3-1987

An Archaeological Survey of Big Bone Cave, Tennessee and Diachronic Patterns of Cave Utilization in the Eastern Woodlands

George Martin Crothers
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by George Martin Crothers entitled "An Archaeological Survey of Big Bone Cave, Tennessee and Diachronic Patterns of Cave Utilization in the Eastern Woodlands." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

Charles H. Faulkner, Major Professor

We have read this thesis and recommend its acceptance:

Walter E. Klippel, P. S. Willey

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a thesis written by George Martin Crothers entitled "An Archaeological Survey of Big Bone Cave, Tennessee and Diachronic Patterns of Cave Utilization in the Eastern Woodlands." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

Charles H. Faulkner, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Vice Provost
and Dean of the Graduate School

STATEMENT OF PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a Master's degree at The University of Tennessee, Knoxville, I agree that the Library shall make it available to borrowers under rules of the Library. Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of the source is made.

Permission for extensive quotation from or reproduction of this thesis may be granted by my major professor, or in his absence, by the Head of Interlibrary Services when, in the opinion of either, the proposed use of the material is for scholarly purposes. Any copying or use of the material in this thesis for financial gain shall not be allowed without my written permission.

Signature George M. Crothers

Date March 5, 1987

AN ARCHAEOLOGICAL SURVEY OF BIG BONE CAVE, TENNESSEE AND DIACHRONIC PATTERNS OF CAVE UTILIZATION IN THE EASTERN WOODLANDS

A Thesis

Presented for the

Master of Arts

Degree

The University of Tennessee, Knoxville

George Martin Crothers

March 1987

to

my parents

Carl M. Crothers

and

Mary D. Martin Crothers

ACKNOWLEDGMENTS

The archaeological survey of Big Bone Cave was made possible by funding from the Tennessee Department of Conservation. The staff of Rock Island State Park and Bone Cave Mountain State Natural Area provided field accommodations at the White home on Bone Cave Mountain and facilities at Rock Island during the survey expeditions. The hospitality of Superintendent J. T. Butler and Mary Lou Wilcox is greatly appreciated.

Professor Charles H. Faulkner served as chairperson of my thesis committee. The guidance of Professor Faulkner and my committee members, Professors Walter E. Klippel and P. S. Willey, has been instrumental during my graduate studies and the preparation of this thesis. I am also indebted to Professor Patty Jo Watson, Washington University in St. Louis, for her assistance and influence on my work.

Larry Blair, Joel and Carole Sneed, and Jim Whidby were instrumental in initiating the Bone Cave survey. Marion Smith made available numerous historic documents and articles. The Big Bone Cave map was surveyed and produced by John Smyre and Ronald Zawislak. I am grateful for the kind permission of John Smyre to reproduce their map in my thesis. I also wish to express my appreciation to the participants of the survey expeditions for enduring long hours, noxious dust, and numerous "tight spots" while venturing underground: Larry Blair, Ken Cannon, Randy Cooper, Lee Ferguson, Bob Ford, Charlie Hall, Mary Kennedy, Roy Meador, Rick and Kathy Richardson, Joel and Carole Sneed, Sherri Turner, Pat Watson, and P. Willey

I greatly appreciate the many helpful comments and suggestions, and the time invested by the various parties, although the responsibility for all shortcomings is mine alone.

ABSTRACT

An archaeological survey of Big Bone Cave, Tennessee was conducted by the author from August 1984 to August 1985. Results of the survey indicate that while numerous historic activities, particularly the mining of saltpetre, have disturbed prehistoric deposits in the cave, evidence of aboriginal use of the cave remains intact. The nature of prehistoric remains, their context, and the radiocarbon dated period of activity are used as evidence to support the interpretation that extensive mining of selenite gypsum occurred in the cave, primarily during the Early Woodland period.

The radiocarbon age chronology from Big Bone and other similar cave sites was statistically analysed to support the evidence for a diachronically patterned use and perception of cave sites during the Late Archaic through Mississippian periods in the Eastern Woodlands. This pattern includes the use of caves as mines and quarries, places for the burial or disposal of the dead, and as ceremonial retreats. Finally, suggestions are offered for guiding future research to test and refine this pattern.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

In August, 1984 the Department of Anthropology, University of Tennessee began a survey of the prehistoric and historic archaeological remains in Big Bone Cave (40VB103), Van Buren County, Tennessee for the Tennessee Department of Conservation. This survey, directed by the author, was completed in August of 1985. The survey was intended to provide information for both the management of the archaeological resources in the cave as well as contribute to our knowledge of prehistory, in particular the prehistoric use of cave sites.

Big Bone Cave has a rich heritage of history, paleontology, and archaeology. The extraction of saltpetre from the cave sediment was a major industry at Big Bone Cave during the War of 1812 and again during the American Civil War (Smith 1984). Large sections of the saltpetre mining works have remained intact since their use over 100 years ago (Barr 1961; Matthews 1971).

The discovery of the remains of a giant ground sloth (*Megalonyx jeffersonii*) in the cave found notice in several important paleontological works of the day (Harlan 1831; Hay 1923; Leidy 1855; Safford 1892; Troost 1834-35). Cultural remains of prehistoric Indians were also noted by numerous visitors to the cave during the nineteenth century and attracted the attention of at least one archaeologist who studied the contexts of these remains (Mercer 1897).

In this study I have drawn upon these early descriptions and history of the cave as they effect the prehistoric archaeological record and present the results of a survey to document the aboriginal use of Big Bone Cave. My interpretations of these results are then statistically analyzed and discussed relative to the radiocarbon age record of deep cave sites in the Eastern Woodlands.

Sites like Big Bone Cave present some different problems for the conduct of archaeology in the field. And for this reason cave archaeology has become somewhat of a specialty in its own right. Light, equipment, confined spaces, and the inability to maintain a sense of direction underground present challenges in the collection of information in deep cave sites. Specific knowledge of the cave environment is required to make intelligent observations and interpretations on the archaeological record in a cave setting.

However, archaeological remains in caves are like archaeological remains anywhere, it is the result of human interaction with the environment. Cave entrances are often highly visible, fixed points on the landscape. As entryways to a subterranean world they undoubtedly had cognitive significance on a cultural level, although cultural interpretations or relevance of the cave world cannot be considered consistent across time or space.

Utilization of the cave and its resources requires intimate knowledge of that environment. In this sense caves are simple extensions of the above ground natural environment except that cave exploration requires perpetual artificial light.

Caves can contain chert, but chert is not an especially difficult resource to obtain in the limestone regions of the Midwest and Midsouth. The efforts required to travel underground hardly seem worthwhile for a resource that is readily obtained on the surface.

Caves can contain a variety of exotic lithic resources: gypsum flowers and crusts, selenite crystals, aragonite and calcite speleothems, and number of other mineral deposits (Hill 1976). But the value of such items is probably more in their beauty or wonderment than their practical uses. The importance attached to such items may have been entirely culturally perceived. The fact that such resources are relatively rare in the context of the natural environment probably enhances their value, particularly if they functioned in trade systems.

The use of caves as ceremonial retreats to decorate the walls with presumably meaningful figures and representations presents a fundamentally different perception of the cave environment. The cave has obtained an entirely cosmological significance. The underground world is no longer a resource, but the domain of supernatural forces to be reckoned with.

The statistical analysis and discussion of cave use through time in the concluding sections of this study are intended to lend corroborating evidence to the idea of diachronically patterned use and aboriginal perception of caves as part of the landscape that transends regional and cultural boundaries in the Eastern Woodlands.

II. PHYSICAL SETTING

Big Bone Cave (40VB103) is the major geologic feature of the Bone Cave Mountain State Natural Area that includes approximately 334 acres of land above the cave. The cave has a mapped horizontal length of 15.5 km (9.6 mi) and a total vertical extent of 65 m (213 ft) (Zawislak and Smyre 1979). The cave, once located within White County, became part of Van Buren County when it was incorporated in 1840. Bone Cave Mountain lies approximately half way between McMinnville and Sparta, Tennessee. The cave is located on the south side of the Caney Fork River above the confluences of the Collins and Rocky rivers with the Caney Fork. The cave entrance lies at the head of a cove, formerly known as Beech Cove, on the north side of the mountain at an elevation of approximately 1060 feet above mean sea level.

Bone Cave Mountain is an erosional remnant of tableland on the western escarpment of the Cumberland Plateau which is the name given to the southern portion of the Appalachian Plateaus physiographic province (Miller 1974:3). The western escarpment, marked by numerous deep gorges cutting into the plateau, extends across Tennessee from northeast to southwest. The sandstone cap of the plateau forms prominent cliff faces and waterfalls along these gorges. Along valleys where limestones have been exposed by erosion, the carbonate rocks are susceptible to karstification. The western escarpment of the Cumberland Plateau is one of the major karst regions of the United States (Crawford 1982:1). Over fifty caves have been recorded in the Bone Cave Mountain area alone (Zawislak 1971:9). The location of Big Bone Cave relative to the western escarpment and major river valleys is presented in Figure 1.

The Cumberland Plateau is capped by Pennsylvanian sandstones, conglomerates, and shales and is underlain by Mississippian limestones which are much less resistant to solution. Locally, Big Bone Cave occurs in the Monteagle Limestone near the bottom of the escarpment. The cave is capped by the Hartselle Formation, a sandstone that is locally calcareous with lenses of shale near the top and bottom. It is very resistant and virtually impermeable. The sinkhole plain at the base of the escarpment corresponds with the area of cherty St. Louis and lower Monteagle limestones. Crawford (1982:10) postulates that conduit caves along the Plateau escarpment result primarily from subterranean invasion of surface streams flowing off the plateau and that they are directly related to caprock removal by slope retreat.

Essentially, what is occurring hydrogeologically can be summarized by Crawford's (1982:16) model of karst valley development. The underlying limestones are protected by

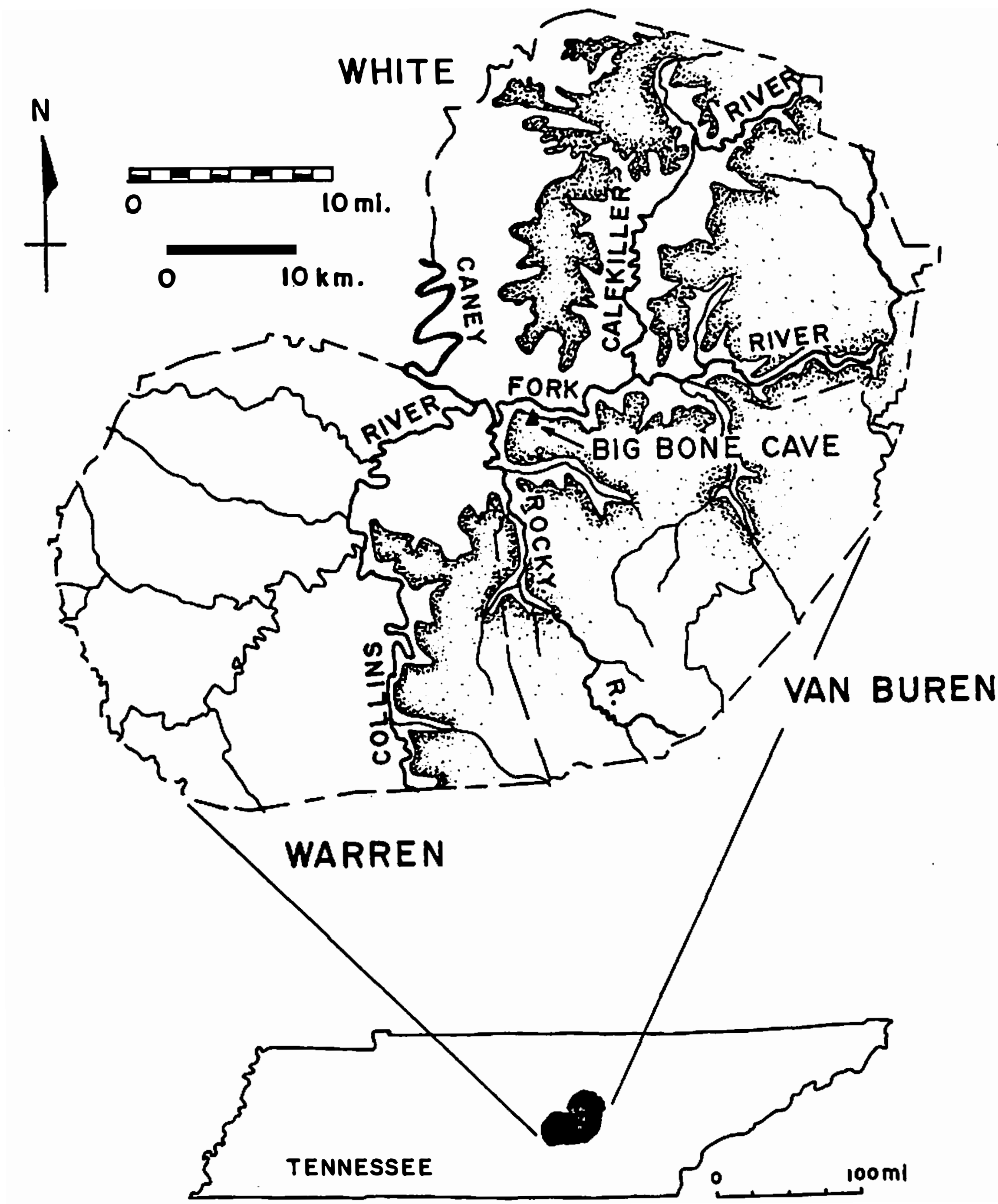

Figure 1. Location of Big Bone Cave (40VB103), Van Buren County, Tennessee.

caprock until erosion by a downcutting stream has breached this layer in a structurally high area, such as a small anticline, several kilometers behind the retreating escarpment. Once the underlying limestone is exposed, subterranean stream invasion occurs as the highly aggressive stream water begins to flow through the joints and bedding planes. Gradually more of the stream will be diverted to the subsurface conduit system as the joints and bedding planes are enlarged by solution and corrasion.

In the case of Big Bone Cave, which occurs at the bottom of the escarpment, stream erosion has breached the Hartselle Formation creating a conduit cave in the Monteagle Limestone. In turn, the subterranean stream that formed Big Bone Cave has been diverted and the cave system is now an abandoned subsurface stream conduit, that is, a cave without a stream. The resistant Hartselle Formation caps what is in fact a mesa (Crawford 1982:18) and provides the dry environment found in much of Big Bone Cave. This observation was made very early by Tennessee's first State Geologist, Gerard Troost:

> Being situated in the upper part of the limestone strata, where the sandstone begins to make its appearance, and therefore the fluids which may penetrate into it not being charged with carbonate of lime; it is natural to suppose that no stalactites embellish its roof nor stalagmites incommode the traveller; in fact, we were not troubled by drippings as is often the case in similar caves; every thing here was dry . . . (Troost 1834-35:237).

Phytogeographically, the Bone Cave Mountain area is located near the boundary of Braun's (1964) Mixed Mesophytic and Western Mesophytic Forest regions. The Mixed Mesophytic Forest, occupying much of the unglaciated Appalachian Plateaus to the east of Big Bone Cave, is characterized by the prevalence of mixed mesophytic climax communities. Dominance is shared by a number of species, particularly beech, tuliptree, basswood, sugar maple, sweet buckeye, chestnut, red oak, white oak, and hemlock. The Western Mesophytic Forest region to the west, which includes the Interior Low Plateau, is a mosaic of unlike climaxes and subclimaxes (Braun 1964:35).

The Bone Cave Mountain vicinity is best characterized by Braun's Southern District of the Cliff Section of the Cumberland Plateau within the Mixed Mesophytic Forest Region. The dissected Eastern Highland Rim of the Mississippian Plateau, adjacent to the Bone Cave Mountain vicinity, has been described by Braun (1964:152) as essentially a part of the Mixed Mesophytic Forest region.

The tableland above Big Bone Cave may be represented by this description:

> Over the greater part of the area, one sees mixed oak, oak-hickory, and oak-pine communities . . . . Not all of these are associated in any one place; the general impression is of oak woods. The large number of showy summer-blooming herbaceous plants suggests that the forest of the upland was not everywhere exceedingly dense, that

> there always were sunny spots in which this now prevalent herbaceous growth found suitable habitats (Braun 1964:113).

The valley below and the escarpment in the vicinity of the Big Bone Cave entrance may be best described by this:

> In the occasional wider parts of valleys there are alluvial terraces and graded talus accumulations presenting a habitat topographically very unlike the slopes but supporting a similar forest community. That is, mixed mesophytic forest has developed on slopes where they have become sufficiently reduced and on depositional areas when they have been sufficiently built up. Forests in these situations always have a high percentage of beech, but the typical species of the Mixed Mesophytic association are present. They may also contain an occasional white elm, relict of an earlier development stage, and bamboo (*Arundinaria gigantea*), generally most abundant near streams. The herbaceous growth is exceedingly luxuriant and like that of rich slope woods (Braun 1964:108).

III. EARLY DESCRIPTIONS OF THE CAVE

Numerous descriptions of Big Bone Cave appeared during the early part of the nineteenth century. Most of these were concerned with the large saltpetre operation, the discovery of the "big bones," or other natural curiosities including remains from prehistoric Indian visitation.

Big Bone Cave was known to have two entrances described as being 600 yards apart on the surface (Haywood 1959:56). One entrance, located in White County, was referred to as Big Bone Cave and the other entrance, located in Warren County, was referred to as Arch Cave. The best information indicates that the Big Bone entrance was discovered by Euro-Americans in 1806 and the Arch entrance in 1811 (Big Bone and Arch Caves 1821).

The Arch Cave entrance is no longer open. There is a large sink on the surface where this entrance was once located. Overgrown spoil-piles, probably from the saltpetre industry, remnants of a road, and rock walls indicate that at one time this entrance was heavily used.

There are numerous stories in circulation concerning the collapse and even the origin of the Arch Cave entrance. Barr (1961:454) states that this entrance was blasted open and has since collapsed. This appears to be incorrect; no references from the nineteenth century indicate that the Arch Cave entrance was ever artificially opened or enlarged.

The most popular story concerning the collapse of the entrance, recorded by Bayless (1982:17), is that it was dynamited by the Confederate troops mining saltpetre from the cave to conceal their operation. According to this story a Union patrol came too near the mine and was ambushed by Confederate guards to prevent their return with reinforcements. The bodies of these Union soldiers are also reported to be buried in a cemetery on the top of Bone Cave Mountain (Bayless 1982:17; Blair 1983:33). There has never been any confirmation of these stories in the historic record. The cause of the collapse, whether intentional or natural, is still unknown.

The earliest recorded description of Big Bone Cave is by D. T. Maddox (1813-14) in a letter to a friend dated August 17, 1813 and published in Nile's Weekly Register of Baltimore. It is evident from Maddox's fanciful writing that he was both terrified and curious to explore the cave. It appears that Maddox entered the cave through the Bone Cave entrance and large saltpetre works were in operation there. This was Maddox's impression of Big Bone Cave:

> The aperture is a semicircle, whose semidiameter is about fifteen feet. The sun was declining in the west, and his rays bore in a direct line against the mouth of the cavern, intermixing light and darkness with such hideous perplexity, as to leave the mind in doubt, which of the two to adopt. At the same time that there is issued from its mouth a column of smoke, occasioned by the burning of torches within, which gave to the whole an appearance that seemed to realize the most exaggerated picture of the infernal regions!

> While a smutty crew, in tatters, resembling nothing but devils incarnate, bore in black sacks, the nitre and bitumen which seemed to constitute the horrors of the place. . . .
>
> . . . .
>
> We now had proceeded beyond the atmosphere of smoke, occasioned by the burning of torches employed to light the workmen. Till now, the sooty walls and ceiling of the apartments, had exhibited the most dismal and lugubrious appearance. The cautious wanderer hearing nothing but the indistinct echoes of hammers and pick-axes, dying upon the ear, with the most appalling sounds, and seeing at intervals, the flame of torches, followed by men in the shape of devils, was easily impressed with the belief, that the place was inhabited by a thousand fabled Cyclops, occupied with their bellows and forges in fabricating thunder! (Maddox 1813-14:175).

The best early description of Big Bone and Arch caves appeared first in the Raleigh, North Carolina Star dated June 6, 1821. No known issues of this paper for June 6th have survived to the present day. However, this article written by the editor was reprinted in several other publications including the Village Record of Westchester, Pennsylvania (Big Bone and Arch Caves 1821).

The editor of the North Carolina Star indicated that the information in this article was based chiefly on notes supplied by Colonel Randolph Ross of Rockbridge County, Virginia who was then the major owner of the cave. Apparently these notes also supplied the majority of information on Big Bone Cave that appeared in Haywood's (1959:56-57) The Natural and Aboriginal History of Tennessee first published in 1823 and the Tennessee Gazetteer (Morris 1834:104-105). Comparing the texts of these publications it is apparent that they contain verbatim copy of the same source, presumably Ross' notes.

The cave is described as having two entrances on the side of a mountain, "a small entry on one side but on the other a mouth of much larger size." The bones "of some large animal" were found half a mile from the small entry (Haywood 1959:56). Presumably the small entry then was the Bone Cave entrance and the larger entry was the Arch Cave entrance. Haywood (1959:57) also notes that Arch Cave was the smaller of the two, probably meaning that the horizontal length was shorter.

Big Bone Cave was described as having several branches, "from one of which the dirt has been collected for upwards of half a mile" (Haywood 1959:57; cf. Big Bone and Arch Caves 1821). This branch of the cave was also explored for several miles by three men who were supposedly in the cave for three days and three nights (Big Bone and Arch Caves 1821; Haywood 1959). This probably refers to the portion of the cave presently known as the Bone Cave Branch and the 1862 Passage.

The _North Carolina Star_ article contains several other interesting notes including "immense quantities of leather winged bats" and rats of unusual size seen 700 feet from the mouth of the cave in the left branch (i.e. Bone Cave Branch), and relates this story:

> Bat excrement was found, extending about 300 yards in length, from 2 to 10 feet deep, and an average of five feet wide, to which fire was applied several years ago with a view of discovering the apertures of the cave, by the smoke - the object was not attained, but the fire continued to burn for nine months, to the great injury of the then propietors - it was finally extinguished by excluding the air and smothering it (Big Bone and Arch Caves 1821)

It is possible to reconstruct several details concerning the cave as it was known in the early nineteenth century. What today as a whole is known as Big Bone Cave was once referred to as two separate caves that were later discovered to connect underground. The Bone Cave entrance was smaller in size than the Arch Cave entrance, but Big Bone Cave was the larger of the two in length and had several branches. Arch Cave probably only referred to what is known as the Muster Ground. The remainder of the cave was known as Big Bone. What today is called the Arch Cave Branch only refers to the fact that it was the route taken underground to reach the old Arch Cave.

IV. HISTORY OF THE ARCHAEOLOGICAL RESEARCH

Extensive remains from the historic saltpetre mining and the prehistoric Indians who utilized the cave are preserved in the dry environment. However, few efforts to systematically record or describe these remains has been attempted.

The prehistoric remains suffered immeasurable destruction primarily by the nitre miners as they removed mass quantities of sediment for leaching. The major and most accessible parts of the cave have been rifled for saltpetre. We have permanently lost this bit of prehistory.

Casual and careless destruction of the saltpetre mining remains occurred following the cessation of mining. However, it took the blatant removal of saltpetre artifacts, including complete leaching vats, to focus attention on the valuable cultural resources being destroyed in Big Bone Cave. A campaign to have Big Bone Cave protected, organized by members of the National Speleological Society (NSS), subsequently led to its incorporation as a State Natural Area and designation as a National Landmark.

The discovery of prehistoric remains in Big Bone Cave is not a recent development. Like the finding of the ground sloth, remains from the aboriginal explorers were observed soon after the cave was discovered. Apparently some artifacts were left in the cave as curiosities for visitors. Maddox (1813-14) noted that he was shown "a fishing net made of bark silk, and a moccason (sic) of the same materials, both perfectly sound."

Clifford (1820) wrote in some detail of the weaving technology that the aborigines must have possessed in order to construct many of the artifacts that were being found, including mummies "enveloped in a coarse species of linen, of about the consistency and texture of cotton bagging." Clifford also noted that "fragments of fishing nets with large meshes, and mocasons (sic) made from a species of rattle" had been found in the cave and had this interpretation of the remains:

> The comparatively small number of human bodies buried in our salt-petre caves shows, that it was not a very general custom to inter their dead in this manner. Neither could it have been usual for our Aborigines to have inhabited these caves, though in one or more instances, such as in the Mammoth Cave on the Green River, it is evident that people must have lived there. The remains of fishing nets and mocasons as before mentioned, the finding of muscle-shells, and parts of gourds, the discovery of fire hearths, and of certain chambers, rendered smooth and even by the pounding of charcoal and ashes with the earth, prove that a race of Troglodytes once existed in this country as well as in the neighbourhood of the Nile (Clifford 1820:36).

The notes on Big Bone Cave written by Randolph Ross and circulated among various sources also contain references to the prehistoric artifacts.

> In this cave was dug up, in the salt petre dirt, six feet below the surface, a scoop net made of bark thread, a mockason (sic) and a mat of the same materials, with feathers worked in, presenting good workmanship, in which was contained human bones. The net, mockason and mat mouldered immediately after exposure to the air (Big Bone and Arch Caves 1821; cf. Haywood 1959:57).

The extreme preservation qualities of the dry caves attracted the attention of some early American anthropologists. William H. Holmes (1891-92) at least noted the presence of perishable fabrics from Big Bone and other caves in the area. However, Henry C. Mercer (1896, 1897) from the Department of American and Prehistoric Archaeology of the University of Pennsylvania made an expedition to Bone Cave in 1896 with some explicit objectives. Mercer was seeking to answer a specific archaeological question: "How long has Man existed in the New World?" (Mercer 1896:609). Mercer was attempting to answer this question through the study of the association of human and animal remains in caves. "There we have endeavored to find if possible his bones still associated with the remains of the extinct mastadon, the mammoth, the tapir, the giant beaver and the fossil sloth" (Mercer 1897:36-37).

Directed to the spot in the cave where remains of the ground sloth had been recovered, Mercer made the first controlled excavation to record their stratigraphic position relative to the aboriginal remains. In effect, Mercer was using the ground sloth as an "index fossil" to establish the relative age of aboriginal activity in Big Bone Cave.

Mercer completed his field work in Big Bone cave in one day, May 6, 1896. Mercer, his assistant Joseph Mussleman, accompanied by Mr. G. B. Johnson the land owner, and guided by James Priest worked from 9:00 A. M. to 5:00 P. M. until "faint from continual inhalation of the noxious dust, we had lost energy to excavate to its bottom, the last and lowest layer" (Mercer 1897:67).

Mercer (1897) defined four layers in his excavation. Layer 1 had a depth of 2 to 3 inches from the surface and contained objects of later age than the bones, or of "doubtful antiquity". Layer 2 had a thickness of 2 to 2.5 feet and contained the ground sloth bones and objects as old as the bones. Layer 3 was one foot thick and contained objects older than the bones. Layer 4 was not completely excavated and had an unknown depth. Mercer also identified disturbances in the stratigraphy that he attributed to burrowing rodents. This is Mercer's conclusion:

> A categorical demonstration that this individual animal was a contemporary of the geologically recent Indian in Tennessee must be abandoned. But the reasonable inference of such association remains. Though the human handiwork, in the form of charcoal and torch refuse . . . lay really on the surface (Layer 1), from six inches to one foot above any sloth bones found; we may justly be satisfied with the recent significance, broadly regarded, of the whole record, and with the

> absence of plants and smaller animals of any extinct or positively ancient form (Mercer 1897:69).

Mercer (1897:58) identified various remains in Layer 1, that is, objects of a later age than the bones or contemporary with the aboriginal or white exploration of the cave. Included in this list are moss (*Hypnum* sp.), charred twigs of hazel (*Corylus americana*), charred resinous yellow pine (*Pinus mitis*), charred and uncharred cane (*Arundinaria* sp.), and various nuts and acorns which were attributed to the denning of cave rats.

Mercer believed that the charred resinous pine, hazel twigs, and cane stalks were the remains of torches of the white miners and the Indians who preceded them. He further interpreted the pieces of resinous pine as remains of the saltpetre miners and other whites because many fragments appeared to have been split and cut with iron tools, and he believed it reasonable to assume that at least some of the cane had been cast away by Indians (Mercer 1897:43).

Following Mercer's work, archaeologists neglected Bone Cave for the next 85 years. It may have been assumed that all evidence of aboriginal activity in the cave had been destroyed by the mining and casual collecting of artifacts. However, cavers, primarily members of the NSS, continued to make observations on the archaeological remains in Big Bone Cave. A good example is Matthews (1979); also see Matthews (1980) for other references.

Speleologists are responsible for the present interest in the archaeology of Bone Cave. In late 1981 and 1982 several members of the NSS made a series of discoveries and initiated communication with professional archaeologists to bring attention to the site. Their discovery was "some type of animal 'scat' (dung). The object was extremely large and oddly shaped, resembling the top of an ice cream cone" (Blair and Sneed 1983:211). This dung was identified as human, comparable to many of the specimens found in Salts Cave, Kentucky (Watson 1969). In subsequent trips numerous torch fragments, other perishable debris, and one complete artifact, a textile bag of open-twined weave with a drawstring closure, were discovered.

On July 25, 1982 professional archaeologists and representatives of the Tennessee Department of Conservation met with the cavers at Big Bone Cave to examine the archaeological material recently discovered and their setting (Watson 1982). The trip was planned primarily as a reconnaissance of the area where the drawstring bag was found. Watson (1982) recorded the aboriginal materials from this passage in a summary fashion and collected three samples for radiocarbon dating. The radiocarbon determinations of these samples are discussed later. Watson's work led to a systematic archaeological survey of the entire cave by the University of Tennessee in 1985 (Crothers 1986).

V. THE ARCHAEOLOGICAL SURVEY

Research Design

By any standards Big Bone Cave is a large cave, totaling over 15 kilometers of mapped passages. The size of this cave necessarily influenced the design of the archaeological survey. The purpose of the survey was primarily to document the extent of human activity and secondarily to make observations on the intensity and integrity of cultural remains in the cave. In this sense the survey may be more aptly termed an archaeological reconnaissance, intended as a preliminary investigation to provide information for making decisions on managing the archaeological resources (Crothers 1986) and for designing future research.

The objectives of the survey were to define sensitive archaeological areas, the variety of prehistoric remains, integrity of the deposits, the nature of prehistoric activity, and to obtain a series of radiocarbon determinations to date this activity. The priorities established during the survey to fulfill these objectives were to (1) systematically survey the most accessible areas of the cave, (2) identify the major areas and extent of historic disturbance, (3) record the presence and absence of prehistoric material, (4) maintain a relative measure of the quantity and integrity of prehistoric deposits, and

(5) select samples that would radiocarbon date the range of prehistoric activity in the cave.

Field Methods

The 15.5 km of mapped passages were divided into nine survey areas. Each area was designed to be completely surveyed in one underground trip lasting approximately eight to ten hours. A final trip was required to collect material for radiocarbon dating. Survey parties were composed of three to seven members. Survey of the nine areas was actually completed in eight trips and radiocarbon samples were collected during the ninth trip. Details of each trip (date, area surveyed, list of members, and time spent underground) are contained in Crothers (1986).

The field procedures consisted of recording observations on each passage as it was systematically encountered and traversed. Presence and absence of cultural material, variety and relative quantity of this material, evidence of disturbance or modification to the passage, and the nature of the passage (e.g. difficult access, rocky crawl, walking passage) were recorded on photocopied portions of the cave map and supplemented with more detailed notes in a field book when appropriate. Photographs of selected artifacts in context were made to supplement descriptive observations. These were intended to be representative of the variety of remains and their contexts. Much of the prehistoric material observed in the cave was considered to be in situ and a decision was made not to collect any remains until more detailed mapping and recording could be made.

In general it was not feasible to survey all of the area designated. Modern cave exploration and mapping far exceeds the bounds of early historic or prehistoric cave exploration. In many instances remote sections of the 15.5 km of passages were virgin (i.e. previously unexplored by humans) when first entered by the mappers. It was not necessary to survey these portions of the cave for the purposes of archaeology.

Emphasis was placed on noting where cultural material began and ended in each passage. However, complete artifacts and items of special interest were indicated directly on the map. The detail and accuracy of the cave passages on the map allowed items to be located within a few meters of their exact location by relating them to points of reference, shape of the passage, and intersections in the cave. This was only intended for tentative interpretations and planning. Detailed mapping and recording of artifacts should be included as part of a larger research project.

All observations were limited to material on the surface of the cave floor. The depth of archaeological deposits was not ascertained. It is assumed that in general the depth of material would be shallow because of the stable environment in the cave. However, movement of sediment by saltpetre miners or other historic activity, or by the aboriginal explorers may have resulted in the burial of original surfaces. Further recording and detailed analysis of the cave passage are necessary to identify the isolated contexts where subsurface remains may exist.

It is not always clear what remains can be ascribed to prehistoric activity and what can be ascribed to historic activity. A review of the evidence from other dry cave sites (Freeman et al. 1973; Munson and Munson 1981; Watson 1969; Watson ed. 1974) indicates that torch material is ubiquitous wherever prehistoric activity has occurred in the total darkness of the cave environment. Torch material that has been identified in prehistoric contexts includes cane, weed stalks, woody sticks and twigs, and hickory bark. Commonly associated with this material is charcoal, charcoal smudges on the cave walls, rough bark or vegetal torch ties, and a myriad of other vegetal and perishable materials.

Pine splints have been identified in numerous areas of Bone Cave and one radiocarbon determination has been obtained on this material (Watson 1982). Whether this material can be ascribed exclusively to either historic or prehistoric exploration is debatable. However, there is at least one reference (Troost 1834-35:237) on the use of resinous pine torches during the early historic period in Big Bone Cave. Mercer (1897) also believed that the pine splints were the remains of the early white explorers and miners because of the iron tool cutting marks observed on several specimens. This observation was also made by the archaeological survey parties. One pine splint was also found with a small fragment of charred historic textile wrapped around one end.

Other evidence of historic activity, especially the saltpetre mining, is usually unmistakable. The saltpetre mining impacted the cave environment to a greater degree than occurred at any other time. Construction of the leaching vats, water pipe system, walkways, and ladders, removal of the cave sediment, in some areas to a depth of several feet, and the dumping of leached sediment have altered the original surface beyond recognition. It is rare when the mining operation has not completely destroyed all evidence of previous aboriginal activity that may have existed in that portion of the cave.

Results

Results of the survey for each of the nine areas are discussed separately. The complete Big Bone Cave map, produced by Ronald Zawislak and John Smyre, is reproduced as Figure 2. General locations in the cave are identified by the name of the passage or direction and relationship to

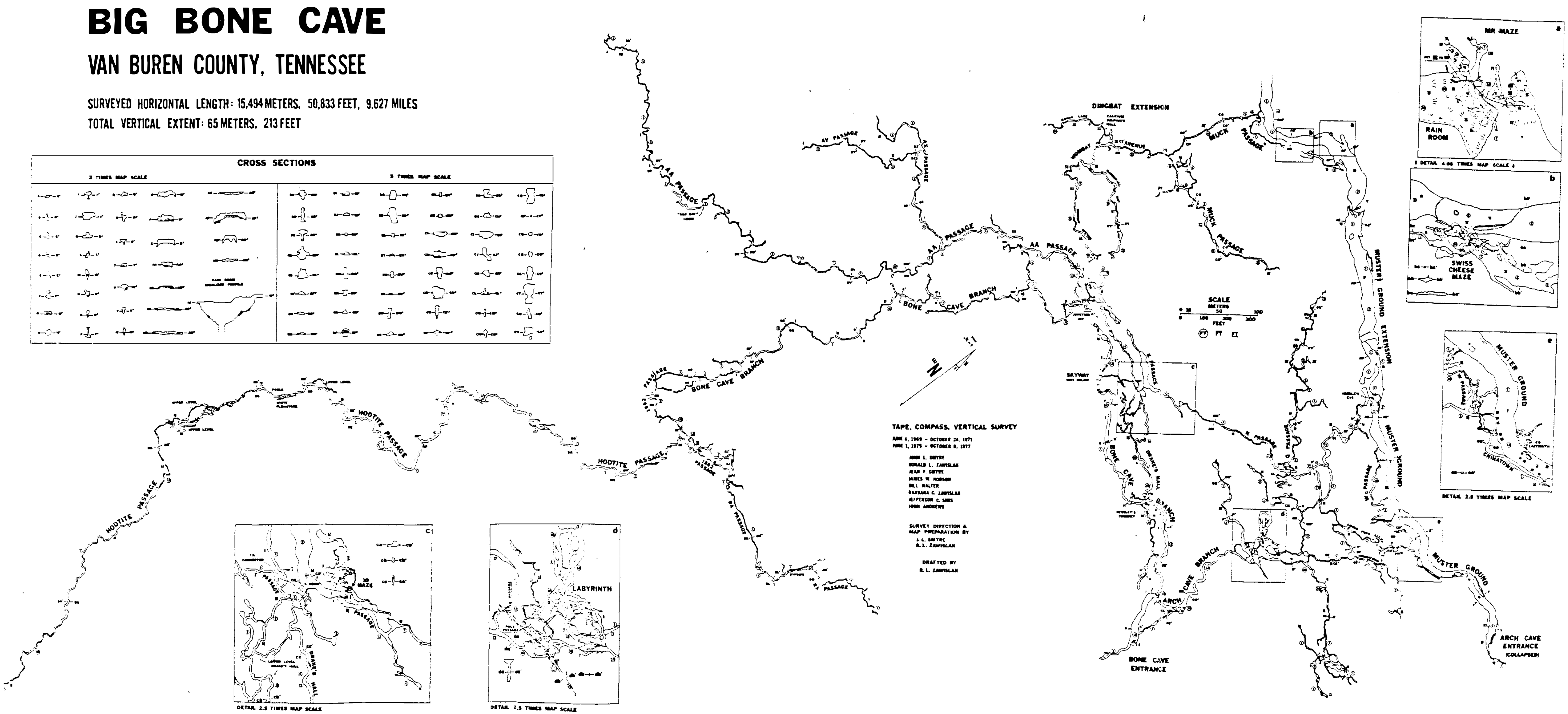

Figure 2. Map of Big Bone Cave (1979 revised edition by R. L. Zawislak and J. L. Smyre).

the nearest named passage. Passages in the cave have generally been named three ways. Some of the passages were named historically (e.g. Arch Cave Branch, Bone Cave Branch, Muster Ground, Chinatown, etc.), and these names are still used today. Some of the passages were named by the mapping crews (e.g. Muck Passage, Hodtite Passage, Ching Fui's Alley, etc.). And several of the passages are designated by their survey letter(s) (e.g. AA Passage, W Passage, RA Passage, etc.) used by the mapping crews. However, some of the passages are unnamed.

Survey Area 1

Survey Area 1 encompasses the left or Bone Cave Branch of Big Bone Cave from the entrance to the Junction Vat Room. It is a large walking passage ranging from 1.5 to 7.6 meters in height. The passage is damp from the entrance to approximately the Drake's Hall intersection and preservation is poor. Beyond Drake`s Hall the cave is dry and preservation is excellent.

Historically this is a very important and intensely utilized portion of the cave. The most complete remains of the saltpetre works are located beyond Drake's Hall, including the largest number of square vats, scaffolding that supported the water pipes, complete segments of augered tuliptree water pipes, and a walkway, called the Skyway, constructed above some of the vats.

The greatest portion of sediment in the Bone Cave Branch was removed during the mining. Debris from construction of the saltpetre works (wood slats, shavings, and lumber) is evident throughout the passage. Other modern trash is also common: bottle glass, cans, gum wrappers, etc.

The entrance area is also known historically to be an area of saltpetre processing. At least one mold of a decayed leaching vat is evident in this area. It is possible that prehistorically the Bone Cave entrance was occupied by humans. However, the original configuration of the entrance has been greatly altered by the extensive deposits of leached sediment deposited there and it is no longer possible to ascertain whether it was once an aboriginal habitation site.

Despite the continuous disturbance in the passage from the mining, isolated vestiges of prehistoric material were observed among the saltpetre remains. The most notable artifact discovered was an intact gourd container (see Prehistoric Cultural Remains). Other material observed includes a fecal specimen, cane, cane charcoal, a large plant fiber (looped and tied with a slip knot), and other fiber torch ties.

The most direct route to all other passages of the left branch of the cave is through the main Bone Cave Branch. It is no longer possible to ascertain the intensity of activity that occurred prehistorically in this area of the cave. Presumably aboriginal utilization in the Bone Cave Branch was as great or greater than any other section of the cave for which we have information, that is, if we assume that with increasing distance from the entrance the ability to sustain an activity decreases. However, alternatively, if the object or intent of activity existed only beyond the area nearest the entrance then material residue may exist in isolated concentrations without respect to the distance from the entrance.

Survey Area 2

Survey Area 2 encompasses the continuation of the Bone Cave Branch from the Junction Vat Room and includes the 1862 Passage, the Hodtite Passage, and the RA Passage. The Junction Vat Room is located at the intersection of three main passages and contains at least five well-preserved square saltpetre vats. The extreme left passage is the continuation of the Bone Cave Branch and has several short side passages. In 1956 one of the side passages was found to continue and apparently had not been entered since the late nineteenth century. It was named the 1862 Passage because copies of a newspaper bearing that date were found there. Signatures and newspaper fragments with earlier dates were also found (Barr 1957). The 1862 Passage also has several branches and cut-arounds, including the Hodtite

Passage which is the single longest passage in the cave.

The Bone Cave Branch continuation is an area with extensive prehistoric remains that appear to be relatively undisturbed. However, historically this section of the cave was well-explored as indicated by the numerous signatures and historic debris including pine torch stubs, textile fragments, and a feather pillow.

The first side passage to the right in the Bone Cave Branch from the Junction Vat Room is the area of the discovery of the open-twined weave bag (Blair and Sneed 1983). Watson (1982) radiocarbon dated three samples from this crawlway. This crawlway also connects with the AA Passage (see Survey Area 3) through a small hole in the ceiling.

Prehistoric remains in the crawlway are similar to those found in the main Bone Cave Branch. The remains include a more or less continuous scatter of spent torch fuel (cane, sticks, and twigs), charcoal, charcoal smudges, loosely bound and knotted fiber ties, and occasional fragments of gourd and squash fruit, cordage, sunflower achnes, and human fecal specimens. Two torch samples (Samples C-9 and C-11) from the Bone Cave Branch have been dated.

Prehistoric remains begin to decrease in quantity before the end of the Bone Cave Branch where the ceiling height drops to approximately 0.6 meters. However, isolated material was observed well into the 1862 Passage and we must assume that this remote region of the cave was at least occasionally entered by the prehistoric cavers.

The archaeological survey was halted at the beginning of the RA Passage and did not include the Hodtite Passage. Both passages are over 75 meters beyond the greatest concentrations of prehistoric remains observed in the Bone Cave Branch.

Survey Area 3

Survey Area 3 encompasses the AA, AY, and AX passages. Passage size varies from a ceiling height of 0.3 to 2.7 meters. There are two ways to enter the AA Passage and both are through very small constrictions in the passage. One route is from the Junction Vat Room and the other is through the first crawlway from the Bone Cave Branch.

The AA Passage contains extensive deposits of prehistoric material, comparable to the Bone Cave Branch, but relatively less disturbed. This lack of disturbance is probably due to the difficult access. However, historic remains, most notably resinous pine torch stubs, were observed throughout the passage. There is no indication that saltpetre was mined from this area.

Prehistoric debris is scattered uninterrupted from the beginning of the AA Passage and continuing approximately 80 meters beyond the AX Passage intersection. Prehistoric material was not found beyond this point in the AA Passage or in the AX Passage. The archaeological survey was discontinued approximately 60 to 90 meters beyond the last observed concentration of material.

The types of remains observed compare to that found in the Bone Cave Branch. Torch debris is most common. Other remains observed include numerous knotted fiber ties, several large fragments of gourd and squash, long pieces of two-ply, S-twist cordage, human fecal specimens, moss, and two (presumably a pair) woven slippers or moccasins (see Prehistoric Cultural Remains). Two torch samples (Samples C-4 and C-7) from the AA Passage have been dated.

Prehistoric remains in the AA Passage appear to be relatively undisturbed other than some scuffling of the sediment from the passing of infrequent traffic. A film of soot and dust coats everything in the passage and contrasts with the orange-brown sediment underneath when disturbed. Based on this observation the greatest portion of material appears to be in its original prehistoric context.

Survey Area 4

Survey Area 4 encompasses all of Drake's Hall and its lower levels from the Bone Cave Branch to the K Passage. Upper Drake's Hall is a narrow canyon varying from 1.5 to 6.7 meters in height. Lower Drake's Hall averages 1.5 meters in height.

The main portion of Drake's Hall has been extensively mined for saltpetre. Several decimeters of sediment have been removed from the areas nearest the Bone Cave Branch. Large hand cut timbers have been placed through much of the upper part of the passage to facilitate traffic. A search of the present floor revealed only fragments of timber and historic debris. No prehistoric remains were observed.

The far end of Drake's Hall nearest the K Passage contains a considerable amount of pack rat (*Neotoma floridana*) debris that appears to reach a depth of several decimeters in the intervening crevices of the canyon. It is in this area that a cervical vertebra of the ground sloth was recently discovered.

The extension of Drake's Hall on the northwest side of the Bone Cave Branch was briefly surveyed with negative results. The passage is damp and would not preserve perishable material. No other evidence of prehistoric exploration (e.g. charcoal or torch marks) was found.

Survey Area 5

The Arch Cave Branch, the Labyrinth, and three unnamed sections of passage comprise Survey Area 5. Passage height ranges from 0.6 to 4.0 meters. However, the Labyrinth is a complex maze of intersecting passages and erosional remnants of limestone dividing a much larger room into segments. The ceiling reaches a height of 10.7 meters in the Labyrinth.

Historically this area of the cave was well traveled and explored. Saltpetre dirt has been excavated from many of the passages. There is some indication that leaching vats or some other wooden construction may have been used in the Labyrinth. However, they have decayed or been removed. Signatures and dates are very common throughout this area. The probable location of the ground sloth remains was in the Labyrinth (see Crothers 1986 for discussion).

A short segment of unnamed passage (approximately 30 to 45 meters in length) heading west from the Labyrinth contains a relatively moderate but continuous scatter of aboriginal torch debris, predominately charred cane and twigs. Radiocarbon determinations were made for two samples from this passage (Samples C-1 and C-3).

Isolated prehistoric debris, again predominately torch remains, were observed elsewhere in Survey Area 5 but the original floor deposits are no longer intact. Evidence of extensive or sustained prehistoric activity in this portion of the cave is scanty.

Survey Area 6

Survey Area 6 encompasses the K Passage, Q Passage, and the Needle's Eye route of the Arch Cave Branch.

Ceiling height varies from 0.6 to 6.1 meters.

The Needle's Eye route is well-traveled and numerous historic signatures are located on the walls. There has been at least a moderate amount of saltpetre mining in these areas. Evidence of historic exploration was prevalent as indicated by the numerous charred pine splints, especially at the beginning of the Q Passage and throughout the K Passage. A hand-made runged ladder is located in the first cut-around in the Q Passage. Beyond this point the passage is very small and little exploration appears to have occurred. The archaeological survey was halted at this point in the Q Passage.

Prehistoric remains were not observed in this area of the cave. Saltpetre mining does not appear to have been intensive enough to have destroyed completely all evidence of prehistoric activity. It is assumed that aboriginal exploration did not encompass this portion of the cave.

Survey Area 7

Chinatown, Ching Fui's Alley, the W Passage, and associated passages comprise Survey Area 7. Passage height is generally 1.2 to 1.8 meters.

Chinatown is a well-traveled portion of the cave, connecting the Arch Cave Muster Ground with the Labyrinth. Modification to all these passages is extensive, sediment has been removed and the rock stacked along the walls in many areas. Pine torch debris is common.

Prehistoric material (cane and fiber ties) was noted in isolated contexts, but no continuous scatters were identified. Aboriginal visitation probably occurred but the intensity and nature of activity can not be ascertained.

Survey Area 8

Survey Area 8 is the Muster Ground of the old Arch Cave. This is the largest passage in the cave. The ceiling height is between 1.2 and 14.0 meters and the average width is over 7.6 meters.

The Muster Ground is one of the two most historic areas in the cave. The name is purportedly derived from the story that miners and Confederate troops were mustered in this area before beginning work. Saltpetre mining was extensive but only a few of the saltpetre works remain. There is considerable evidence that numerous more vats were once in use, but most have decayed or have been removed.

The Arch Cave entrance was apparently once intensely used. On the surface near the collapsed sink are numerous large unnatural mounds of soil and rock, presumably tailings from the saltpetre mining. Portions of an abandoned road and rock walls and features are also evident.

No evidence of prehistoric activity has been found in the Muster Ground. Either the mining was so intense to completely destroy or obscure all vestiges of this earlier activity or the Arch Cave entrance was not utilized prehistorically. Presumably, if the Arch Cave entrance was open prehistorically, then the aborigines must have been aware of the cave.

Survey Area 9

The Muster Ground Extension and a series of passages referred to as the Dingbat Extension comprise the ninth survey area. The Muster Ground Extension is a wide passage, but the ceiling height is rarely greater than 0.9 to 1.2 meters.

The Muster Ground Extension has not been heavily visited. A few charred pine splints were found indicating that at least the passage was entered by early historic explorers. No other activity has taken place there. The remains of a Pleistocene jaguar (*Panthera onca*) were discovered in the Muster Ground Extension in 1970 by a mapping crew (Guilday and McGinnis 1972).

It was hoped that if the Muster Ground had been utilized prehistorically then there might be some indication that the aboriginal explorers also entered the Muster Ground Extension. However, no evidence of aboriginal exploration was found. The archaeological survey was discontinued at the Rain Room, a deep pit at the end of the Muster Ground Extension, and did not include the Dingbat Extension.

Summary

Remains from the prehistoric exploration and utilization of Big Bone Cave were found in good context and uninterrupted association in three areas. They are, in increasing order of integrity, the unnamed passage west of the Labyrinth (Survey Area 5), the Bone Cave Branch beyond the Junction Vat Room (Survey Area 2), and the AA Passage (Survey Area 3). Two radiocarbon samples were dated from each of these areas.

Isolated and fragmentary aboriginal remains were found in portions of the main Bone Cave Branch, the Arch Cave Branch and the Labyrinth, and Chinatown (Survey areas 1, 5, and 7, respectively). No evidence of prehistoric utilization or visitation was found in Drake's Hall, Needle's Eye route, the Muster Ground, or the Muster Ground Extension (Survey areas 4, 6, 8, and 9). However, the absence of material in Drake's Hall and the Muster Ground may be due to the disturbed nature of the deposits.

Two areas of the cave contain well-preserved remains of the saltpetre mining period. They are the Bone Cave Branch from Drake's Hall to the Junction Vat Room (Survey Area 1) and the Muster Ground (Survey Area 8). Secondary remains of historic activity were found in the Bone Cave entrance area (Survey Area 1), the Labyrinth (Survey Area 5), and the Q Passage (Survey Area 6). These are former areas of saltpetre mining or construction efforts to aid in the mining (e.g. ladders and walkways).

Excavation of saltpetre earth was intense in the Bone Cave Branch, Drake's Hall, and the Muster Ground (Survey areas 1, 4, and 8). Removal of sediment also occurred in a more limited and less intense fashion in Survey areas 2, 5, 6, and 7. There does not appear to have been any mining in the AA Passage (Survey Area 3) or the Muster Ground Extension (Survey Area 9). Difficult access to these areas is probably the reason for the limited historic activity.

VI. INTERPRETATION AND DISCUSSION

Prehistoric Cultural Remains

The types of prehistoric remains found in Big Bone Cave are generally of four classes of material: torch debris, miscellaneous vegetal remains, human paleofecal specimens, and perishable artifacts. The classes of material generally found on open-air archaeological sites -- chert and modified stone, ceramic, bone, and shell -- have not been found in prehistoric contexts in Big Bone Cave.

Torch Debris

The remains of aboriginal torches, charred ends of spent torches, charcoal, and charcoal marks caused by a torch being struck or stubbed against the wall, are the most common remains found in the cave. Any activity beyond the daylight area of the entrance requires the use of some kind of material to produce light. Consequently, torch debris was the most useful indicator of aboriginal activity and was used to define the limits of prehistoric exploration during the archaeological survey. A typical scatter of torch debris is illustrated in Figure 3.

A variety of materials from prehistoric contexts has been identified as torch fuel. Cane (Arundinaria sp.) and dried weed stalks (predominately Gerardia and Solidago)

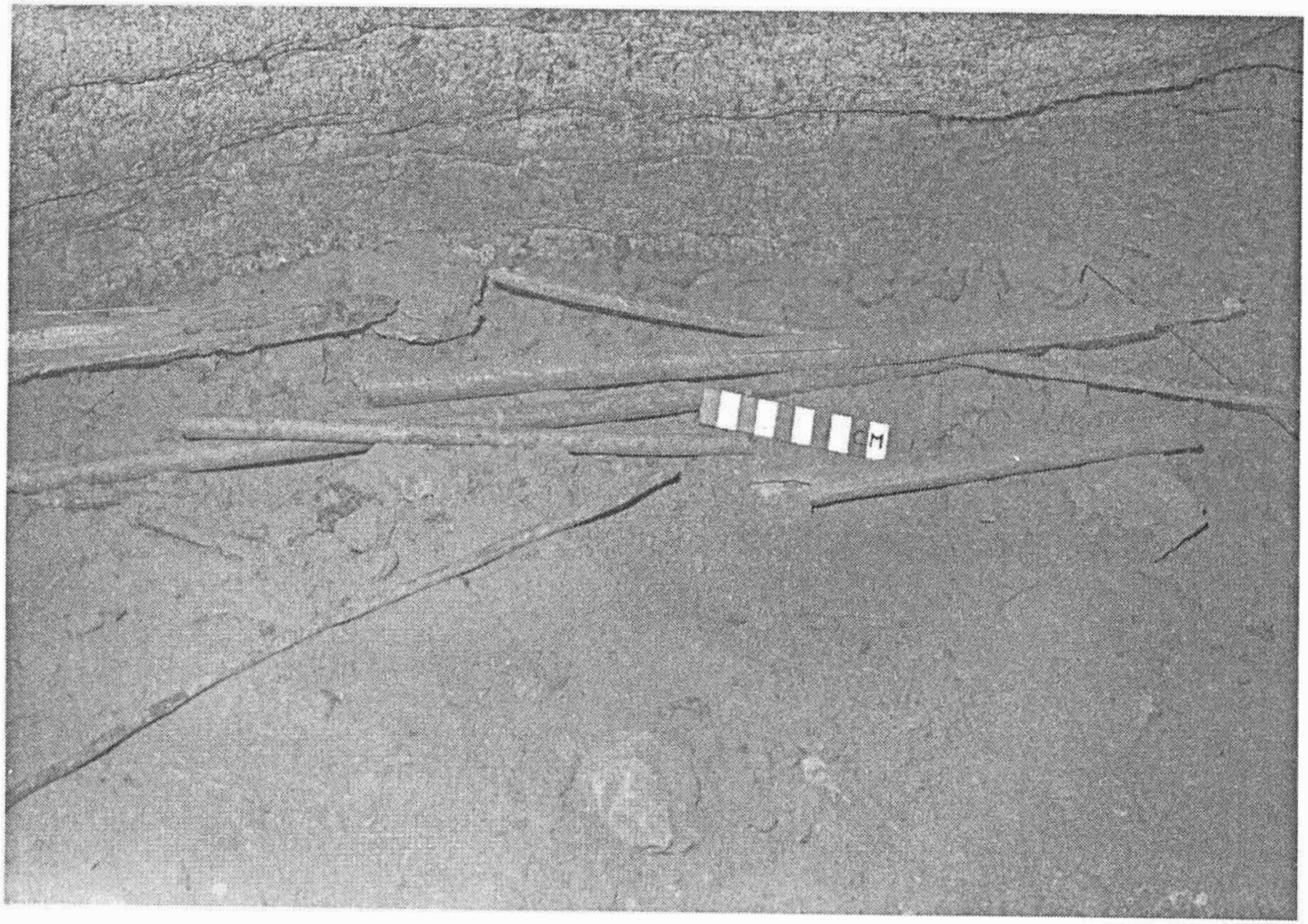

Figure 3. Torch debris in situ in the unnamed passage west of the Labyrinth.

were the most common materials identified from Mammoth and Salts caves, Kentucky (Watson 1969; Watson ed. 1974). Strips of hickory bark (cf. *Carya ovata*) were extensively used in Wyandotte Cave, Indiana, but other torch material includes giant ragweed and an unidentified cane-like material (Munson and Munson 1981). Commonly associated with torch fuel in both Mammoth and Salts caves and Wyandotte Cave are strips of bark and bast fibers usually looped and knotted with diameters of 5 to 13 cm and believed to be ties for bundling the torch material.

Experiments have been conducted to assess the efficiency and reliability of the numerous materials used as torch fuel (Ehman 1966; Watson 1969:33-36; Munson and Munson 1981:27-28). In general these experiments have indicated that the prehistoric materials used provide a satisfactory and reliable source of light and that it is possible to take extended trips into a cave without cumbersome amounts of fuel.

Material identified as torch remains in Big Bone Cave include cane and a variety of woody twigs and sticks. The use of weed stalks and hickory bark has not been identified. However, recording and identification of torch material has not been exhaustive. Superficial analysis indicates that cane (*Arundinaria gigantica*) predominates in the archaeological assemblage. Twigs and sticks of various woody plants were also commonly used as torch fuel. Three species have been identified among the woody torch material. They are hazel (Corylus americana) (Mercer 1897:58), Prunus sp., and hickory (Carya sp.). Radiocarbon determinations have been obtained on the latter two of these remains.

Torch marks on the cave walls are commonly found in association with areas of aboriginal material. However, in many areas torch marks are obscured by soot, dust, and signatures, and can not always be distinguished from the marks of the early saltpetre miners, who commonly used pine splints as torches.

Miscellaneous Vegetal Remains

This class of material is a catch-all category for the various materials in the cave whose use or origin is not known. This includes numerous wads of moss, leaves, sunflower achnes, strips and tangled coils of plant fiber, and various nut hulls. It is probable that at least some of this material, especially the nut hulls, were brought into the cave by pack rats. Other material may have been used as tinder, stuffing or packing, and as food by the aboriginal explorers or they may be incidental deposits.

Human Paleofeces

Fecal deposits of the aboriginal explorers could be one of the most useful and informative classes of remains found in Big Bone Cave. They provide the most direct evidence of prehistoric diet and subsistence and potentially may contain information relative to the early domestication and processes of plant food production in the Eastern Woodlands. Intensive analysis of the fecal remains from Mammoth and Salts caves (Yarnell 1969; various in Watson ed. 1974) was one of their most rewarding avenues of investigation.

Human feces of various shapes and sizes were observed primarily in the AA Passage and the Bone Cave Branch crawlway and secondarily in the Bone Cave Branch. Typical specimens are illustrated in Figure 4. There is some concern about the ability to identify human fecal specimens in the cave environment from that of other animals. This question, which has been addressed by Watson (1969:41), does not occur to those who have seen the context in which these specimens are found. In all instances in Big Bone Cave, fecal specimens are associated with unmistakable evidence of human visitation. Both the number of specimens and the considerable distances they are found from the entrance tends to support the belief that they are human products. Further evidence to support this belief includes both the size, shape, and content of the specimens. However, as a cautionary note, some of the fecal deposits may only date to the nineteenth century saltpetre mining.

Figure 4. Human paleofecal specimens in situ in the Bone Cave Branch crawlway.

Perishable Artifacts

Artifacts are distinguished from other material remains in that they are formal objects modified by a set of humanly imposed stylistic and functional attributes (cf. Clarke 1978:206). The types of perishable artifacts can include cordage, basketry, fabric, modified gourd or squash fruit, and modified wood.

Perishable prehistoric artifacts are relatively rare and incompletely documented from sites in the eastern United States. Preservation of these types of remains is usually limited to dry caves and rockshelters. Consequently, sites like Big Bone are not only rare, but limited geographically.

Perishable artifact assemblages documented from dry cave sites include Mammoth and Salts caves (Orchard 1920; Watson 1969, ed. 1974; King 1974) and Wyandotte Cave (Munson and Munson 1981), as previously mentioned. Dry rockshelter or bluff shelter sites are slightly more common and provide similar varieties of perishable materials. Perishable remains have been recovered from eastern Kentucky (Funkhouser and Webb 1929, 1930; Webb and Funkhouser 1936; Jones 1936; Cowan et al. 1981), southern Ohio (Shetrone 1928), and the Ozark Mountains of Arkansas and Missouri (Fowke 1922; Gilmore 1931; Harrington 1960; Scholtz 1975).

Although Tennessee is ideally situated for the location of numerous dry rockshelter and cave sites, little archaeological work has been directed toward recording them. Undoubtedly many sites have been destroyed or looted beyond study. Only a few notes have been made by archaeologists on the perishable remains from dry sites in Tennessee (Hassler 1947; Lewis 1947; Guthe 1964), and only one field project has been initiated to excavate and analyze the remains from a dry rockshelter (Hall 1985).

Perishable artifacts were noted in several of the early descriptions of Big Bone Cave. There are several references to a "fishing net" (Maddox 1813-14; Clifford 1820) or "scoop net" (Haywood 1959) made of "bark silk" or "thread" and a "moccasin" made of similar material. Clifford describes the moccasin as being "made from a species of rattle." Perhaps rattle refers to the common name, "rattlesnake master," for Eryngium yuccaefolium, the fiber of which is commonly identified in prehistoric contexts (Whitford 1941:120).

The most notable artifact discovered was described as a "mat" (Haywood 1959:57) or "envelope" (Clifford 1820:36) which contained the bones or mummified remains of a human. The mat or bag is described as woven in a loose mesh with feather-wrapped cordage.

Comparable to the Bone Cave "mummy" or burial was the discovery, approximately at the same time, of two well-preserved and elaborately interred prehistoric bodies from a cave in nearby Warren County, Tennessee (Miller 1812). The cave is described as being located on the Caney Fork of the Cumberland River, 10 miles below the falls. The cave was being mined for "copperas" and the burials were found six feet below the floor of the cave.

A complete bag of open twined weave with a drawstring closure was collected recently in Big Bone Cave (Blair and Sneed 1983). It appears comparable to a bag of open twined weave discovered in Salts Cave, Kentucky (Orchard 1920:17-19). The Bone Cave specimen has been deposited with the Tennessee Division of Archaeology (Artifact #1./F.S. No. 82-28).

Perishable artifacts observed during the archaeological survey include numerous fragments of cordage, gourd container fragments, one complete gourd container, and two woven slippers.

Isolated fragments of cordage, predominately 2-ply, S-twist, were observed among the archaeological debris in the Bone Cave Branch and AA Passage. The most notable specimen recorded was a 1.0 m length of 2-ply, S-twist cordage with Z-spun elements. One end of this cord was knotted to the middle of a 0.75 m length of unidentified raw plant fiber. This artifact was found in the AA Passage.

Gourd container fragments were observed in numerous areas of the Bone Cave Branch and AA Passage. A concentration of large gourd fragments is located near the end of the prehistorically utilized AA Passage. One complete container specimen was found in the historic section of the Bone Cave Branch and is illustrated in Figure 5. Permission was obtained from the Tennessee Divison of Archaeology to remove this artifact from the cave for study.

The container is made of a large, thick-walled bottle gourd (Lagenaria siceraria) cut lengthwise from the stem to the flower scar. The gourd is pear-shaped and measures 30 cm from stem to base and 25.5 cm across the widest part of the fruit. The thickness of the shell varies from 5.8 mm near the stem to 9.4 mm near the flower scar. The mean shell thickness taken from six measurements at various points along the rim is 7.1 mm. This is rather thick compared to gourd fragments found at Phillips Spring, Missouri (King 1985:82), Salts Cave (Yarnell 1969:51), and Cloudsplitter Rockshelter, Kentucky (Cowan et al 1981). which have mean shell thicknesses of 1.9 mm, 4.9 mm and 5.2 mm, respectively. A fracture near the stem of the gourd had been mended using a 2-ply, Z-twist cord with an alternating loop stitch.

A veneer of material adhering to the inner portion of the container was removed during cleaning of the artifact and sorted under low magnification. The residue, weighing

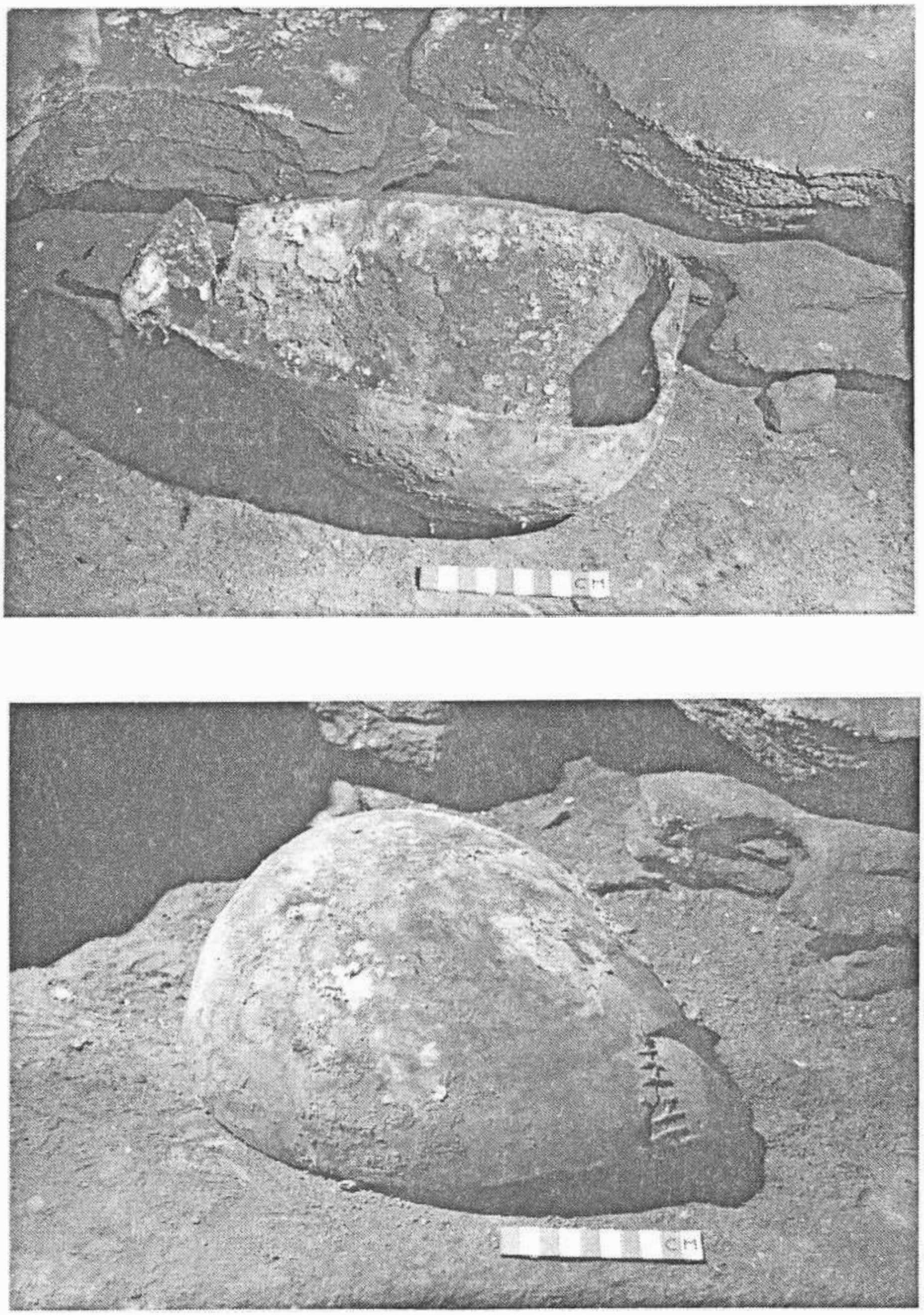

Figure 5. Complete gourd container discovered in the Bone Cave Branch.

40.3 gms, is composed of sunflower (Helianthus annus) achnes, bat excrement, rock fragments, mold, dust, and strands of hair.

One other gourd fragment was found that had been repaired with 2-ply cordage. This artifact, illustrated in Figure 6, was found near the end of the AA Passage. The repair is made with a simple cross stitch. Several of the gourd fragments identified during survey appear to be rim sections of containers or bowls. Squash fragments are relatively rare in the cave and no complete artifacts were found.

A pair of slippers found in the AA Passage were the only woven artifacts found during the survey and are shown in Figure 7. The construction of these slippers has not been analyzed in detail because they were found in situ and were not handled. Both appear to be toe sections missing the heels and are presumed to be a matching pair.

One of the slippers is lying right-side-up and measures 16.5 cm from the toe to the torn end. The total width across the ball of the foot is 9.7 cm and would accommodate a foot width (at the ball) of 7.8 cm. The second slipper, lying up-side-down, is 17.0 cm long from the toe to the torn end and the foot width is 7.9 cm.

Figure 6. Cross-stitch mended gourd container fragment discovered in the AA Passage.

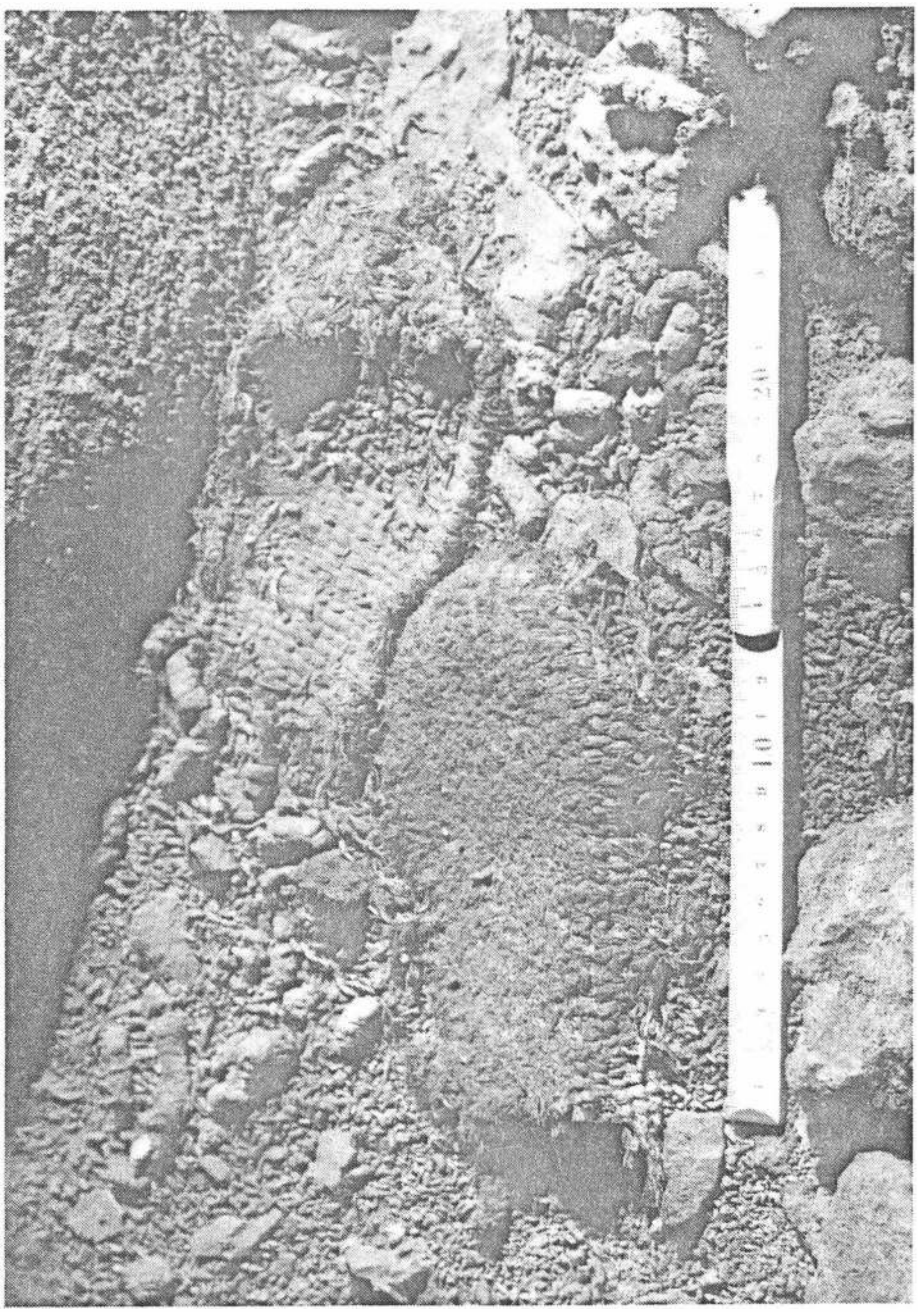

Figure 7. Pair of woven slippers in situ in the AA Passage.

Radiocarbon Determinations

Nine samples have been radiocarbon dated from Big Bone Cave. Three of the samples were collected by Watson (1982), the remaining six samples were collected during the archaeological survey. Two samples were dated from each of the three passages that contained continuous scatters of prehistoric material. Watson dated three samples from the crawlway containing the twined bag which connects the Bone Cave Branch to the AA passage.

The determinations are uncorrected and reported as radiocarbon years before A. D. 1950. The quoted errors represent one standard deviation (68% probability), based on the random nature of the radioactive disintegration process.

1. 440 + 55: A. D. 1510 (SI-6014) - Watson's sample #3 was a fragment of _Pinus_ wood charred on one end and was collected near the woven bag findspot in the Bone Cave Branch crawlway.

2. 1595 + 55: A. D. 355 (SI-6013) - Watson's sample #2 consisted of 16 _Prunus_ twigs that were collected in the Bone Cave Branch crawlway near the woven bag findspot.

3. 1615 + 60: A. D. 335 (SI-6012) - Watson's sample #1 consisted of three fragments of woody grape vine (_Vitis_ sp.) that were collected near the end of the Bone Cave Branch crawlway.

4. 2120 + 60: 170 B. C. (Beta-13972) - Sample C-11 consisted of ten twigs identified as predominately, but not exclusively, hickory (Carya sp.). This sample is from the Bone Cave Branch between the Junction Vat Room and the crawlway. Most of the twigs were charred on one end. Weight before radiocarbon assay was 38.3 gms.

5. 2170 + 60: 220 B. C. (Beta-13970) - Sample C-7 consisted of four large stalks of cane (Arundinaria gigantica) from the far end of the AA Passage. Each stalk was charred on one end. Weight before radiocarbon assay was 86.1 gms.

6. 2230 + 70: 280 B. C. (Beta-13971) - Sample C-9 was a single large stick (cf. Carya sp.), charred on one end, and collected from the far end of the aboriginally explored Bone Cave Branch. Weight before radiocarbon assay was 25.2 gms.

7. 2340 + 60: 390 B. C. (Beta-13969) - Sample C-4 consisted of 15 twigs, predominately hickory, most charred on one end. This sample is from the AA Passage near the slipper findspot. Weight before radiocarbon assay was 36.0 gms.

8. 2380 + 70: 430 B. C. (Beta-13967) - Sample C-1 consists of three large sticks (cf. hickory) from the unnamed passage west of the Labyrinth. Two of the sticks were charred on one end. Weight before radiocarbon assay was 17.4 gms.

9. 3000 + 70: 1050 B. C. (Beta-13968) - Sample C-3 consisted of three large stalks of cane (Arundinaria gigantica) from the unnamed passage west of the Labyrinth. Each stalk was charred on one end. Weight before radiocarbon assay was 42.3 gms.

Seven of the nine radiocarbon samples were presumably the remnants of aboriginal torches. It is not clear what use the woody grape vine may have had in the cave. It is probable that the pine wood is not an aboriginal artifact, but rather the remains of a saltpetre miner's or early historic explorer's resinous pine torch.

The other eight radiocarbon determinations span a period of 1400 years, from the Terminal Archaic to the late Middle Woodland period. However, the majority of determinations date to the Early Woodland period. This corresponds well with dates for the extensive mining that occurred in Mammoth and Salts caves (Watson ed. 1974:236).

The Nature of Prehistoric Activity

It is clear that prehistoric groups extensively and probably intensively explored Big Bone Cave. It also appears that their activity went beyond simple reconnoitering to sustained activity in remote areas of the cave. The extraction of mineral or lithic resources is a likely explanation for the intensity of prehistoric debris found in the cave. Three sources of information can be used to support this argument: (1) evidence of mineral and lithic resource exploitation from other cave sites, (2) available mineral and lithic resources in Big Bone Cave, and (3) the association and prescribed use of certain artifacts relative to the resources in the cave.

The aboriginal extraction of chert, aragonite, calcite, gypsum, and other sulfate minerals have been documented from caves in Tennessee, Kentucky, and Indiana. Chert was mined exclusively from Saltpetre Cave, Tennessee (Ferguson 1982). The procurement of aragonite, possibly calcite, high quality chert, and potentially some sulfate minerals all occurred in Wyandotte Cave, Indiana (Munson and Munson 1981; Tankersley 1985; Tankersley et al. 1987) Mining of sulfate minerals, primarily gypsum and secondarily epsomite and mirabilite, was an extensive and sustained activity in Mammoth and Salts caves (Watson 1969; Watson ed. 1974; Tankersley et al. 1986). There is also some evidence that chert was mined in Mammoth Cave (Watson ed. 1974).

An effort was made during the survey of Bone Cave to note the occurrence of the various mineral and lithic resources found in the cave, especially when they were associated with areas of aboriginal activity. Chert was rarely observed in the cave. The few nodules found exposed in the limestone matrix were of poor quality. There is no evidence that chert cobbles were mined from the cave sediment. Flowstone and other carbonate speleothems in the form of calcite or aragonite are also rare in Big Bone Cave.

Gypsum crusts are more commonly found in Big Bone Cave, but nowhere was there obvious evidence that gypsum had been battered and pounded from the walls of the cave as is characteristic of the mining in Mammoth and Salts caves. The best and most continuous sulfate wall deposits were found well beyond the most intense areas of aboriginal debris. However, other forms of gypsum, especially selenite crystals or needles and fibrous speleothems or "satin spar" (Hill 1976), occur in great abundance in the gypsiferous soil of Big Bone Cave.

Recently there has been some evidence that selenite mining may have been more widespread in Mammoth and Salts caves than previously thought (Tankersley et al. 1986). Interpreting evidence for extraction of selenite or satin spar from the dry clay fill deposits in Big Bone Cave is a more tenuous argument than the battering of gypsum crusts from the wall. The loose structure of the dry sediment does not hold the outline of aboriginally dug pits very well. There are numerous activities that can distort or destroy evidence of aboriginal mining. In the confined passages of Big Bone Cave simply crawling through the passage churns up the sediment beyond recognition of the original surface.

However, there is an indisputable association of selenite crystals in the sediment and extensive cultural remains from the aboriginal exploration of these areas of the cave. The most conspicuous artifacts among the debris are fragments of gourd containers. The location of artifacts, like the gourd containers and the woven bag, in remote, difficult to negotiate passages indicates that they were intended for very specific uses. The transport of selenite in such containers seems likely.

Mineralogical analysis of the residual contents of a complete gourd container recently discovered in Salts Cave demonstrated the potential use of these artifacts in the procurement of powdered gypsum from the Mammoth Cave system (Tankersley et al. 1985). The discovery of a small piece of selenite in the bottom of the woven bag from Big Bone Cave (Kutruff 1986) lends even greater evidence, if not conclusive evidence, that at least one of the prehistoric activities carried out in the cave was the procurement of gypsum in the form of selenite.

Detailed recording and mapping of the prehistoric remains in Big Bone Cave may indicate more precisely the logistics of mining selenite from the cave sediment. Attention should be paid to identifying extraction pits or areas, small hearths that would indicate sustained activity in one area, extraction tools such as digging sticks, and possibly processing areas if the crystals were altered before removal from the cave.

Prehistoric Miners of Big Bone Cave

The Terminal Archaic through Middle Woodland span of activity in Big Bone Cave encompasses a range of archaeological phases represented at open sites in the Middle Tennessee area. Archaeological work, especially in the Normandy Reservoir on the upper Duck River (Faulkner and McCollough 1973, 1974, 1982) provides the best cultural material context in which to place the prehistoric remains from Big Bone Cave.

Middle Woodland McFarland and Owl Hollow phases are two of the best documented occupations known for the Middle Tennessee area. The McFarland and Owl Hollow projects (Cobb and Faulkner 1978; Kline et al. 1982) have provided a considerable body of information on site distributions, settlement patterns, and subsistence. The prehistoric activity in Big Bone appears to be at least partially Middle Woodland in age. McFarland and Owl Hollow phase populations in the Eastern Highland Rim may be directly responsible for some of the material in the cave and potentially isolated botanical and paleofecal remains may be directly relevant to the Middle Woodland subsistence data from Middle Tennessee (Crites 1978a, 1978b).

The Early Woodland period is the most poorly defined cultural horizon in the upper Duck River Valley (Faulkner and McCollough 1973:442). It is during this time period that the most intense prehistoric activity appears to have occurred in Big Bone Cave. It would seem that we need to look elsewhere for core population areas to attribute the extensive Early Woodland activity in Big Bone Cave. Possibly Early Woodland settlement was focused in the coves along the western escarpment of the Cumberland Plateau drained by the head waters of the Elk River or the Caney Fork and its numerous tributaries.

The earliest prehistoric activity in Big Bone Cave, which dates to the Terminal Archaic Wade phase, coincides with the manifestation of trade networks and an increase in ceremonialism, most evident in burial complexes that occur throughout the Eastern Woodlands. The increase in occurrence of exotic lithic resources, such as steatite and certain cherts, during the Terminal Archaic period may be a clue to the use and importance of gypusm and other cave minerals as items in prehistoric trade networks and ceremonial practices (Faulkner and McCollough 1982:553).

The mining of gypsum, first identified in the Mammoth Cave area (Watson ed. 1974), appears to be a regional development for which the origin and spatial boundaries are still undefined. As evidence increases for the widespread procurement of gypsum and exotic cave minerals, it would seem that ultimately our understanding of the demand for these resources and tasks undertaken to supply this material, represented by sites like Big Bone Cave, is tied to the elaboration of trade and ceremonial interaction that first develops during the Terminal Archaic period.

VII. A COMPARISON OF RADIOCARBON AGE DETERMINATIONS FROM BIG BONE CAVE AND OTHER CAVE SITES

An increasing number of deep cave archaeological sites have been discovered in the Interior Low Plateaus and Appalachian Plateaus physiographic regions of the Eastern Woodlands. This body of work, beginning with the seminal study by Watson (1969; Watson ed. 1974) in the Mammoth Cave system, encompasses a number of widely distributed sites and has documented a variety of diverse human activities in the remote and sometimes difficult-to-reach confines of the deep cave environment (e.g Faulkner 1986; Faulkner ed. 1986; Ferguson 1982; Munson and Munson 1981; Robbins et al. 1981; Tankersley et al. 1986; Tankersley et al. 1987).

Common among many of these sites is the stable nature of the cave environment that has preserved some very fragile evidences of human activity, including footprints in soft mud (Robbins et al. 1981), drawings in soft mud veneer on the cave walls (Faulkner ed. 1986), and digging tool marks from the quarrying of lithic resources in the sandy sediments of the cave (Ferguson 1982; Tankersley et al. 1986). In all instances, aboriginal activity in the remote cave setting required fuel for light, and, if the activities were sustained, potentially for heat. The lack of temporally diagnostic material and the abundance of perishable material and torch charcoal has resulted in a significant number of radiocarbon dates from these cave sites.

This radiocarbon chronology lends itself well to statistical comparison for combining a series of dates if they are found to be internally consistent or when a series is found to be significantly different for splitting this series of dates into homogeneous groups (Ward and Wilson 1978; Wilson and Ward 1981). These comparisons can be made on a series of dates from one site to determine if they are consistent or among different sites to determine if they are effectively dating consistent events.

The procedures and paradigms discussed by Ward and Wilson (1978) and Wilson and Ward (1981) are especially applicable to the cave site radiocarbon chronology because of the lack of stratigraphical information and other considerations for evaluating intrasite and intersite aboriginal activity. Further, cursory examination of the radiocarbon age series of determinations from the well-documented sites appears to represent a diachronic pattern of cave utilization for the Midwest and Midsouth in general. Wilson and Ward (1981) provide us with a statistical procedure for testing these "fixed split" hypotheses on the combined mean radiocarbon age from one or more sites, which is in effect a test of the contemporaneity between distinct prehistoric activities documented at different cave sites.

The Cave Sites and Radiocarbon Samples

Fifty-seven radiocarbon age determinations from twelve documented cave sites, as well as the Big Bone Cave samples, are considered in the following statistical analysis. The location of cave sites used in the analysis is shown in Figure 8. The radiocarbon age determinations and error variables used in the analysis for Big Bone Cave are presented in Table 1. Determinations for Mammoth and Salts caves are presented in Table 2 and the other cave sites are presented in Table 3. The prehistoric activity at eight of these sites has been well documented. The other four sites, although containing clear evidence of prehistoric human visitation, have not revealed obvious evidence of human activity or use other than simple exploration.

The types of human activity identified in cave sites has been discussed by Watson (1986b). They include the prehistoric use of caves as mines or quarries, the use of caves as mortuary pits or burial sanctuaries, and the use of caves for ceremonial or ritual purposes. A fourth type of cave site is the "foot print" cave. No distinct use of these caves has been identified. However, the unmistakable evidence of prehistoric human visitation is well documented by the prints in mud of the bare or slippered feet of the aboriginal cavers and remains of their torches.

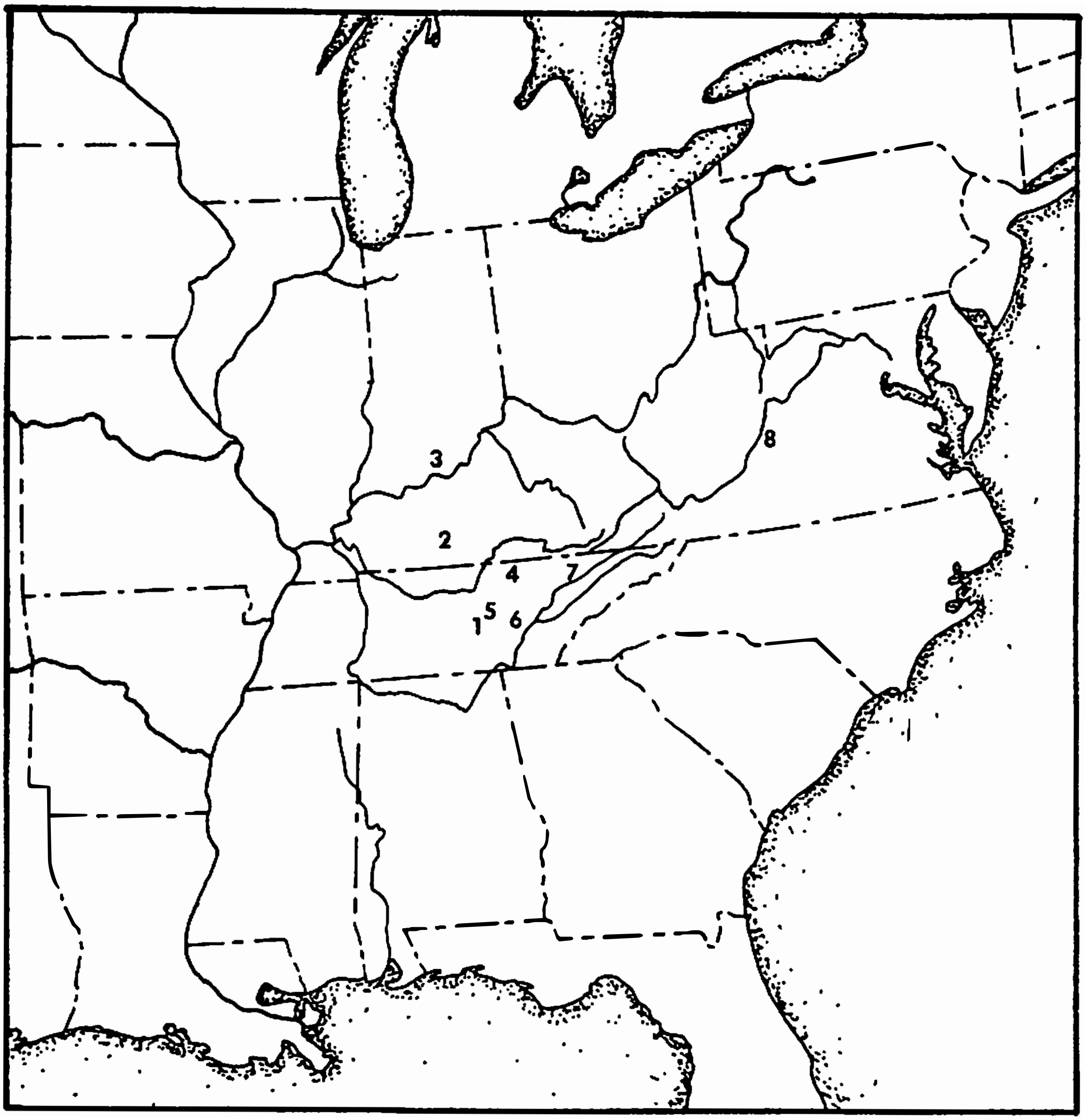

Figure 8. Location of cave sites used in this study. 1) Big Bone Cave, 2) Mammoth, Salts, Lee, and Fisher Ridge caves, 3) Wyandotte Cave, 4) Jaguar and Saltpetre caves, 5) Indian Cave, White Co., 6) Devil Step Hollow, 7) Indian Cave, Grainger Co., 8) Williams Cave.

Table 1. Big Bone Cave radiocarbon age determinations and error variables.

Sample Number	Age b.p. (a)	Counting Error (e)	Calibration Error (f)	Sunspot Effect (g)	Sum Squared* (s)
SI-6013	1595	55	50	0	75
SI-6012	1615	60	50	0	80
Beta-13972	2120	60	50	0	80
Beta-12970	2170	60	50	70	105
Beta-13971	2230	70	50	0	85
Beta-13969	2340	60	50	0	80
Beta-13967	2380	70	50	0	85
Beta-13968	3000	70	60	70	115

* Rounded to nearest 5

Table 2. Mammoth and Salts caves radiocarbon age determinations and error variables.

Sample Number	Age b.p. (a)	Counting Error (e)	Calibration Error (f)	Sunspot Effect (g)	Sum Squared* (s)
Internal tissue from the Salts Cave Mummy					
M-2259	1920	160	50	70	180
M-2258	1960	160	50	70	180
Upper Salts Excavation, Test A					
M-1584	2510	140	50	70	165
M-1585	2430	140	50	70	165
M-1586	2840	150	60	70	175
M-1587	2520	140	50	0	150
Salts Cave Interior					
Mummy	1940				130
M-1573	2240	200	50	70	220
M-1777	2270	140	50	70	165
M-1577	2350	140	50	70	165
Test A	2564				80
M-1574	2570	140	50	70	165
M-1770	2660	140	50	70	165
M-1588	2720	140	60	0	150
M-1589	3140	150	60	0	160
Salts Cave Vestibule Excavation					
GaK-2622	2660	100	50	0	120
GaK-2765	2940	120	60	0	135
GaK-2764	3360	220	60	0	230
GaK-2766	3410	220	60	0	230
GaK-2767	3490	110	60	0	125
Mammoth Cave Interior					
X-8	2230	40	50	0	65
X-9	2370	60	50	70	105
SI-6890B	2495	80	50	70	115
SI-6890A	2920	60	60	70	110
UCLA-1730B	3000	70	60	0	90
UCLA-1730A	4120	70	60	0	90

* Rounded to nearest 5

Table 3. Radiocarbon age determinations and error variables from other cave sites.

Sample Number	Age b.p. (a)	Counting Error (e)	Calibration Error (f)	Sunspot Effect (g)	Sum Squared* (s)
Mud Glyph Cave, Tennessee					
SI-5473	190	80	50	70	115
SI-5472	345	65	50	70	110
SI-5471	615	60	50	70	105
SI-5469	635	50	50	70	100
SI-5098A	715	60	50	0	80
SI-5470	750	45	50	0	65
SI-5098B	795	60	50	0	80
SI-5468	1485	60	50	70	105
Indian Cave, White Co., Tennessee					
Beta-13935	590	80	50	70	115
Beta-13936	940	60	50	70	105
Devil Step Hollow, Tennessee					
Beta-13938	620	150	50	70	175
Beta-13937	1030	90	50	70	125
Indian Cave, Grainger Co., Tennessee					
SI-6982	400	55	50	70	100
SI-6983	660	55	50	70	100
SI-6981	1695	45	50	70	95
Williams Cave, Virginia					
SI-5791	890	70	50	0	85
SI-5891	920	65	50	0	80
SI-5792	955	75	50	0	90
Wyandotte Cave, Indiana					
SFU-199	1400	270	50	0	275
SFU-222	1560	150	50	0	160
UCLA-1731A	1710	80	50	0	95
UCLA-1731B	2860	60	60	0	85

Table 3 (Continued)

Sample Number	Age b.p. (a)	Counting Error (e)	Calibration Error (f)	Sunspot Effect (g)	Sum Squared* (s)
Saltpetre Cave, Tennessee					
SI-5065	2745	75	60	70	120
SI-5063	2805	75	60	70	120
SI-5066	2950	65	60	70	115
SI-5064	3115	65	60	70	115
SI-5067	4350	60	60	70	110
Fisher Ridge Cave, Kentucky					
SI-**	2750	85	60	0	105
SI-**	3175	80	60	70	120
Lee Cave, Kentucky					
UCLA-1729A	4200	65	60	70	115
Jaguar Cave, Tennessee					
SI-3005	4530	85	60	70	125
SI-3003	4590	75	60	70	120
SI-3006	4695	85	60	70	125

* Rounded to nearest 5
** Sample numbers not reported (Kennedy et al. 1984)

One of the most obvious materials extracted from the cave setting is chert. Exclusive and the best preserved evidence of this activity is in Saltpetre Cave, Tennesse (Ferguson 1982). Five radiocarbon determinations have been obtained from Saltpetre Cave dating between 795 and 2400 B. C. (Table 3).

Although there is good evidence that chert was at least occasionally mined from the Mammoth Cave system, there is clearly greater evidence that the mining of gypsum and possibly some co-occurring sulfate minerals were the intent of the massive prehistoric efforts in both Mammoth and Salts caves. Watson reports 24 radiocarbon determinations from her work (Watson ed. 1974: 236; Watson 1986a:32) that I have selected for analysis (Table 2). The Mammoth Cave samples date between 280 and 2170 B. C. and samples from Salts Cave interior date between A. D. 30 and 1190 B. C. Material excavated from the Salts Cave vestibule dates from 710 to 1540 B. C.

A high quality chert was also mined from Wyandotte Cave, Indiana (Tankersley 1985). However, the mining of a massive aragonite column has also been well-documented and evidence to suggest that it was traded throughout the Midwest (Tankersley et al. 1987). Four radiocarbon dates from Wyandotte range between A. D. 550 and 910 B. C. (Tankersley et al. 1987; Watson ed. 1974:236)

A significant number of mortuary pits and caves have also been documented (Haskins 1983; Turner 1984; Walthal and DeJarnette 1974; Willey and Crothers 1986). However, the interment or disposal of the dead in solutional pits and small horizontal caves is not strictly comparable to the deep cave utilization considered here. There are also very few radiocarbon determinations available that date these activities. The dates that exist (see Haskins 1983; Willey and Crothers 1986) are from bone samples and not considered reliable. No dated burial sites have been entered in the analysis.

A number of ceremonial cave sites have been discovered. The prehistoric use of these cave is significantly different from that of other types of caves. The sole purpose these sites appears to have been for use as a sanctum to communicate with, or to approach, the supernatural (Watson 1986:115). The best documented site is Mud Glyph Cave, Tennessee (Faulkner et al. 1984; Faulkner ed. 1986). Eight radiocarbon samples (Faulkner et al. 1986:30) date the use of Mud Glyph Cave between A. D. 1760 and A. D. 465 (Table 3). Other sites with evidence of ceremonial use include Indian Cave, White County, Tennessee, Devil Step Hollow, Tennessee, and Williams Cave, Virginia (Faulkner 1986). These sites have been dated between A. D. 1360 and A. D. 920 (Table 3).

Four other cave sites have been discovered that contain evidence of prehistoric human visitation. Two of these are "footprint caves": Jaguar Cave, Tennessee (Robbins et al. 1981), dating between 2580 and 2745 B. C., and Fisher Ridge Cave, Kentucky (Kennedy et al. 1984), with dates of 800 and 1225 B. C. (Table 3). The other two caves containing distinctive prehistoric torch remains are Indian Cave, Grainger County, Tennessee and Lee Cave, Kentucky. Three torch charcoal samples from Indian Cave (Charles Faulkner, personal communication) dated from A. D. 1550 to A. D. 255 (Table 3). A single torch remain sample was obtained for Lee Cave (Watson ed. 1974:236) and dated 2250 B. C. (Table 3).

Statistical Methods

The procedures for comparing radiocarbon age determinations by Ward and Wilson (1978) provide two fundamentally different statistical modeling techniques based on the source of the samples being dated. These modeling approaches are called Case I and Case II. Case I is appropriate when two or more samples from the same object are being compared and Case II is appropriate when the samples cannot be assumed to have been derived from the same object.

In the Case II situation if a series of determinations are judged to be different, Wilson and Ward (1981) define two types of clustering procedures for determining the best split among determinations until the groups are judged to be homogeneous. The first type of clustering procedure ignores sampling variability (Case IIa) and the second, generally more realistic type, takes sampling variability into account (Case IIb) by utilizing a clustering technique that is based on the method for grouping mean values in standard analysis of variance.

The Case IIb situation is more appropriate to the series of radiocarbon determinations from the cave sites used in this analysis. First, we wish to test the hypothesis that the series of radiocarbon determinations for each cave site are consistent (i.e. effectively estimating the same age). If the determinations are judged not to be significantly different, then they can be combined with a pooled mean age and variance of the mean which is our best estimate of the true radiocarbon age of the activity represented in that cave site. If the determinations are judged to be significantly different, then we must consider alternative hypotheses to account for the inconsistent estimated true ages.

The general mathematical model for the representation of Case IIb (Wilson and Ward 1981:25) is:

$$a_i = \theta_i + r_i + e_i + f_i + g_i$$

$$i = 1, \ldots, n$$

where θ_i is the unknown true radiocarbon age of the object and r_i is the sampling error with zero mean and unknown sampling variance σ^2. The expression e_i is the counting error variable supplied by the laboratory. The expression f_i represents the calibration error variable which is taken to be 50^2 or 60^2 depending on whether the determination is less than or greater than 2700 years b.p., respectively, as recommended by Clark (1975). The expression g_i represents the "sunspot effect" error variable equal to 70^2 where the effect is suspected and zero otherwise. Radiocarbon dates of short-lived samples (with lifetimes on the order of one year) were suspected of sunspot effect error as recommended by Clark (1975). Short-lived samples defined in this analysis include cane, fecal specimens, and nut hulls. Samples listed as simply "torch charcoal" were assumed to be at least partly composed of cane and given sunspot effect error variables equal to 70^2. The expression n is simply the number of observation or determinations for the particular site being analysed.

The null hypothesis is:

$$H_o: \theta_i = . . . \theta_n$$

that is, the determinations are estimating the same true radiocarbon age. The maximum likelihood estimates of the unknown true radiocarbon age and the sampling variance can be obtained using the procedures detailed by Wilson and Ward (1981:Appendix 1) for Case IIb. To determine if there is statistical evidence for a split at the value that maximizes the likelihood ratio (m.l.r.) statistic, one compares this value with the chi-square approximation given by Scott and Knott (1976).

Wilson and Ward (1981:Appendix 2) provide a computer algorithim for determining the value of m.l.r. and the maximum likelihood estimates of the true radiocarbon age and variance. This program, written in ALGOL for use with a DEC-10 interface, was rewritten for this study to run interactively in GWBASIC for use with an IBM compatable personal computer.

After determining that a set of dates from two or more sites are consistent and having obtained the maximum likelihood estimates of the true radiocarbon age and the variance for each site, we may then test a "fixed split" hypothesis to determine whether two or more sets of dates are consistent among sites. That is, we are testing the null hypothesis that each site has the same date, θ versus the alternative that each site has a different date, one of value ϕ_1, and the other of value ϕ_2. The m.l.r. statistic for fixed splits is distributed according to a chi-square distribution with two degrees of freedom if sampling error variance is not considered to be equal between the two sites (Wilson and Ward 1981:25).

The procedure for determining the m.l.r. statistic for fixed splits is presented by Wilson and Ward (1981: Appendix 1), and the maximum likelihood estimates of the true radiocarbon age and sampling error variance can be obtained from the procedure in the computer algorithim.

Results and Discussion

The series of radiocarbon dates for each site were analysed using Case IIb, taking into account sampling error. The counting error variables entered into the analysis for each radiocarbon sample are presented in Tables 1, 2, and 3. The resulting pooled mean age (years B.P.), estimated sampling error variance, and variance of the pooled mean age for consistent sets of dates are presented in Table 4.

For each set of dates analysed, with one exception, the series of radiocarbon age determinations were found to be statistically consistent. That is, they are effectively estimating the same date.

For example, eight radiocarbon determinations from Big Bone Cave were entered into the analysis (sample SI-6014 was rejected before analysis because it is considered to be an historic sample based on previous discussions). The resulting m.l.r. statistic equals 5.1. This value, compared with the chi-square approximation table in Scott and Knott (1976), is not significant ($5.1 < 6.8$) at the 95% confidence level. Therefore we are statistically justified in combining the eight radiocarbon dates from Big Bone Cave with a date of 2177 years B. P. and variance of the

Table 4. Combined radiocarbon age determinations of Eastern North American cave sites.

Cave Site	No. Obs. n	Pooled Mean Age (B.P) $\hat{\theta}$	Sampling Error Variance* $\hat{\sigma}^2$	Variance of Mean* $V(\hat{\theta})$
Mud Glyph Cave	8	694	340	125
Indian Cave, Wt. Co.	2	773	135	125
Devil Step Hollow	2	861	135	145
Indian Cave, Gr. Co.	3	919	550	325
Williams Cave	3	921	0	50
Wyandotte Cave	4	1909	565	295
Big Bone Cave	8	2177	405	145
Salts Cave	9	2496	290	110
Mammoth Cave	6	2856	625	260
Saltpetre Cave	4	2908	85	70
Fisher Ridge Cave	2	2953	180	150
Salts Vestibule	5	3145	300	155
Lee Cave	1	4200	0	115
Jaguar Cave	3	4604	0	70

* Rounded to nearest 5

estimate of the mean of the combined determinations is 145 years. Note that these are uncalibrated dates. If one wishes to obtain the calendar dates follow the procedures in Clark (1975).

Several considerations had to be made for the series of dates from Salts Cave (Table 2) before they could be compared. First, the Salts Cave vestibule dates were analysed separately because they represent activities dissimilar to material from the cave interior; that is, entry area occupation versus mining activities. Second, two dates on internal tissue from the Salts Cave mummy were analysed as Case I (samples from the same object) and found to be consistent. This combined date was entered as a single sample with a new variance. Third, Test A excavation in Upper Salts (interior cave) revealed a series of stratigraphically defined ash layers reaching a depth of 1.5 m (Watson 1969:20-21). Single dates on four of these layers (Table 2) are not stratigraphically consistent. However, they are statistically consistent or are effectively dating the same event. This may be taken as evidence that the stratigraphic profile represented in Test A is a result of human action. Aboriginal excavation of the sediments (potentially the mining of selenite) or intense activity in this area may have contributed to the mixed nature of the deposits. But this activity appears to be from effectively the same period and not necessarily use, abandonment, and reuse. The combined date for the activity in Upper Salts, Test A area was entered into the analysis as a single sample.

The combined date ($\hat{\theta}$ = 2496, $\hat{\sigma}^2$ = 290) for activity in the Salts Cave interior was judged not to be significantly different (m.l.r. = 5.8 < 7.5 = $X^2_{app;9;0.95}$): that is, effectively dating the same event.

Likewise the other radiocarbon series were found to be consistent within sites except for Saltpetre Cave, Tennessee (Table 3). The m.l.r. statistic was judged to be significantly different (m.l.r. = 4.8 > 4.6 = $X^2_{app;5;0.95}$) and sample SI-5067 (4350 b. p.) considered to be an outlier. Removing this determination results in a consistent combined age of 2908 B. P. and sampling error variance ($\hat{\sigma}^2$) of 85 for the remaining four dates.

The combined radiocarbon age dates and variance of the mean of the combined observations for each site are represented graphically in Figure 9. Immediately apparent in the distribution of cave sites is the grouping of caves with similar utilization patterns along the time scale. Ceremonial caves are grouped on the late end of the scale, quarry caves are grouped in the middle, and the footprint caves are toward the early end.

The combined ages and variances of selected sites were statistically tested using Wilson and Ward's (1981) procedures for fixed split hypotheses. The sites selected

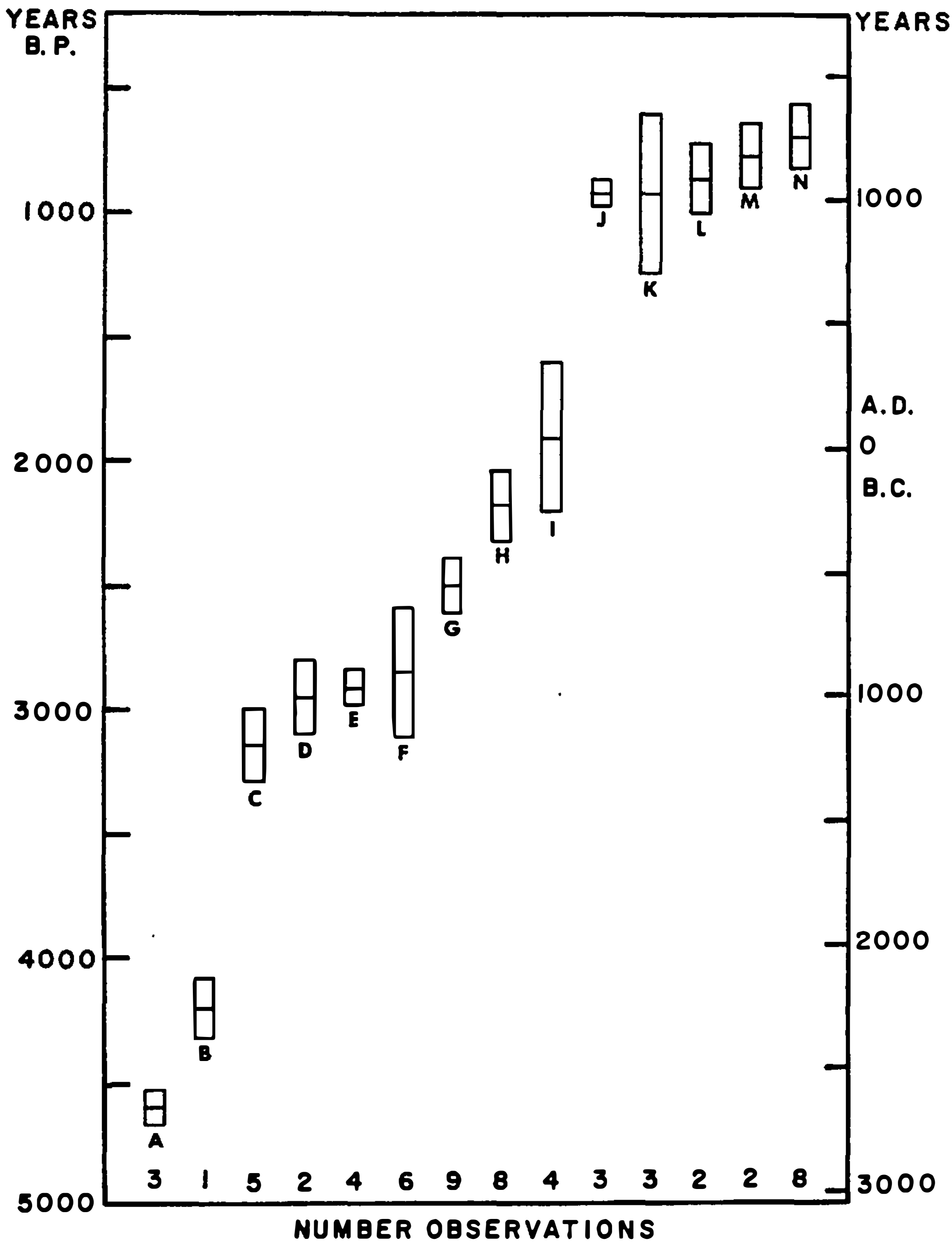

Figure 9. Mean and variances of combined dates for cave sites used in this study. A) Jaguar, B) Lee, C) Salts vestibule, D) Fisher Ridge, E) Saltpetre, F) Mammoth, G) Salts interior, H) Big Bone, I) Wyandotte, J) Williams, K) Indian, Grainger Co., L) Devil Step, M) Indian, White Co., N) Mud Glyph.

and test statistic results are shown in Figure 10. These results further support the diachronic pattern of change in cave utilization discussed earlier. The fixed split hypothesis, that two sites represent the same date, was accepted for comparisons between Wyandotte and Big Bone, Big Bone and Salts, and Salts and Mammoth, but rejected for comparisons between Mud Glyph and Wyandotte, Big Bone and Mammoth, Mammoth and Saltpetre, Saltpetre and Jaguar, and Salts interior and Salts vestibule. A three split hypothesis was also tested among Big Bone, Salts and Mammoth, but the null hypothesis was rejected. These three sites, with similar evidences of prehistoric activity, the mining of gypsum, when entered into a three way analysis do not represent the same date.

It is interesting to note that the period of activity occurring in the Salts Cave interior is not statistically consistent with the activity occurring in the Salts Cave vestibule. The occupation of the vestibule represents an earlier date than that of the mining in the cave interior. Future work might be directed toward comparing material remains between the aboriginal groups represented by these two events.

The utilization of cave sites through time is rather interesting. The earliest known sites, Jaguar Cave, Lee Cave, and Fisher Ridge Cave, have no evidence of activity other than exploration. The occupation of Salts vestibule

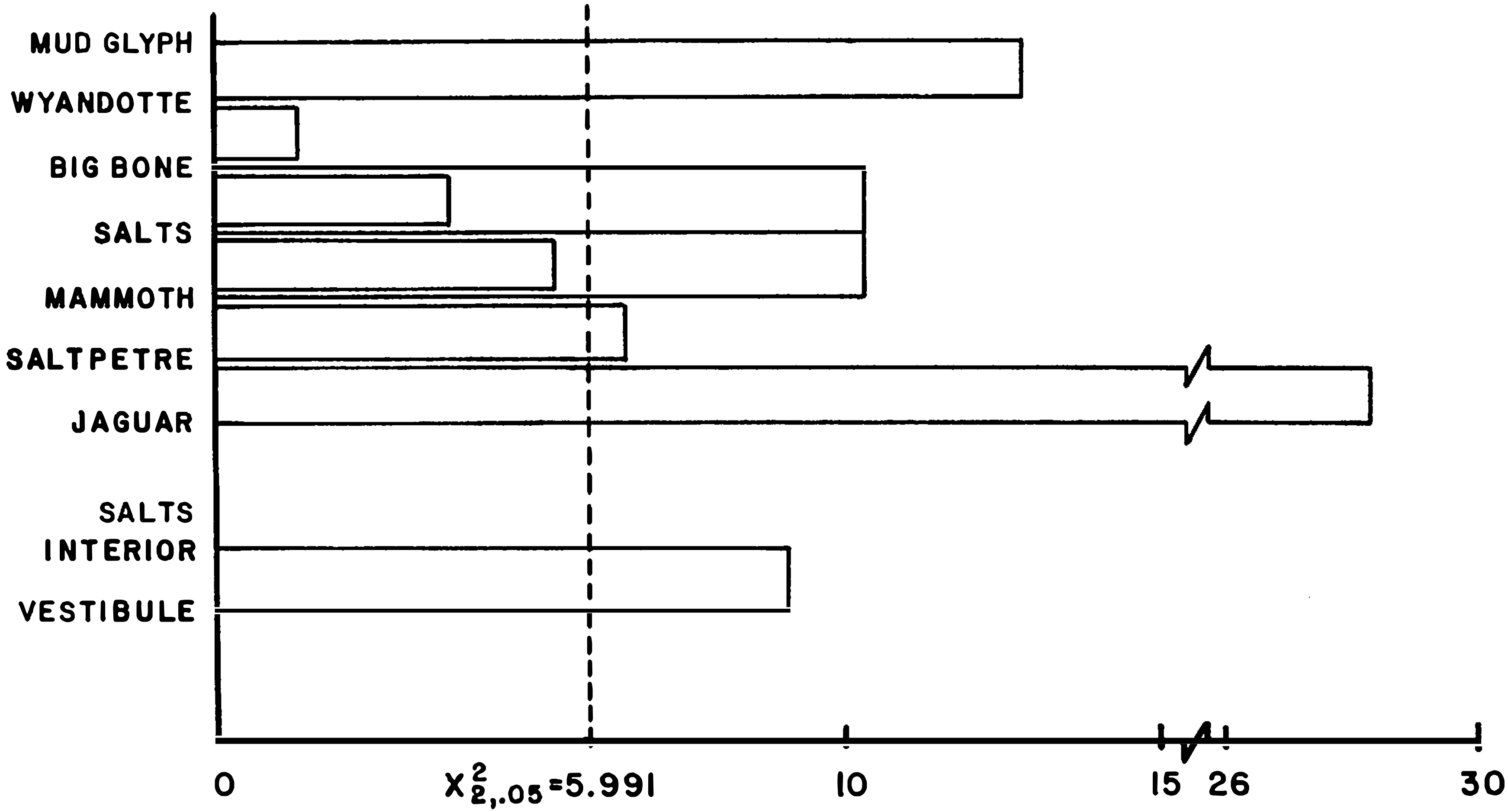

Figure 10. Fixed split statistics for comparisons among selected cave sites.

is earlier than extraction of gypsum from the interior. The mining of Mammoth, Salts, Big Bone, and Wyandotte is represented by an overlapping progression of dates. Any two time-wise neighboring sites are consistent, but the combined sites are not consistent. The grouping of Indian Cave in Grainger County with the ceremonial caves leads to the expectation that upon closer examination we should find evidence of ceremonial use of this cave. However, considering the intense historic use of this cave, evidence of this activity may have been destroyed.

Based on the results of this analysis I suggest that dates obtained from prehistoric material from a cave interior in the Eastern Woodlands may be a good predictor of the types of activity conducted in the remote cave environment. It is hoped that continued efforts to date and identify evidence of prehistoric activity found in cave situations will refine these conclusions. It would be especially informative to gain a better understanding of the interesting phenomenon of cave burials to determine if, likewise, there are consistent patterns of this use of caves in the Eastern Woodlands.

VIII. SUMMARY

Big Bone Cave has been the site of considerable historic activity, particularly the mining of saltpetre. Although this activity has had a major destructive effect on the prehistoric archaeological record, three remote passages, totaling over 1000 m in length, were found during an archaeological survey to contain integral surface deposits of perishable prehistoric material. Material documented during the survey includes cane and woody torch debris, cordage, gourd and squash container fragments, human paleofecal deposits, woven slippers, and miscellaneous other vegetal debris.

A preponderance of the evidence from other known cave sites, lithic resources found in Big Bone, and the types of material remains found in the cave indicate that the best explanation for the prehistoric activity in Big Bone Cave was the mining of selenite from the gypsiferous cave sediment.

Eight radiocarbon determinations obtained on material collected during the survey date between 1600 and 3000 B. P. The determinations were compared using statistical procedures and judged to be consistent if sampling error is taken into account. The combined date for this series is 2177 B. P. with variance of 145 years.

Likewise, 12 series of radiocarbon determinations from other well-dated deep cave sites, including Saltpetre, Mammoth, Salts, Wyandotte, and Mud Glyph caves, were tested for consistency and combined when judged not to have significant test statistics. The 12 series of dates compared favorably within-sites; only one site (Saltpetre Cave, Tennessee) was found to have a significant outlier. When this sample was removed, the remaining determinations were consistent.

A select number "fixed split" hypotheses were then considered to test whether the combined radiocarbon ages between sites with similar activities were effectively estimating the same date. The results of this analysis were illustrated graphically to represent the diachronic pattern of cave utilization supported by the statistical procedures.

A consideration of the results of the survey of Big Bone Cave and the analysis of radiocarbon series from cave sites in the Eastern Woodlands suggest that specific prehistoric use of deep caves follows consistent patterns that have been found to be bounded only by time, but not necessarily by space. It is hoped that efforts will continue to refine these bounds and discussion broadened to begin considering implications outside the cave setting.

LIST OF REFERENCES

LIST OF REFERENCES

Bayless, Tony
1982 Bone Cave. _Van Buren County Historical Journal_, Vol. II, pp. 15-20.

Barr, Thomas C., Jr.
1957 Lost Passage Discovered. _NSS News_ 15(5):54.

1961 _Caves of Tennessee_. Bulletin 64, Tennessee Division of Geology, Nashville.

Big Bone and Arch Caves
1821 Reprinted. _Village Record_, Westchester, Pennsylvania. Wednesday, August 8. Originally published 1821, _North Carolina Star_, Raleigh, June 6.

Blair, Larry O.
1983 Big Bone Cave Burial Ground. _Journal of Spelean History_ 17(3):33-37.

Blair, Larry O. and Joel M. Sneed
1983 Archeological Investigations in Big Bone Cave, Tennessee. _NSS News_ 41(8):211-212.

Braun, E. Lucy
1964 _Deciduous Forests of Eastern North America_. Reprinted. Hafner, New York. Originally published 1950, Blakiston, Philadelphia.

Clark, R. M.
1975 A Calibration Curve for Radiocarbon Dates. _Antiquity_ 49:251-266.

Clarke, David L.
1978 _Analytical Archaeology_. 2nd. ed. Columbia University, New York.

Clifford, John D.
1820 Miscellany, Indian Antiquities, Letter VI to the editor. _The Western Review and Miscellaneous Magazine_. February 2(1):29-36.

Cobb James E. and Charles H. Faulkner
1978 _The Owl Hollow Project: Middle Woodland Settlement and Subsistence Patterns in the Eastern Highland Rim of Tennessee_. Submitted to the National Science Foundation, Grant No. BNS76-11266.

Cowan, C. W., H. E. Jackson, K. Moore, A. Nickelhoff, and T. L. Smart
1981 The Cloudsplitter Rockshelter, Menifee County, Kentucky: A Preliminary Report. Southeastern Archaeological Conference Bulletin 24:60-76.

Crawford, Nicholas C.
1982 Karst Hydrogeology of Tennessee. Western Kentucky University. Guidebook prepared for U. S. Environmental Protection Agency Karst Hydrogeology Workshop. Copies available from Center for Cave and Karst Studies, Bowling Green, Kentucky.

Crites, Gary D.
1978a Paleoethnobotany of the Normandy Reservoir in the Upper Duck River Valley, Tennessee. Master's thesis, Department of Anthropology, University of Tennessee, Knoxville.

1978b Plant Food Utilization Patterns During the Middle Woodland Owl Hollow Phase in Tennessee: A Preliminary Report. Tennessee Anthropologist 3:88-92.

Crothers, George M.
1986 Final Report on the Survey and Assessment of the Prehistoric and Historic Archaeological Remains in Big Bone Cave, Van Buren County, Tennessee. Submitted to the Tennessee Department of Conservation, Nashville, Contract ID 2087.

Ehman, Michael F.
1966 Cane Torches as Cave Illumination. NSS News 24(3):34-36.

Faulkner, Charles H.
1986 A Study of Seven Southeastern Glyph Caves. Submitted to the National Geographic Society, Grant No. 2815-84.

Faulkner, Charles H. (editor)
1986 The Prehistoric Native American Art of Mud Glyph Cave. University of Tennessee Press, Knoxville.

Faulkner, Charles H. and Major C. R. McCollough
1973 Introductory Report of the Normandy Reservoir Salvage Project: Environment, Typology, and Survey, Vol. 1, Normandy Archaeological Project. Report of Investigations 11, Department of Anthropology, University of Tennessee, Knoxville.

1974 Excavations and Testing, Normandy Reservoir Salvage Project: 1972 Season, Vol. 2, Normandy Archaeological Project. Report of Investigations 12, Department of Anthropology, University of Tennessee, Knoxville.

1982 Seventh Report of the Normandy Archaeological Project: 1974 Excavations at the Ewell III Site (40CF118), Jernigan II Site (40CF37), and Parks Site (40CF5). Report of Investigations 32, Department of Anthropology, University of Tennessee, Knoxville.

Faulkner, Charles H., Bill Deane, and Howard H. Earnest, Jr.
1984 A Mississippian Period Ritual Cave in Tennessee. American Antiquity 49:350-361.

Faulkner, Charles H., Robert Stuckenrath, and Gary D. Crites
1986 Dating the Glyphs: Charcoal and Stoke Marks. In The Prehistoric Native American Art of Mud Glyph Cave, edited by Charles H. Faulkner, pp. 26-32. University of Tennessee Press, Knoxville.

Ferguson, Lee G.
1982 A Preliminary Report of Archaeological Investigations at a Chert Quarry Cave in Fentress County, Tennessee. Ms. on file, Department of Anthropology, University of Tennessee, Knoxville.

Fowke, Gerard
1922 Archeological Investigations. Part I: Cave Explorations in the Ozark Region of Central Missouri. Part II: Cave Explorations in Other States. Bulletin 76, Bureau of American Ethnology, pp. 13-150, Smithsonian Institution, Washington, D.C.

Freeman, John P., Gordon L. Smith, Thomas L. Poulson, Patty Jo Watson, and William B. White
1973 Lee Cave, Mammoth Cave National Park, Kentucky. NSS Bulletin 35:109-125.

Funkhouser, W. D. and W. S. Webb
1929 The So-Called "Ash Caves" in Lee County, Kentucky. Reports in Archaeology and Anthropology, Vol. 1, No. 2, pp. 1-112, University of Kentucky, Lexington.

1930 Rockshelters of Wolfe and Powell Counties, Kentucky. Reports in Archaeology and Anthropology, Vol. 1, No. 4, pp. 240-306. University of Kentucky, Lexington.

Gilmore, Melvin R.
1931 Vegetal Remains of the Ozark Bluff-Dweller Culture. Papers of the Michigan Academy of Science, Arts and Letters 14:83-102.

Guilday, John E. and Hellen McGinnis
1972 Jaguar (Panthera onca) Remains from Big Bone Cave, Tennessee and East Central North America. NSS Bulletin 34:1-14.

Guthe, Alfred K.
1964 Editor's Note: Moccasin from a Rockshelter. Tennessee Archaeologist 20:82-83.

Hall, Charles L.
1985 Bugtussle Rockshelter: A Preliminary Statement. Tennessee Anthropological Association Newsletter 10(2):1-6.

Harlan, Richard
1831 Description of the Fossil Bones of the Megalonyx, Discovered in "White Cave," Kentucky. Journal of the Academy of Natural Sciences of Philadelphia, Ser. 1, Vol. VI, Part II, pp. 269-288.

Harrington, Mark R.
1960 The Ozark Bluff-Dwellers. Indian Notes and Monographs, Vol. 12. Museum of the American Indian, Heye Foundation, New York.

Haskins, Valarie A.
1983 The Archaeology of Prewitts Knob, Kentucky: Preliminary Analysis and Interpretations. Paper presented at the 1983 National Speleolgical Society Annual Convention, Elkins, West Virginia.

Hassler, E. F.
1947 Rock Shelter Exploration. Tennessee Archaeologist 3:42-43.

Hay, Oliver P.
1923 The Pleistocene of North America and its Vertebrated Animals from the States East of the Mississippi River and From the Canadian Provinces East of Longitude 95°. Publication No. 322, Carnegie Institute, Washington, D.C.

Haywood, John
1959 The Natural and Aboriginal History of Tennessee. Reprinted. Kingsport Press, Kingsport, Tennessee. Originally published 1823, George Wilson, Nashville.

Hill, Carol
1976 Cave Minerals. National Speleological Society, Huntsville, Alabama.

Holmes, William H.
1891-92 Prehistoric Textile Art of Eastern United States. Thirteenth Annual Report of the Bureau of Ethnology, pp. 9-46. Smithsonian Institution, Washington, D.C.

Jones, Volney H.
1936 The Vegetal Remains of Newt Kash Hollow Shelter. In Rock Shelters in Menifee County, Kentucky, by W. S. Webb and W. D. Funkhouser, Reports in Archaeology and Anthropology, Vol. 3, No. 4, pp. 147-167. University of Kentucky, Lexington.

Kennedy, Mary C., Christine Hensley-Martin, and Patty Jo Watson
1984 CRF Archaeological Project - 1983. Cave Research Foundation 1983 Annual Report, pp. 22-23. Cave Research Foundation, Washington D.C.

King, Frances B.
1985 Early Cultivated Cucurbits in Eastern North America. In Prehistoric Food Production in Eastern North America, edited by Richard I Ford, pp. 73-97. Anthropological Papers No. 75, Museum of Anthropology, University of Michigan, Ann Arbor.

King, Mary Elizabeth
1974 The Salts Cave Textiles: A Preliminary Account. In Archaeology of the Mammoth Cave Area, edited by Patty Jo Watson, pp. 31-47. Academic Press, New York.

Kline, Gerald W., Gary D. Crites, and Charles H. Faulkner
1982 The McFarland Project: Early Middle Woodland Settlement and Subsistence in the Upper Duck River Valley in Tennessee. Miscellaneous Paper No. 8, Tennessee Anthropological Association, Knoxville.

Kutruff, Jenna T.
1986 A Twined Bag from Big Bone Cave, Tennessee: Manufacture, Repair, and Use. Paper presented at the 43rd. Southeastern Archaeological Conference, Nashville, Tennessee.

Leidy, Joseph
1855 A Memoir on the Extinct Sloth Tribe of North America. Contributions to Knowledge, Vol. 7, Art. 5, Smithsonian Institution, Washington, D.C.

Lewis, Thomas M. N.
1947 News and Comments: Rock Shelters. Tennessee Archaeologist 3:32-33.

Maddox, D. T.
1813-14 Big Bone Cave: A Description of the Big Bone Cave, in White County, Tennessee in a Letter to a Friend, August 17, 1813. Nile's Weekly Register - Supplement to Vol. V, pp. 175-176, Baltimore.

Matthews, Larry E.
1971 Description of Tennessee Caves. Bulletin 69, Tennessee Division of Geology, Nashville.

1979 Soot Deposits and Other Observations in Big Bone Cave, Van Buren County, Tennessee. The Windy City Speleonews (February) 19:6-7.

1980 Bibliography of Tennessee Speleology. 3rd. ed. Bulletin No. 1, Tennessee Cave Survey.

Mercer, Henry C.
1896 Cave Exploration by the University of Pennsylvania in Tennessee. The American Naturalist 30:608-611.

1897 The Finding of the Remains of the Fossil Sloth at Big Bone Cave, Tennessee, in 1896. Proceedings of the American Philosophical Society 36:36-70.

Miller, Pleasant M.
1812 Preservation of Human Bodies in a Cave in Tennessee. Medical Repository and Scientific Journal 15:147-149.

Miller, Robert A.
1974 The Geologic History of Tennessee. Bulletin 74, Tennessee Division of Geology, Nashville.

Morris, Eastin
1834 Arch Cave and Big-bone Cave. Tennessee Gazetteer or Topographical Dictionary, pp, 104-105.

Munson, Cheryl Ann and Patrick J. Munson
1981 Archaeological Investigations, 1980, Wyandotte Cave, Indiana. Indiana University. Submitted to Indiana Department of Natural Resources, Division of Forestry.

Orchard, William C.
1920 Sandals and Other Fabrics from Kentucky Caves. Indian Notes and Monographs, Misc. Series No. 4, Museum of the American Indian, Heye Foundation, New York.

Robbins, Louise M., Ronald C. Wilson, and Patty Jo Watson
1981 Paleontology and Archaeology of Jaguar Cave, Tennessee. Proceedings of the VIII International Congress of Speleology, pp. 377-380. Bowling Green, Kentucky.

Safford, James M.
1892 The Pelvis of a Megalonyx and Other Bones from Big Bone Cave, Tennessee. Bulletin of the Geological Society of America 3:121-123.

Scholtz, Sandra Clements
1975 Prehistoric Plies: A Structural and Comparative Analysis of Cordage, Netting, Basketry, and Fabric from Ozark Bluff Shelters. Research Series No. 9, Arkansas Archaeological Survey, Fayetteville.

Scott, A. J. and M. Knott
1976 An Approximate Test for Use with AID. Applied Statistics 5:103-106.

Shetrone, H. C.
1928 Some Ohio Caves and Rock Shelters Bearing Evidences of Human Occupancy. Ohio Archaeological and Historical Quarterly 37:1-34.

Smith, Marion O.
1984 Notes on the Early History of Big Bone Cave. Paper presented at the Tennessee Cave Survey Seminar, University of the South, Sewanee, Tennessee.

Tankersley, Kenneth B.
1985 The Diagnostic Properties of Wyandotte Chert. Cave Research Foundation 1983 Annual Report, pp. 24-25. Cave Research Foundation, Washington D. C.

Tankersley, Kenneth B., John L. Bassett, and Samuel S. Frushour
1985 A Gourd Bowl from Salts Cave, Kentucky. Tennessee Anthropologist 10:95-104.

Tankersley, Kenneth B., Cheryl Ann Munson, Patrick S. Munson, Nelson R. Shaffer, and R. K. Leininger
1987 The Mineralogy of Wyandotte Cave Speleothems and Its Archaeological Significance. In _The Archaeological Geology of North America_. Geological Society of America, in press.

Tankersley, Kenneth B., Patrick J. Munson, and Cheryl Ann Munson
1986 Prehistoric Selenite Mining in the Mammoth Cave System. Paper presented at the 51st Annual Meeting of Society for American Archaeology, New Orleans.

Troost, G.
1834-35 On the Localities in Tennessee in which Bones of the Giant Mastodon and _Megalonyx jeffersonii_ are Found. _Transactions of the Geological Society of Pennsylvania_, Vol. I (1834), Part 1, pp. 139-146, Vol. II (1835), pp. 236-243.

Walthall, John A. and David L. DeJarnette
1974 Copena Burial Caves. _Journal of Alabama Archaeology_ 20:1-59.

Ward, G. K. and S. R. Wilson
1978 Procedures for Comparing and Combining Radiocarbon Age Determinations: A Critique. _Archaeometry_ 20:19-31.

Warden, D. B.
1819 _A Statistical, Political, and Historical Account of the United States of North America_, Vol. II. A. Constable and Company, Edinburgh.

Watson, Patty Jo
1969 _The Prehistory of Salts Cave, Kentucky_. Reports of Investigations No. 16, Illinois State Museum, Springfield.

1982 Notes on a Visit to Big Bone Cave, Van Buren County, Tennessee, July 25, 1982. Ms. in possession of the author.

1986a CRF Archaeological Project - 1985. _Cave Research Foundation 1985 Annual Report_, pp. 31-32. Cave Research Foundation, Cedar Falls, Iowa.

1986b Prehistoric Cavers of the Eastern Woodlands. In _The Prehistoric Native American Art of Mud Glyph Cave_, edited by Charles H. Faulkner, pp. 109-116. University of Tennessee Press, Knoxville.

Watson, Patty Jo (editor)
1974 Archaeology of the Mammoth Cave Area. Academic Press, New York.

Willey, P. and George Crothers
1986 Archaeological and Osteological Survey of Bull Thistle Cave (44TZ92), Virginia. Submitted to Virginia Division of Historic Landmarks, Richmond.

Wilson, S. R. and G. K. Ward
1981 Evaluation and Clustering of Radiocarbon Age Determinations: Procedures and Paradigms. Archaeometry 23:19-39.

Webb, W. S. and W. D. Funkhouser
1936 Rockshelters in Menifee County, Kentucky. Reports in Archaeology and Anthropology, Vol. 3, No. 4, pp. 105-167. University of Kentucky, Lexington.

Whitford, A. C.
1941 Textile Fibers Used in Eastern Aboriginal North America. Anthropological Papers of the American Museum of Natural History, Vol. 38, Part 1, pp. 1-22.

Yarnell, Richard A.
1969 Contents of Human Paleofeces. In The Prehistory of Salts Cave, Kentucky, by Patty Jo Watson, pp. 41-54. Report of Investigations No. 16, Illinois State Museum, Springfield.

Zawislak, Ronald L.
1971 Guidebook for the 1971 SERA Convention. Ms. on file, Nashville Grotto of the National Speleological Society, Nashville, Tennessee.

Zawislak, R. L. and J. L. Smyre
1979 Big Bone Cave, Van Buren County, Tennessee. Map in possession of the author.

VITA

George Martin Crothers was born in Denver, Colorado on June 17, 1959. He attended public schools in Bloomington, Minnesota and Little Rock, Arkansas and was graduated from Little Rock Central High in June 1977. He entered Washington University in St. Louis the fall of 1977 and received a Bachelor of Arts degree in Anthropology in May 1981.

While an undergraduate and following graduation he worked on several archaeological projects in the states of Missouri, Kentucky, Arkansas, Illinois, North Dakota, and Tennessee. In September 1983 he entered The Graduate School of The University of Tennessee, Knoxville and received a Master of Arts degree with a major in Anthropology in March 1987.

The author is a member of the Society for American Archaeology, Southeastern Archaeological Conference, Tennessee Anthropological Association, National Speleological Society, and a joint-venturer with the Cave Research Foundation.