified by many as one of the problems confronting agencies in the preservation of sites. We need to find the means to undertake these inventory investigations."

The Interior Secretary's new policy also focuses on the curation of collections and records including protecting the vast numbers of artifacts and other remains excavated from sites on public lands or from sites that government activities have disturbed.

"These remains must be curated properly," Lujan emphasizes. "For sites that have been destroyed, these remains and records are the only heritage left to future generations from which they can learn about the archaeological record. These remains and records must be cared for to ensure their preservation for future use. We must begin more systematic programs to meet this preservation challenge."

In conclusion, Lujan's statement says that federal strategy will improve the preservation of America's archaeological heritage when public agencies adopt and implement appropriate activities. "The loss of any of this heritage diminishes all of us and future generations. There is no quick fix to our challenges. Public agencies must provide for archaeological preservation as an important part of their ongoing programs."

Reports Available from Park Service

The booklet on archaeology in the classroom and the two technical briefs on protection and stabilization of sites that are mentioned in this article are available free of charge from the National Park Service. Request *Archaeology and Education: the Classroom and Beyond* or Technical Briefs No. 11 and No. 12 from Publication Specialist, National Park Service, Archaeological Assistance Division, P.O. Box 37127, Washington DC 20013-7127.

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