MAMMOTH TRUMPET

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FLINT FLAKES YIELD TRACES OF ELEPHANT

Elusive Second Mastodon Delays Remote-sensing Plan

New, preliminary excavations began this summer in an area of east-central Ohio where skeletons of three extinct Ice Age mammals have been discovered. Flint tools were found there last summer with one of the skeletons that has come to be known as the Martins Creek Mastodon. Nigel Brush of the University of Akron's Center for Environmental Studies hopes to learn whether remote-sensing techniques can be used to locate additional skeletal materials.

Last summer, Dr. Brush and a crew of geology and anthropology students excavated a disarticulated mastodon skeleton from the Martins Creek site and discovered several flint flakes, some of which were among the mastodon bones (See **Mammoth Trumpet** 8:4 "Worked Flint Found with Mastodon Bones"). Subsequent analysis confirmed traces of elephant blood on one of the flakes; study of the Martins Creek material is continuing. **Current Research in the Pleistocene** is publishing two papers by Brush and his colleagues about the site. These will be in its Volume 11, which is due for distribution soon.

Brush said this summer's excavation was undertaken at a site near Berlin in Holmes County approximately 30 miles south of Akron and 1 mile east of the Martins Creek Mastodon site. Mastodon bones were encountered at this new site about a decade ago during the construction of a pond. Subsequent work on the pond avoided the area where the bones were found, but test excavations this summer could not relocate the skeleton. "I'm beginning to wonder if the bone was from underneath the pond," Brush said in a telephone interview. His strategy had been to relocate the bones of this mastodon, but leave them buried and then employ sonar to determine what it might show of the bone. If remote-sensing techniques locate the known mastodon bones, Brush plans to expand the survey from the known to the unknown, first surveying the landform that contained the Martins Creek Mastodon, and then surveying an area about 2 miles farther east, where the skeleton of a giant ground sloth was found during the 19th century.

The area to be examined formerly was boggy.

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INSIDE

IN MEMORIAM

H. M. WORTHINGTON: 1914–1994

With the passing of Marie Wormington on May 31, 1994, the **Center for the Study of the First Americans** has lost a valued and distinguished friend. She has graced the **CSFA** with her style, wit and unerring dedication to science. Marie was always there and ready to help. Though we are immeasurably saddened by our loss, the entire field of First American Studies will continue to benefit from her intelligence, insight and wisdom.

–Robson Bonnichsen, Director, CSFA

Hannah Marie Wormington was born Sept. 5, 1914, in Denver. Her mother was French, and she acquired fluency in the language at an early age. She attended Denver public schools and aspired to study literature at the Sorbonne in Paris. Instead of studying there, she entered the University of Denver intending to study zoology or medicine. After taking classes in her sophomore year taught by E. B. Renaud, she decided to switch to archaeology.

Dr. Wormington was graduated in 1935 and traveled to Europe, where she studied in France, England, and Spain. She studied typology at the Museé de l'Homme and Laboratoire d'Anthropologie in Paris. In the summer of 1935 she worked on French Paleolithic sites in the Dordogne region under the direction of Dr. Henri Martin. While at the Museé, Wormington met Harper Pat Kelly, who introduced her to Martin and his colleague Dr. Peyrony and American Paleoindian archaeologist Edgar Howard. These contacts set the stage for her association with the Museum of Natural History in Denver.

H. M. Wormington

After returning to Denver later in 1935, Wormington joined the Denver Museum of Natural History as a staff archaeologist. She got what she thought would be a temporary job by arranging an exchange of French artifacts for photographs of American tools. Her salary for photographing the artifacts was $50 per month. The job became permanent, and in only two years Wormington rose to the position of Curator of Archaeology. She held this position for the next 31 years until her retirement from the Museum in 1968.

Wormington began her field work in 1936 with the excavation of a Folsom site near La Porte, Colo. She followed this with the excavations of two rockshelters in Montrose County, Colo., in 1937 and 1938. Also in 1937, Wormington attended the International Symposium on Early Man held in Philadelphia; it was the first of many meetings she attended throughout her career.

Next, Wormington participated in the excavation of a Fremont village site in Grand County, Utah, from 1938 to 1941. She finished her field work there in 1947.

In addition to her field work and duties at the Denver Museum, Wormington began to write the first of her highly regarded books, *Ancient Man in North America*, shortly after her arrival at the Museum in 1935. The book was published in 1939 and went through four editions. She fully revised the last edition, which was published in 1957.

Ancient Man in North America synthesized the findings of Paleoindian scholars and is still used today. Wormington wrote the book so it could be used by professional archaeologists and lay people alike. In the preface to the fourth edition Wormington wrote,

> There are many thousands of persons, with no formal training in archaeology, who are eager to receive information about the subject if it is presented in a manner acceptable to the intelligent layman.
>
> *–H. M. Wormington*

> She was the center of communication and was a compiler of just about everything that went on in the field.
>
> *–Joe Ben Wheat*

> She was a major role model for many women because, of course, archaeology at the time she started into it was a very male-dominated field.
>
> *–J. S. Day*

It was felt that there might be a great many persons

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New Books

***Method and Theory for Investigating the Peopling of the Americas* edited by Robson Bonnichsen and D. Gentry Steele. 264 8½x11-inch pages; hardbound $38, softbound $30. Center for the Study of the First Americans, 355 Weniger, Oregon State University, Corvallis, OR 97331.**

Packed with a variety of papers on prehistory, dating methods, physical anthropology, linguistics and other topics relating to First Americans studies, this book grew out of the 1989 First World Summit Conference on the Peopling of the Americas at the University of Maine. It is not a "conference book," however; papers include some added since the conference. "There is a need to move beyond the present period of controversy," the editors note in their introduction. They suggest that though there may be no single resolution that will lead to scientific advancement in Paleoindian studies, "the search for American origins should develop viable scientific models that explain the dispersal of humans across Asia, North America, and South America."

Method and Theory continues with David J. Meltzer's review of controversies involved with the study of American prehistory and proceeds to two papers on radiocarbon dating of bone by R. E. Taylor and Thomas W. Stafford, and a paper on the role of geoarchaeology by C. Reid Ferring.

The book's series of physical anthropology papers begins with Wu Xinzhi's examination of Pleistocene human fossils in China and likely relationships with North American peoples. Nancy S. Ossenberg describes her examination of nonmetric skeletal traits found among peoples of northwestern North America and eastern Asia. Emöke J. E. Szathmary's paper, "Modelling Ancient Population Relationships from Modern Population Genetics," details tests of the hypothesis of a "three-wave" model of peopling the Americas. Christy G. Turner II analyzes human teeth, whose shape offers evidence to the origins of Native Americans. D. Gentry Steele and Joseph F. Powell present their metric analysis of Paleoindian skeletal remains as further clues to the origins of early North Americans. In the final biological paper, David L. Andrews writes on molecular approaches to isolating and analyzing ancient nucleic acids.

Linguistic evidence for the Peopling of the Americas is presented in a paper by that name by Merrit Ruhlen that is followed by a paper on the implications of the history and classification of American Indian Languages. Next, the all-important study of stone tools and toolmaking technologies is examined in a paper by David E. Young, Robson Bonnichsen, Diane Douglas, Jill McMahon and Lise Swartz. Finally, an application of nitrocellulose membrane for identifying blood residues on artifacts is described by David C. Hyland, Jean M. Tersak, James M. Adovasio and Michael I. Siegel.

We're Sorry!

We unintentionally deleted our **Mammoth Trumpet** data base, which left us with a not-so-up-to-date backup copy. There was some confusion surrounding the timing, circumstances and notification of the deletion, and as a result:

1. We sent out renewal notices to people who had already renewed
2. We lost recent new subscriptions.

We apologize for the inconvenience this has caused all our valued subscribers. We want to thank all of you who responded to the renewal notices with humor, understanding, and even offers of assistance with data bases. We greatly appreciate getting the information needed to reconstruct the list.

If you sent us a check to subscribe or renew between January and May, 1994, we ask that you please call or send us a note with your name, address, date, and the amount of your check. No need to send a copy of the check. If you are aware of anyone who became a new subscriber during this period, please let them know of the problem and have them contact us. Meanwhile, we have taken measure to minimize the chances of this ever happening again. Thanks again for your patience.

***Florida's First People, 12,000 Years of Human History* By Robin C. Brown, Pineapple Press, Inc. Clothbound, 262 8½x11-inch pages, $34.95. P.O. Drawer 16008, Sarasota, FL 34239.**

The author learned much about tools prehistoric peoples used by replicating their possessions. But this book with its 16 pages of color photos and 360 black-and-white photos is not merely a how-to book; it is written to be accessible to readers with little background on human prehistory or Florida. The first section, "Who They Were," describes Florida's earliest-known cultures down through time. Starting from the discovery of Clovis and Suwannee lithic points in north Florida rivers, the book describes five significant sites.

The second section, "How They Lived," examines the worldly goods of early peoples, not only describing them but revealing the sources of materials and how they were made. Dr. Brown learned to make tools from stone, wood, bone and shell and then used them to make baskets, rope, fish traps, buckskin and fabric. He also found, processed and stored food.

The book's third section is devoted to archaeological research in field and laboratory. It contains a photographic atlas for identifying Florida's archaeological artifacts and plant and animal remains. The author encourages readers to participate in projects led by professional archaeologists.

***Integrative Paths to the Past* edited by Robert S. Corruccini and Russell L. Ciochon. 716 8½x10½-inch pages; $60. Prentice-Hall, Englewood Cliffs, NJ 07632.**

Though none directly relate to the peopling of the Americas, the 30 chapters by 32 prominent contributors provide excellent background on studies of human evolution. This comprehensive compendium on paleoanthropological advances is in honor of more than 45 years of research by F. Clark Howell, paleoanthropologist and professor emeritus at the University of California at Berkeley.

Barbecue Serves Dual Purposes

PARADISE VALLEY, Mont.— A bison barbecue to benefit the **Center for the Study of the First Americans** attracted more than 200 people here July 2. Karl Knuchel, Jackson Lake and George Cremer, members of the **CSFA** Advisory Board, were hosts for the event, which was held at Knuchel's home. Guests feasted on roast bison, salads, beans and corn on the cob, and took part in a silent auction of art works and outdoor adventures held in Knuchel's airplane hangar. A presentation by well-known wildlife photographer Tom Murphy was also featured, as were displays on **CSFA** research projects and publications.

"Mother nature had perfect timing by presenting a typical Montana hail storm at about the time Tom Murphy put on a spectacular wildlife slide show in the hangar," said Knuchel. "Despite the excessive noise, the crowd enjoyed the beautiful photography." The auction was previewed by a catalog prepared by Heather Harrison and Amanda Knuchel sent to prospective guests about two weeks before the event. Besides works donated by various artists, the auction offered elk hunts, fishing trips, airplane trips and archaeological tours. Rebecca Foster, assistant director of the **CSFA,** said that the event was quite successful and that plans are now being made for a similar event in Oregon.

"The barbecue also presented a great educational opportunity for the **Center,**" Knuchel said. Especially prepared visual displays explained the **Center**'s role in excavating sites, interpreting archaeological data, and utilizing scientific breakthroughs. Knuchel expressed thanks for the many who made the event possible. He noted that Don Gimbel, **CSFA** Board member from Connecticut, flew in two days early and prepared the hangar, chuck wagon and grounds for the event. He also cited Board member David Bobb of Ashland, Ore., and Foster for labeling auction items and bid sheets; George and Helen Cremer for donating the bison and helping with the sale; Tom Murphy for donating two prints and doing the slide show; and Allen and Babe Carter for donating fishing rights and the elk hunt.

Montana Field Work Awaits Consultations

Field work at the highly productive Mammoth Meadow site in southwestern Montana was cancelled this summer pending resolution with the U.S. Bureau of Land Management of various permit-requirement issues, principal investigator Robson Bonnichsen announced. Work by a multidisciplinary team of scientists and volunteers from the **Center for the Study of the First Americans** and Earthwatch had been scheduled to resume in June. Excavation in the site's two units near a source of high-grade chalcedony, a colorful flint used widely for tools, has documented that people had utilized the quarry site for more than 11,000 years—just how much longer is the important issue that remains to be investigated.

Alan L. Schneider, vice-chair of the **CSFA**'s Advisory Board, said that the delay at Mammoth Meadow will allow further consultation with Native Americans, the BLM, and other interested parties concerning the potential benefits and consequences of the research there. Investigation of the site has pioneered a number of new avenues of research not contemplated when current permit procedures and land-use regulations were adopted. For example, hairs found preserved in the site's wet clays have firmly established the presence of animals not represented in the assemblage of animal bones. Hairs of animals as diverse as mammoths and small mammals have been found, and the site also has yielded naturally shed human hairs. No human burials have been encountered at the high-altitude site.

Mammoth Meadow researchers developed at the site a flotation method of recovering the hairs and subsequently, laboratory researchers have discovered that ancient DNA can be retrieved from hairs. Information stored in DNA, one of life's principal building blocks, offers enormous potential for learning more about the people and animals that inhabited North America long ago. Because of the newness of methodologies employed by **CSFA,** questions have been raised concerning potential application of consultation and repatriation requirements of the Native American Graves Protection and Repatriation Act and other federal statues. It is hoped that these concerns can be resolved so as to permit the resumption of field work in 1995.

Though field work has been held up, archaeological lab work on the site's great wealth of lithic materials and its extensive record of faunal remains continues.

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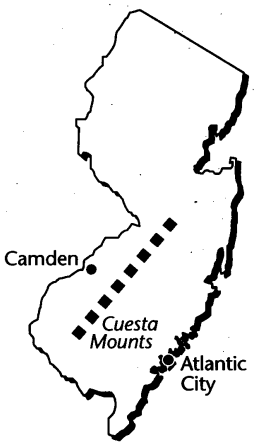
New Jersey Fluted-Point Survey Points to Pleistocene Landforms

A survey of fluted points by the Archaeological Society of New Jersey confirms previous evidence that the location of that state's Paleoindian sites is highly predictable, based on landforms. John H. Cresson, a Moorestown, N.J., contract archaeologist with a lifelong passion for stone tools, along with Anthony Bonfiglio, has been spearheading the survey, which is nearing completion. The work, a labor of love for Cresson and other members of the Southern New Jersey chapter of the Society, suggests that makers of fluted points utilized upland features of the coastal plain and also relic wetland features created during Ice Age permafrost conditions.



"We've seen a distinct pattern associated with late-glacial landforms," Cresson said in a recent telephone interview, "and we've seen a distinct orientation to these sites." Citing research he has been involved in for more than 20 years, Cresson says there is reason to believe that Paleoindian peoples utilized wetland features, possibly as game traps. Paleoindians also utilized the coastal plain's hills or "cuesta mounts," which range in elevation from 150 to 350 feet in a band tending southwest to northeast that constitutes the drainage divide between the Delaware Basin and the Atlantic, and they frequented stream and river terraces. Cresson suggests that the cuesta landscapes may have been lookouts, travel corridors, and sources of lithic materials, while periglacial landforms were resource areas. Features he identifies as relic pingos (soil-covered ice mounds raised by hydrostatic pressure in permafrost environment) and palsas (smaller but similar features raised by freezing) became thaw lakes or wetlands surrounded by low ridges in Paleoindian times. They now can be found as low, circular or oval features scattered across agricultural fields of southern New Jersey's extensive coastal plains, and they tend to be visible on both topographic and soil-type maps. Sites often occur on the south or southwest rims of these features, Cresson says.

Initial fluted-point discoveries tended to be on the cuesta uplands, remnants of earlier coastlines, but subsequent analysis of the location of these tools that are indicative of the earliest-known humans suggests that Paleoindians also utilized a predictable variety of Ice Age features. Find these landscape features, Cresson suggests, and that is where to find the Paleoindian sites.

In 1991, Tom Radlov and Brian Wagner began the society's survey of fluted points, building on an earlier survey conducted by Ronald J. Mason and Herbert C. Kraft that recorded about 280 such artifacts statewide and 60 Paleoindian biface points on New Jersey's coastal plain, the focus of the current survey. The new survey has recorded and analyzed 29 additional fluted points from new sites as well as from collections. Cresson has identified the material of three of these as being from faraway sources: Plum Nellie chert from Ohio, Munsungen chert from Maine, and Cattail Creek chalcedony from Virginia. Eleven were made of Pennsylvania jasper, seven of Normanskill chert, and five of an unidentified black chert; the other three were of Onondaga chert, pebble chert and milky quartz. He says 10 of the these bifaces can be categorized in morphology and technology as early Clovis types, while 14 are middle types and five are late types.

Fluted points are diagnostic of Paleoindian occupation. Though no one knows why, Paleoindian toolmakers crafted distinctive projectiles quite unlike those made later. They were thinned at the basal end by the removal of shallow channel flakes to create "flutes" on each side. Presumably the flutes allowed the points to be fitted firmly into the ends of split shafts and then secured by sinews or cordage. To practiced observers, channel flakes are as distinctive as the finished points themselves.

Identification of potential sites can alert investigators to preserve or salvage sites that are about to be developed. Cresson described one archaeological survey he did at a construction site for a large discount store on the coastal plain in Ocean County. When he recognized a buried dune-terrace landform he believed might indicate prehistoric occupation, he increased the number of auger holes in his survey. Sure enough, he discovered lithic artifacts that included channel flakes. Subsequent work at the site yielded channel flakes indicating projectiles with very long flutes—70–90 mm. "We highly recommended it for preservation," he said of the site, but he isn't sure that it was preserved. Though recognition of landforms diagnostic of Paleoindian sites has the potential to help preserve them, Cresson said the information "hasn't sunk in yet with the administrators and the people who are managing these sites. We're losing them left and right," he said.

–DAH

Landmark Status For Paleo Sites Is Goal of Program

The U.S. National Park Service is undertaking a program to identify and protect the country's earliest archaeological sites as national historic landmarks. The Paleoindian National Historic Landmark study is a cooperative project involving the National Historic Landmarks Archaeology Committee, the Society of American Archaeologists (SAA), and state and tribal historic-preservation offices.

Organizers of the project, the feasibility phase of which is due for completion Sept. 30, call Paleoindian sites the nation's most threatened as well as the most significant cultural resources. The sites are particularly susceptible to damage or destruction by natural forces, development, and vandalism because they are rare, small in size and contain artifacts highly prized by collectors. Coordinators in various regions of the country will work with scholars, agencies, avocational archaeologists, and preservationists to identify all existing knowledge about Paleoindian sites. The goal will be to develop a framework to identify, evaluate, and finally designate Paleoindian sites as National Historic Landmarks.

Robson Bonnichsen, Director of the **Center for the Study of the First Americans,** is involved with the project through the SAA. Noting the urgency of protecting Paleoindian sites, he notes that no such coordinated effort to identify and designate early sites has been undertaken since the early 1960s.

Complex Stratigraphy Obscures Paleoindian-Elephant Association

Complexity of geologic deposits in New Jersey is making it difficult to associate fluted points with remains of elephants that have been found in close proximity. Discovery of an elephant rib in a stratum that has yielded Paleoindian-type tools at first seemed to have established the association (**Mammoth Trumpet** 9:1 "Discovery of Elephant Rib Provides Valuable Date"). The find appeared to be a breakthrough in the quest for the antiquity of many fossils that have been found in brook deposits in Monmouth County, N.J., and it promised to establish the age of associated artifacts.

However, subsequent research has called that confirmation into question. The problem, David C. Parris, curator of Natural History at the New Jersey State Museum, explains, is that because of the receding sea level during the Ice Age, later Pleistocene strata were deposited at lower elevations than earlier ones. Thus materials from the older, higher deposits can erode onto later, lower deposits, causing confusion about the chronology.

There was never any doubt that the brook deposits were a reworked mixture of material of differing ages, but the carefully excavated elephant rib, found in 1992 by Joe and Sandy Camburn, was in a discrete deposit of the Cape May Formation known to be of Wisconsin (late Pleistocene) age. The Camburns donated the bone to the State Museum, and Parris had it dated. The result was 12,470 ± 260 years B.P. (Gx-18789)—a plausible age for an elephant and an exciting age for the fluted points found elsewhere in the same stratum. Nearby, a fluted point had been discovered near the tooth of an extinct giant beaver, but two radiocarbon dates from peat in the same stratum were about 10,000 years younger than the age of the elephant rib. Obviously, more research was needed.

Parris organized a two-pronged investigation of faunal remains to look for an answer. One project reidentified relevant material in the museum's collection, and the other analyzed the antiquity of the plentiful muskrat remains from the area.

Michael Mills, a student at Princeton University, studied the faunal material from the stratum in question. Perhaps his most significant find was the tooth of a 500,000-year-old horse. Obviously it did not fit in a deposit with a 12,000-year-old elephant or the 2,000-year-old peat. The horse tooth, Parris said in a recent telephone interview, "does come from the same bed." He said the study indicates the faunal remains are mostly found isolated—that a number of Pleistocene formations have been reworked by erosion. "The assemblages we're getting from the brooks there, while mostly Wisconsin to Recent, do include material of a number of different ages." Parris was not surprised; he knew, for example, that shark teeth of Cretaceous age had turned up in the material.

Throughout Monmouth County there are deposits of varied Pleistocene ages. Parris, a geologist, explains that they were deposited in terraces, the oldest of which are higher than the younger. "Since the sea was gradually receding, the ones of a more recent age are actually lower.

"It appears that the older of these have been providing derived material that has gone into this ultimate deposit that now yields the brook fossils." Unfortunately, that means the associations between material of known age and Paleoindian-type artifacts are now suspect.

Parris said the muskrat study indicates the deposits in question are mostly late Pleistocene or Recent in age. That project made use of the fact that muskrats' molar teeth have gradually increased in size over time. Evelinn Nieb, a student at Monmouth County High Technology High School, measured muskrat teeth in the museum's collection. "She established that practically all are in fact Wisconsin to Recent," Parris says. "That's probably true of most of the fossils."

The elephant rib is probably that of an American mastodon *(Mammut americanum)*, the best-known of New Jersey's extinct mammals. Mammoths are rare in the state's record. Pleistocene horses, such as the one Mills' study discovered, are also relatively rare in New Jersey.

Undoubtedly, the Pleistocene stratum that yielded fluted points is a complex one. "The material is practically all Pleistocene. It's just that it appears now that in these brook deposits there are fossils that are derived from a number of previously existing sub epochs." And that, Parris notes, makes them all the more difficult to interpret.

–DAH

Chronicling Time with Volcanoes

By Stefan C. Radosevich, Ph.D.

ERUPTING VOLCANOES offer multiple means for dating archaeological sites, even those long distances away. Tephrochronology is a dating technique based upon superimposed sequences of layers of volcanic ejecta. Tephra, fragmented volcanic material deposited after an explosive volcanic eruption, is useful in several different ways. Following geology's law of superposition, which tells us the oldest layers are on the bottom, we can use stratigraphy to assay the *relative* age of an artifact, fossil, or object strata by determining the sequence of depositional events associated with the object to be dated.

It is possible to ascertain both a chronometric and a relative date using tephrochronology. For example, a burned tree trunk embedded in a tephra fall can produce a radiocarbon date for the event. Then if we identify the tephra's unique chemical proportions—its chemical "signature" or "fingerprint"—we will know the age of that tephra deposit at an archaeological site some distance away or anywhere else it occurs. Assuming the deposit was not reworked and redeposited, we can assume a similar date for both tree trunk and archaeological site. We need not know which volcano the tephra came from. Even without the radiocarbon date of the tree trunk, we can place the tephra in a stratigraphic sequence of sediments and other tephrogenic events.

Chronometric dates are often indirect; that is, we cannot directly date an archaeological object or fossil but must "bracket" the object or the stratum in which it lies by dating layers above and below. Most often, the archaeological object or stratum is not buried in tephra. Such bracketing can provide either relative dating, placing the object in a series or sequence of strata, or chronometric dating if appropriate minerals or elements are present. If chronometric bracketing is possible, we still have only a range of dates between which the object or object stratum was deposited. Occasionally we may be able to directly date something that may be encased in a layer of tephra. An example of this is found in the preserved footprints of the early hominid site at Laetoli, Tanzania, 3.7 million years ago.

Tephras are more useful for dating than other types of deposits and sediments for several reasons:

- Volcanic eruptions occur from a single source at a specific geographic point;
- Eruptions are short-lived, and tephras accumulate over a short period of time. Thickness of a deposit and its grain size are functions of distance from the volcano more than they are functions of time;
- Tephras are usually easy to distinguish from one another chemically or physically, even though they may represent different eruptive events from the same volcano;
- Primary tephra blankets tend to be preserved in or near places that humans have frequented, such as lake sediments, caves, and rockshelters;
- Once a primary deposit has been dated, deposits elsewhere of the same source can be assigned to the same age. It does not matter whether the tephra is from a known source, if we can assure there is not a volcano with an identical chemical signature in the same region and time.

USGS

Mount St. Helens spews silicic tephra in its 1980 eruption.

The area covered by tephra fallout from a single eruption will vary, depending in part upon the kind of tephra ejected. **Basaltic** tephras, which are composed of heavier minerals (dark, ferro-magnesium or "mafic" rocks), drop out quickly, so the area they cover will be small, often only a few square kilometers. In a study of basaltic tephras of the Oregon High Cascades, Craig Skinner and I found that, with few exceptions, such tephras present geographically limited applications for correlating archaeological sites and/or eruptive events. However, **silicic** (glassy, silica-rich) tephras are lighter and may be blown over an area of thousands of square kilometers, making the correlation of many archaeological sites feasible. The great eruption of Mount Mazama about 7,700 years ago and the eruption of Mount St. Helens in 1980 spread silicic tephras.

Differences in tephra sources also result in different clast (grain) sizes and varying degrees of vesicularity (bubbles contained in the clasts). Pyroclasts are divided by size into three groups: 1/16 mm to 2 mm (ash or coarse ash), 2 mm to 64 mm (lapilli), and greater than 64 mm (bombs). Pyroclasts that are lapilli or larger in size may be separated into scoria, cinders, and pumice. Pumice is usually lighter in color and will float in water, while scoria and cinders are usually basaltic and will not float (cinders also tend to be darker in color).

Clean, unworked, non-transported primary deposits of tephra are the ideal materials for either field or laboratory characterization. Field identification is based upon visual physical characters, while chemical analysis can be made in the laboratory. Field recognition of a Mount Mazama tephra, for example, can vary depending on how close one is to Oregon's Crater Lake, the eruptive center. The farther away one is from the volcano, the smaller the clast or grain size will be. (Absolute distance of deposition for a given size and weight of clast will depend on the power of the blast, quantity of tephra ejected, and prevailing wind). Lapilli, the mid-sized volcanic ejecta, will be smaller the farther they are from the source. If the lapilli are rounded, rather than angular, and of the same uniform small size (2–5 mm), it may be evidence that they have been transported some distance and are not a primary deposit. Secondary deposits, however, may be useful—they can at least put a minimum date on a stratum. If a particular kind of volcanic ejecta is found, it means the stratum that it is buried in cannot be older than the original eruptive event.

It should be noted that soil-forming processes will sometimes produce aggregates (called "peds") that resemble lapilli and may be mistaken for them. Granular and small blocky peds can be distinguished by their "cutans" or clay coatings in well-developed soils, or by their lack of concentric weathering layers when the ped is broken open.

Silicic tephra is usually lighter colored (light-gray to tan to yellowish orange) and is easily contrasted with darker, well-developed soils and those soils formed in basaltic tephra. In some arid environments, calcium carbonate horizons (often called caliche) are mistaken for tephra. If a clast does not feel gritty or if it dissolves in water, it is probably a mineral salt or gypsum. If an application of 10 percent hydrochloric acid produces significant fizzing, it is probably caliche.

Chemical characterization (or "fingerprinting") of ash and lapilli from a primary deposit can be done using any number of available laboratory techniques (neutron activation, XRF, electron micro-probe, AAS, etc.). Chemical characterization is most important for correlating tephras over some distance where the actual facies cannot be followed. Secondary deposits (those that have been reworked or transported and mixed with other sediments) are suspect, though larger clasts (large lapilli, bombs, and blocks) found in secondary deposits may be used because chemical weathering may not have produced much change in elemental abundances. The reason for suspicion of the results of chemical analysis from secondary deposits, and to some extent of primary as well, is that diagenesis of the primary airfall tephra may have occurred. Diagenesis is the effect of physical or chemical change in the tephra after deposition. For both primary and secondary deposits, elements chosen for analysis should be those that are not easily mobilized or transported.

Absolute Ages

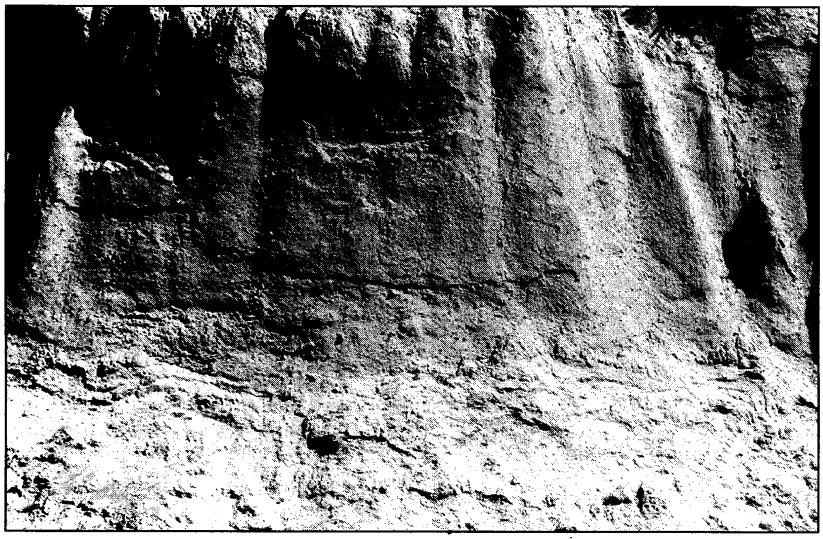
Researchers commonly obtain chronometric or "absolute" ages of volcanic material through potassium-argon or fission-track dating. Potassium, the seventh-most abundant element of Earth's crust, has one rare isotope, potassium-40, which is radioactive with a half-life of 1.25 billion years. Potassium-40 decays into calcium-40 and argon-40. Argon, a gas, accumulates within the potassium-bearing minerals of cooled volcanic material at a fixed rate. The ratio between potassium-40 and argon-40 in volcanic material gauges the duration since its eruption. Development of the mass spectrometer in 1954 enabled practical application of the potassium-argon method, developed primarily by geologists Garniss Curtis and Jack Evernden. There have been several refinements on the original method, the most elegant of which is the single-crystal laser-fusion system that gives ages on individual crystals. In good conditions, margins of error may be as low as 0.5 percent.

A famous controversy surrounding the dating of an early East African hominid (cranium ER-1470 and the KBS tuff) involved potassium-argon dating. The original date for this tuff, a volcanic ash, was assayed at 2.6–2.9 million years, making the associated fossil cranium the oldest large-brained hominid ever found. Later analysis, occurring after improvements in the potassium-argon methodology, revealed the cranium to be 1.8-1.9 million years old, causing reassessment of ER-1470's place in human evolution.

Fission-track dating is based not on decay and resulting buildup of daughter elements such as potassium-40, but on the cumulative effect of radiation on crystal structure. Isotopes of uranium in a mineral such as zircon, or in a glass such as obsidian, occasionally decay by spontaneous splitting (fission) of atomic nuclei. When the mineral or glass is properly treated in a laboratory, the resulting tracks of fission can be seen with an optical microscope and counted.

To estimate age, a sample's natural fission tracks are counted as are fission tracks in a sample that has been exposed in a nuclear reactor. The ratio of the number of tracks between sample and control is proportional to the time since the sample was last heated. Resultant dates of obsidian tools can either reveal the date of the volcanic activity that produced the obsidian or the date a tool was last exposed to a hot fire.

Useful time limits for potassium-argon and fission-track dating depend on circumstances, and technological advances are likely to extend them both to more-recent and earlier times.



Mount Mazama's great eruption was dated by radiocarbon analysis of charred wood found in this massive tephra deposit in Clearwater Canyon about 25 miles northwest of Crater Lake. This characteristic tephra, which spread over much of North America, has an age calibrated to 7,700 years B.P. This photograph shows approximately 5 vertical meters of the material.

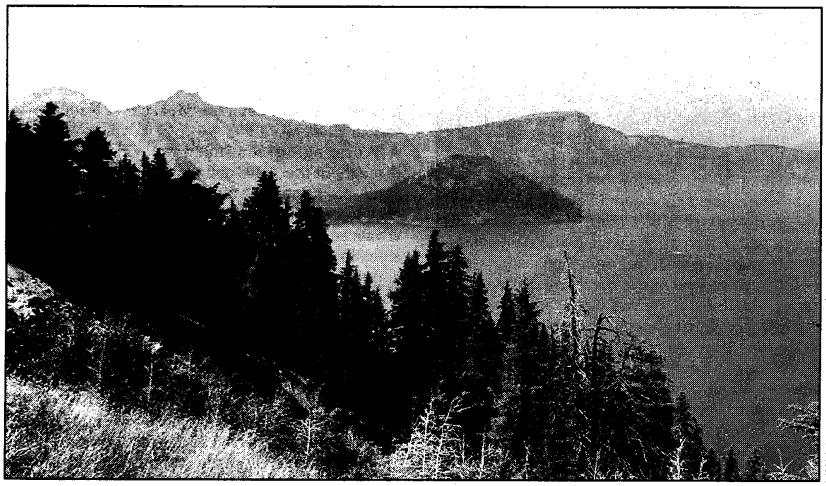
Consultation with a geochemist or someone who does tephrochronology is a necessity if an archaeologist wants to correlate tephra strata by their chemical signatures. I am unaware of any commercial laboratories doing tephrochronology specifically, however; it is usually done by archaeologists in conjunction with field geologists, soil specialists, and geochronologists.

Samples for further analysis should be taken from a section representative of the tephra as a whole. Careful examination of the bed being sampled is highly recommended to ensure that features indicating reworking or multiple origins of the tephra are noted. Photographs, which may later be shown to a professional tephrochronologist or volcanic stratigrapher, should be taken as a record of the sampling site. At least two samples should be taken from each sampling unit, one a representative bulk sample that can later be studied for grain size, mineralogy, etc., the second a selection of the largest, least-weathered lapilli present for chemical analysis. The bulk sample should weigh at least 100 grams (fist-sized or larger).

If the bed reveals internal layering, it becomes necessary to decide how many sub-samples should be collected. Based upon traits one sees in the field—color changes, clast-size changes, disconformities in grading, etc.—each distinguishable layer should be sampled. Samples are best stored in plastic bags with resealable closures, although if the tephra is damp or wet, it must be stored in paper bags with twist tie closures until it dries out (to avoid growth of fungi, etc.). If it is very wet, you can store a sample temporarily in an open plastic bag inside a paper one.

The reliability of tephrochronology is very good, based as it is on the fundamental rules of stratigraphy. However, some problems do exist with distinguishing strata. Most significant of these problems is that tephras from different sources may be stacked one upon the other with little indication as to where the boundaries are. Tephra air-fall deposits commonly have few if any internal structures, bedding, or lamination. Color may be useful in separating the different tephras in the field, as well as variation in grading or grain size. In the lab, differences may be seen in chemical components or in varying percentages of vitric versus lithic versus crystalline components. The last two methods are perhaps the best way to determine where one tephra begins and another ends. Buried soils (paleosols) may be distinguished from buried tephras by the presence of root traces, differently colored soil horizons that grade slowly into one another, and soil structures such as peds.

There is no geological time limit to tephrochronology, dependent as it is upon stratigraphy. Chronometric, or absolute, time limits are those of the specific technique applied. In addition, confidence in chronometric dates derived from tephras is a function of each technique's reliability and accuracy. Tephrochronology is not a single dating technique but is rather a term encompassing multiple subfields of chronology (stratigraphy, geochemistry, volcanology) having in common a basis in the stratigraphy of volcanic ejecta. Practical application of tephrochronology requires the investigator to tailor the methods to each site, depending upon the problems presented.



WORDS & PICTURES UNLIMITED

Mount Mazama collapsed after its great eruption, and Crater Lake eventually formed in its caldera.

SUGGESTED READINGS

ON Ice Age Quest

Graham, Russell W., C. V. Haynes, D. L. Johnson, and M. K. Kimmswick 1981 A Clovis-Mastodon Association in Eastern Missouri. *Science* 213:1115–1117.

Hyland, D. C., J. M. Tersak, J. M. Adovasio, and M. I. Siegel 1990 Identification of the Species of Origin of Residual Blood on Lithic Material. *American Antiquity* 55:104–112

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Toth, Nicholas 1987 The First Technology. *Scientific American* 256:112–121.

Ver Steeg, Karl 1938 Mastodon Discovered in Ohio. *Science* 88:498.

White, George W. 1982 Glacial Geology of Northeastern Ohio. Ohio Division of Geological Survey, Bulletin 68.

Yohe, R., M. E. Newman, and J. S. Schneider 1991 Immunological Identification of Small-Mammal Proteins on Aboriginal Milling Equipment. *American Antiquity* 56:659–666.

ON Chronicling Time with Volcanoes

Aitken, M. J. 1990 *Science-based Dating in Archaeology.* Longman, London

Self, S., and R. S. J. Sparks, eds. 1981 *Tephra Studies.* D. Reidl Publishing Co.: Boston, Mass.

Steen-McIntyre, Virginia 1977 *A Manual for Tephrochronology.* Steen-McIntyre, Idaho Springs, Colorado, 167pp.

COMING CONFERENCES

Sept. 26–Oct.2 Seventh Congress of the International Council for Archaeozoology, Constance, Germany.
Contact: Dr. M. Kokabi, Landesdenkmalamt Baden-Wurttemberg, Fischersteig 9, 78343 Gaienhofen-Hemmenhofen, Germany, or S. J. Miller (see below.)

Sept. 26–Oct.1 Eighth Meeting of Working Group No. 1, Bone Expediency Tools/Taphonomy, (in conjunction with ICAZ) Constance, Germany.
Contact: S. J. Miller, Idaho National Engineering Laboratory, P.O. Box 1625, MS 2091, Idaho Falls ID 83402. 208-525-0062. Fax: 208-525-0071. Deadline for registration, June 30.

Oct. 14–16 Science and Archaeology: A Multi-Disciplinary Approach sponsored by Society for Archaeological Sciences, Cambridge, Mass.
Contact: Robert H. Tykot, Archaeometry Laboratories, Harvard University, Cambridge, MA 02138. 617-496-8991; Fax: 617-495-8925.

Oct. 18–20 Symposium celebrating the 65th anniversary of the Institute of Vertebrate Paleontology and Paleoanthropology, Beijing.
Systematics, evolution, biogeography, paleoecology, and biostratigraphy of vertebrates and human beings followed by an excursion to Zhoukoudian. Contact: Qiu Zhanzing, Director IVPP, P.O. Box 643, Beijing, China.

Oct. 18–22 Rewriting the Pacific: Culture, Frontiers and the Migration of Metaphors, Davis, CA.
Contact: Kay Flavell, Critical Theory, University of California, Davis, CA 95616. Fax: 916-752-8630.

November International Symposium on Pleistocene/Holocene Boundary, Mendoza, Argentina.
Contact: Marcelo Zárate, Centro de Geología de Costas y del Cuaternario-UNMP, Casilla de Correo 722 — Correo Central, 7600 Mar del Plata, Argentina.

Nov. 13–18 Annual Meeting, Soil Science Society of America, Seattle.
Contact: SSSA, 667 S. Segoe Road, Madison, WI 53711. 608-367-4373.

March 15–19 1995 Annual Meeting, Association of American Geographers, Chicago.
Contact: AAG, 1710 16th St. N.W., Washington DC. 202-234-1450.

To Many She Was 'The Queen'

A Memoir by C. Vance Haynes, Jr.

Between geology and archaeology I have had many mentors, but no one has had more influence on my life than H. Marie Wormington. Prior to reading her *Prehistoric Indians of the Southwest*, my connection with archaeology was little more than as an arrowhead collector, one of several hobbies I then pursued. Her book turned my interest from that of idle curiosity to a desire to really understand the significance and meaning of the artifacts I was finding on the surface.

Growing up in the East, I was fascinated by arrowheads found in plowed fields or in baskets in country antique stores my parents would visit on trips from Langley Field, Va., to my father's home in Mt. Airy, N. C. Eventually I forgot about arrowheads as my interests turned to rocketry at Johns Hopkins and to geology at the Colorado School of Mines. Then military matters occupied my thoughts as the Korean conflict intensified. It was while stationed at Sandia Base in Albuquerque, N.M., that my attention turned once again to arrowheads. Gerald C. Shelton, a fellow officer, and his wife took me arrowhead hunting one weekend and, lo and behold, there was a beautiful little sidenotched point lying in a bare spot between some juniper trees. The contrast between this weapon and the nuclear weapons I was involved with struck me forcefully, and turned me to reading about prehistory and hence to Marie's book. Thereafter, just about every weekend and holiday was spent exploring the prehistory of New Mexico, and week nights were spent reading. This reading included Frank C. Hibben's *The Lost Americans* and Marie's *Ancient Man in North America*, but Wormington was many miles away in Denver and Hibben was right there in Albuquerque. So it was Hibben and Paul Reiter to whom I first inquired about my finds. Both were very helpful and inspiring and had tremendous praise for Marie. Then I met Fred Wendorf at the Museum of New Mexico in Santa Fe. Fred was equally encouraging and had the highest regard for Marie Wormington. Fred introduced me to Alex Krieger and both encouraged me to write up the finds I was documenting in Torrance County, N.M.

Eventually I was transferred to Bergstrom Air Force Base in Austin, Tex., and there met another mentor, E. H. Sellards, a geologist with an intense interest in archaeology. He had just completed his book, *Early Man in America*. He also encouraged me to write up my finds, but Air Force work did not leave enough time until I was transferred to Alaska on special duty. There I had all kinds of time. Our top-secret project required working 24 hours a day two or three days at a time every month. For the rest of the month there was very little to do. So I became a prolific reader and read practically everything that had been written about "Early Man" up to that time. I also became more and more interested in the geologic record as it related to archaeology.

The Fairbanks area further enhanced my interests in all things Quaternary. The muck deposits with their contained extinct fauna I found fascinating. The archaeologist Ivar Skarland introduced me to Otto Geist and David Hopkins, and David introduced me to Troy Péwé. By the time I returned to Austin in the "lower 48" I had a wonderful wife, a box of fossil ivory, and a completed manuscript on the Torrance County finds. My father, then stationed at Sheppard Air Force Base in Wichita Falls, Tex., passed the manuscript on to Floyd Studer, director of the Panhandle Plains Museum in Canyon. From Studer it went to Jack Hughes, who helped me reorganize it and encouraged me to send it to *American Antiquity*. It was my first rejection, but Alex Krieger said he wanted it for the Texas Archaeological Society bulletin. With Marie's help and his help it was further improved and eventually published.

In the spring of 1954, as I left the Air Force to return to the Colorado School of Mines by way of the blowouts of eastern New Mexico, "Doc" Sellards encouraged me to stop in Midland, Tex., long enough to meet Glen Evans. Great idea! Before reaching Midland, my 1951 Ford, which had a 1942 Jeep in tow, developed universal-joint problems that caused a half-day layover at the Ford dealer in Midland. This turned out to be the most enjoyable car-repair session I've ever experienced. Glen came right down and spent the rest of the afternoon talking about Quaternary geology and Early Man. Here again was a geologist who was making significant contributions to understanding the world of Paleoindians.

As soon as my wife, Taffy, and I were settled in student housing at CSM, I visited Marie at the Denver Museum of Natural History. She had been encouraging me by mail, but meeting her in person was indeed a highlight. An added bonus was meeting Pete Volk, her husband and a CSM alumnus—another economic geologist with an interest in archaeology. They invited Taffy and me to join them on a Friends of the Pleistocene field trip to the Medicine Bow Range of Wyoming, one of the leaders being John Montagne, my geomorphology professor at CSM. There I met Hal Malde, Roger Morrison, Jerry Richmond, Glenn Scott and other U.S. Geological Survey geologists devoted to Quaternary geology.

There is very little spare time while receiving a Colorado School of Mines undergraduate education, so it was not until after I entered graduate studies at CSM that I could really devote some time to archaeology by visiting sites and studying the collections at the Denver Museum of Natural History. When the fourth edition of *Ancient Man in North America* came out in 1957, I was delighted to find that Marie had included my Torrance County work. My first discovery in her laboratory was what Frank H. H. Roberts had called Folsom fluted knives from Lindenmeier that I thought might actually be a Folsom point broken during manufacture. In one box of John Cotter's Lindenmeier finds I found a crude fluted base that matched a large fluted biface fragment in another box. When I showed these to Marie, she completely agreed with my new interpretation.

I became so interested in geology as it related to archaeology that I was spending more spare time doing consulting geology for archaeologists than mining-geology consulting, the difference being my compensation for the former was pleasure and fascination rather than fees.

Marie introduced me to Jo Brew from Harvard and his students Henry and Cynthia Irwin. I enjoyed working with them at the Magic Mountain site not far from my home in Golden. It was at Magic Mountain that I began to experience archaeological field techniques. Also, it was through Marie that I got to know Joe Ben Wheat.

About this time George Agogino contacted me to find out about some preceramic sites near Grants, N.M., that my Air Force buddy Jerry Shelton and I had worked on while at Sandia Base. I was interested in collecting samples for radiocarbon dating because many old Paleoindian site reports mentioned charcoal in Paleoindian levels. At Kirk Bryan's sites at Grants, we found many hearths with charcoal. We were particularly interested in collecting charcoal from the Folsom level at Lindenmeier, and Marie suggested that we ask Frank H. H. Roberts. He was quite enthusiastic as long as we confined our collecting to arroyo walls and did not open up new excavations. After 500 person hours (George says it was 700) we had collected about a teaspoon of charcoal. At Jerry Richmond's suggestion, I asked Meyer Rubin of the USGS in Washington, D.C., if he would run it, only to be told it was insufficient. With help from Marie, we secured enough money to obtain an

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H. M. Wormington

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who were keenly interested in archaeology, but unable to obtain such information because of a lack of training and of time. . . . There are many thousands of persons, with no formal training in archaeology, who are eager to receive information about the subject if it is presented in a manner acceptable to the intelligent layman.

Wormington's acceptance and encouragement of avocational archaeologists went beyond her writings and into the field. In a 1984 **Mammoth Trumpet** interview she stated, "I think we're terribly dependent on the amateurs, because they are the ones who so often *find* the sites."

C. Vance Haynes, Jr., Regents Professor of Geosciences and Anthropology at the University of Arizona, is a former amateur archaeologist who credits Wormington with inspiring him to study archaeology professionally. "Before I read Marie's books I was nothing more than an arrowhead collector," Dr. Haynes said. "I was in economic geology at the time and eventually it was essentially through her efforts and the efforts of some others that I went completely into geo-archaeology. So she had quite an influence on my career."

Haynes credits another of Wormington's books as having an influence on amateurs. "*Prehistoric Indians of the Southwest* became a classic to the lay audience because it put in lay terms what Southwestern archaeology was all about," Haynes said.

> She encouraged avocational and professional archaeologists alike. . . . It was the quality of what she thought people were doing and their attitude that she endorsed.
>
> –George Frison

George Frison, Professor of Anthropology at the University of Wyoming, is another former amateur who credits Wormington for help and inspiration. "At the time I met Marie in 1951 or '52, I was simply an avocational archaeologist who had done a little work on the side. I happened to go through Denver and stopped at the Denver Museum and showed her some material," Dr. Frison said. "She expressed a lot of interest.

"She encouraged avocational and professional archaeologists alike and it didn't make any difference to her. It was the quality of what she thought people were doing and their attitude that she endorsed," Frison said. "She helped me along the way a couple of times when I needed it—when I went back to school. I always appreciated that. She was a great person."

Frison credits Wormington with clearing up much of the chronology and typology of the eastern Colorado sites in the late 1930s and early 1940s, especially those in and around Yuma County. "It was Marie who made sense out of what later became known as the Cody complex, jettisoned the term 'Yuma' and kind of got Paleoindian chronology and typology on the right track," Frison said. "That was, I think, the beginning of good Paleoindian archaeology." Wormington's work led to the report, "A Proposed Revision of Yuma Point Terminology," published by the Colorado Museum of Natural History in 1948.

Wormington continued working vigorously throughout the 1940s and took a part-time Assistant Professor position at the University of Denver from 1947 to 1949. She realized, however, that she needed advanced degrees to progress further in her profession. In 1950 she received a fellowship to study anthropology at Radcliffe College and was the second woman ever to be admitted to the Harvard Anthropology Department. She graduated from Radcliffe in 1954 with the first Ph.D. in anthropology ever awarded by the college.

Wormington continued her field work, publishing and teaching while at Harvard. She worked on the excavations of rockshelters in Mesa County, Colo., in 1951–1952 and served as consultant with archaeologists of the Direccion de Prehistoria in excavating mammoth and associated artifacts in the Valley of Mexico. Her work in Mexico was sponsored by the

MAMMOTH TRUMPET/STEVE BICKNELL

Hannah Marie Wormington

Rockefeller Foundation and led to the book, *Origins*, published in 1953. Among Wormington's other publications while at Harvard is "The Story of Pueblo Pottery" written with Arminta Neal and published in 1951. She was also named visiting lecturer at the University of Colorado from 1950 to 1953.

Wormington's field work and publishing continued for more than 20 years after she graduated from Harvard. She conducted a survey in Alberta in 1955–1956 and worked on the Frazier Agate Basin and the Jurgens Cody sites in Colorado. The latter project was conducted jointly with Joe Ben Wheat.

Dr. Wheat, Curator Emeritus of Anthropology at the University of Colorado remembers his association with Wormington, which began in 1934, with fondness. "We were good friends over the years and colleagues in the sense that we were both invited to visit and authenticate archaeological sites," Wheat said. "She was a close friend and we visited each other as families and went on trips together. Also because we were at various times in the same kind of

> There was always an incredible interchange of ideas and personalities. . . . I don't know when we will ever see that again.
>
> —*Jim Grady*

excavation processes, we discussed results a lot. She was a consultant and discussant at times. She was a colleague who did more than just sit on the sidelines and cheer."

Wormington's field work in the 1940s led to the publication of *Reappraisal of the Fremont Culture with a Summary of the Archaeology of the Northern Periphery* in 1955. This influential book led others to reassess Southwestern prehistory. In 1956 Wormington published a definitive book with Robert Lister on the virtually unknown Uncompahgre complex in west-central Colorado.

Wormington's increasing recognition as an expert in Paleoindian studies led to her being sought as a consultant for Paleoindian projects in Iowa, Nevada, Alaska, Nebraska, and South Dakota. From the 1950s through the 1970s, she represented the United States at many international congresses. These meetings took Wormington all over the world. She visited no fewer than 33 foreign countries and six continents. She was one of the first Western anthropologists to enter the Soviet Union in 1958 and was among the first Western anthropologists to visit the People's Republic of China as part of the United States Academy of Science's Paleoanthropology Delegation in 1978.

Wormington gained more recognition in her latter years as evidenced by the many honors and awards she received. At the World Summit Conference on the Peopling of the Americas sponsored by the **Center for the Study of the First Americans** in 1989, she was presented the National Geographic Society's $5,000 Franklin L. Burr Prize. Among her other awards: Guggenheim Fellow, 1970–1971; Colorado State Archaeologists Award, 1979; Society for American Archaeology, Distinguished Service Award, 1983; C. T. Hurst Award for Extraordinary Service, presented by the Colorado Archaeological Society, 1985. She received Honorary Doctor of Humane Letters degrees from Colorado State University in 1977 and Colorado College in 1988. She was also appointed Curator Emeritus of Archaeology by the Denver Museum of Natural History in 1988.

In addition to her professional achievements and recognition as a scholar, Wormington is recognized by her colleagues as a pioneer in opening up archaeology to women. She became the first woman president of the Society for American Archaeology in 1968 after serving two terms as vice-president in 1950–51 and 1955–56.

Jane Stevenson Day, Chief Curator of the Denver Museum of Natural History said, "She was a major role model for many women because, of course, archaeology at the time she started into it was a very male-dominated field. She became probably the best-known woman archaeologist of her time. She did her best to encourage women in the field."

Wormington inspired enthusiasm for archaeology in her students and colleagues alike. Because they held her in high respect and regard, they always wanted to let Wormington know how they were doing and what their latest discoveries were. In this way, Wormington became an unofficial information center for many Paleoindian archaeologists across the Southwest and the nation. "Everybody was anxious to share everything they found with her and get her comments," said George Frison. "She was kind of a clearinghouse for Paleoindian archaeology. She was very interested in what people were doing and she had a lot a protégés."

Joe Ben Wheat agrees with Frison in his characterization of Wormington as a "clearinghouse." Wheat said, "She was the center of communication and was a compiler of just about everything that went on in the field. Every time somebody would dig something they would tell Marie and she would pass it along to the rest of us."

Ann Johnson, archaeologist for the National Park Service in Denver, was the last in a series of professional and nonprofessional archaeologists who helped Wormington with her office and correspondence. According to her, Wormington kept up her role as mentor and consultant until her death. "She served as a focal point for information," Johnson said. "People were interested in her views on the subject and she was very generous in sharing what she knew and what people had sent her with anybody who had a legitimate interest."

There are many other sides to Marie Wormington that her friends and colleagues remember. Frison remembers the gourmet cook and the ambassador of American archaeology to other archaeologists throughout the world. Wheat describes Wormington as "gracious" and "unequivocally honest." Jim Grady of the University of Colorado, Denver, compared her home to a European salon. "Marie's place was very stimulating . . . and you never knew who was going to be there, but there was always somebody there," Grady said. "There was always an incredible interchange of ideas and personalities there. I don't know when we will ever see that again."

Many who knew Wormington remember her sense of humor. Frison jokes, "Her philosophy can be summed up in one statement. She used to say, 'When I die, cremate my body but be careful that you don't scatter it where it will foul up the radiocarbon dates.'"

–Robert W. Richards

'The Queen'

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analysis at Isotopes, Inc. The result was the first reliable radiocarbon date for Folsom. Marie then encouraged us to publish our results in the DMNH's Popular Series. Being asked for a publication—and by H. M. Wormington—was to me heady stuff. I began to entertain thoughts of trying to make a living at this enjoyable business.

George Agogino and I set out to solve all the Paleoindian chronological problems by collecting charcoal from old sites while at the same time looking for new ones. Things really began to happen in Wyoming. The Union Pacific Mammoth site was found and led to our acquaintance with Dennis Stanford from Rawlins. James Duguid from Raltson Buttes showed us the Brewster site at Agate Basin and the Hell Gap site that his father had discovered during the 1930s. We also met George Frison at that time. We had more than we could handle, so Marie suggested we try to get the Irwins interested. We didn't have to try very hard. Thus began a long-standing and very pleasant association.

Marie and Pete's house was a gathering place at all times for anyone working on archaeology in the region. It was essentially the "command center" for Paleoindian studies. This went for geologists as well. It was at Marie's that I first met John P. Miller, the last teacher of the Kirk Bryan "school" of geology at Harvard. Through Fred Wendorf I had already met Luna and Estella Leopold, so I was happy to learn that Luna and John Miller were close friends and collaborators. They, along with Jo Brew and Marie, encouraged me to make a career of what we now call geoarchaeology by returning to academia for a Ph.D. With further encouragement from mentors at the University of Arizona, I eventually qualified in the eyes of Marie. I became even more aware of this when, in 1962, she recommend me to Dick Shutler as the geologist on the Tule Springs project.

Marie, more than anyone, pioneered the way for women in archaeology and never failed to encourage women. Everyone took great pride in being a part of Marie's world and for every new find of every new season we couldn't wait to tell Marie. Her response was invariably enthusiastic and charged with encouragement. One always left Marie on a high note. Seldom did she disapprove of one's actions, but if she did, you knew about it right then and there.

In early June George Frison and I conducted geoarchaeological investigations at the Hell Gap site. We were anxious to let Marie know that we had collected 64 stratigraphically controlled, single-lump charcoal samples for AMS radiocarbon dating and that two of these were in direct association with an Agate Basin point and bison bones. It was the last day at Hell Gap that we learned the devastating news of Marie's untimely death.

Many of us referred to Marie amongst ourselves as "the Queen." We always sought approval from the Queen. We will miss her dearly.

C. Vance Haynes, Jr., is Regents Professor of Geosciences and Anthropology at the University of Arizona.

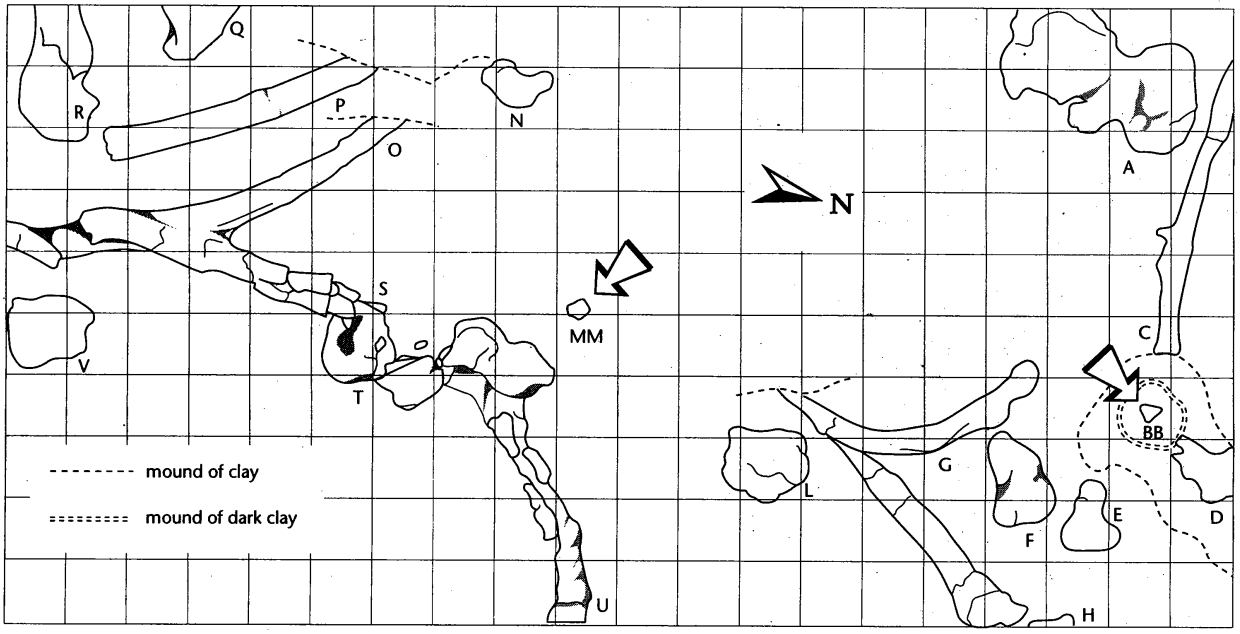

Diagram of half a 2-by-2-m Martins Creek excavation unit depicts mastodon bones. Arrows indicate flakes that tested positive for the antiserum of elephant (center) and deer (right).

Ice Age Quest

continued from page 1

Among other local landforms it displays the effects of the Wisconsin ice sheet reaching its maximum extent against the uplands of the Allegheny Plateau and then melting. The area is about 2 miles north of the terminal moraine, which marks the maximum advance of the glaciation; glacial melting periodically created lakes there. Martins Creek site is on a peninsula of land that extended into the Ice Age lake. Brush speculates that it may have been a place where large mammals came to drink, and it seems to have been a place where people cornered and killed them.

Brush and Forrest Smith, a professor of biology at the University of Akron's Wayne College, describe the Martins Creek discoveries in their paper in **Current Research in the Pleistocene**.

> Mingled among the mastodon bones on the southern and eastern margins of the site were deer bones and teeth. The deer bones increased in frequency to the south and east as the mastodon bones decreased in number. The highly disarticulated state of both the mastodon and the deer skeletons suggested the possibility that these animals had both been butchered.

The paper goes on to describe the related discoveries of seven flint flakes, which could have served as effective butchering tools, and a flint side scraper.

"Although the flint flakes had not been retouched, they were clearly waste flakes derived from flintknapping activities and were made of material that outcrops some 20 miles to the southwest." Brush and Smith note that Indiana University anthropologist Nicholas Toth has demonstrated that unmodified waste flakes could have served as very effective butchering tools (**Suggested Readings**).

Brush submitted the side scraper and four flakes to Margaret Newman of the University of Calgary's Department of Anthropology for immunological analysis of possible protein residues. Brush, Smith and Newman describe that process in another paper in **Current Research in the Pleistocene** Vol. 11. Two of the flakes produced positive results, one for deer antisera, and one for elephant antisera. Laboratory materials used in the testing do not distinguish between different closely related species. Elephant antisera, for example, give positive results for samples from all members of the order Proboscidea, which includes modern as well as extinct elephants.

Because flakes found in association with mastodon and deer bones show evidence of having once been bloodied by mastodon and deer, Brush and his colleagues conclude that they were probably used as butchering tools. However, Brush says he is pursuing further avenues of investigation.

Antiquity of the mastodon has not yet been established, although radiocarbon analysis is pending. Dr. Daniel C. Fisher of the University of Michigan's Museum of Paleontology and Department of Geological Sciences is studying the bone. The skeleton was badly weathered and cracked, so recovery of it was difficult. Its initial discovery dates to 1938, when a farmer was digging a drainage ditch. The trenching machine brought up eight teeth, and a geologist from the College of Wooster came to investigate. He identified the teeth, the largest of which weighed six pounds, and a femur that also had been excavated, but because the bone was poorly preserved no more excavation was attempted. The 1938 investigation did not reveal that the mastodon had been disarticulated. Contemporary accounts, including a brief item in *Science*, said part of the skeleton had been damaged by dynamite used in a previous ditching project about ten years earlier (see **Suggested Readings**). Brush presumes that preservation of the bone deteriorated even more rapidly in the intervening decades as farm machinery rolled repeatedly over the dryer soil.

The mastodon bones were relatively near the surface; rib and leg bones were only 46 cm deep, and the pelvis and part of the spine were at a depth of 56 cm. Before they found the skeleton last summer Brush and his crew opened 18 excavation units each 2 m square and up to 1.5 m deep. The son of the farmer who made the 1938 discovery pointed out the location for Brush.

The giant sloth (*Megalonyx jeffersoni*) found two miles away in 1890 was reported to have been excavated from under more than 6 feet of sediments. Its bones were in excellent condition, and the specimen was subsequently mounted and displayed in a museum at Ohio State University. The 1938 *Science* report of the Martins Creek Mastodon suggested that the animals had become mired in the bog left by the filling of the glacial lake. Few, if any, scientists at that time would have speculated that the mastodon might have been butchered by humans.

–DAH

MICHAEL HANSEN/OHIO GEOLOGICAL SURVEY

1993 excavations at the Martins Creek Mastodon site paralleled a drainage ditch installed in 1938. The site is near the tip of a narrow peninsula that had extended into a glacial lake.

UW Lab Does TL, OSL Dating

The University of Washington's Luminescence Dating Lab has been doing thermoluminescence and optically stimulated luminescence dating on a commercial basis since 1986. Mention of this facility, which analyzes both sediments and ceramic materials, was unintentionally omitted from the article "Measuring Energy Stored in Trapped Electrons" in the last **Mammoth Trumpet.** Researchers wanting information should write to Jim Feathers, Luminescence Dating Lab, Department of Anthropology, DH-05, University of Washington, Seattle WA, 98195, phone 206-685-1659, or FAX 206-543-3285.