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**Comments by Francis P. McManamon, Chief Archeologist, National Park Service and Department of the Interior at Press Conference Announcing the C14 Dates for the Kennewick Remains and the Determination that They Are "Native American" According to the Native American Graves Protection and Repatriation Act**

**The Burke Museum**
**University of Washington**
**Seattle**

**13 January 2000**

## Introduction

** I am very happy to be back today at the Burke Museum and University of Washington where last February, we began an exciting process of scientific discovery and documentation. I want to express special thanks to Dr. Karl Hutterer, Director of the Burke Museum and his staff for their curation of the remains and the great hospitality they have shown consistently to those of us working on this matter.

** Today, thanks to invaluable assistance from expert anthropologists, archeologists, curators, and renowned radiocarbon analysis laboratories, we can, with reasonable certainty, answer the first of two questions the Corps of Engineers has asked the NPS and DOI to decide.

** We now know:

- More than 380 bones and bone fragments discovered in the shallows of the Columbia River in Kennewick and collected from there in July and August, 1996, are the nearly complete skeletal remains on one man who died more than 9,000 years ago.

- These remains meet the definition of "Native American" under NAGPRA (by "Native American", we mean: "...relating to tribes, peoples, or cultures that resided within the area now encompassed by the United States prior to the historically documented arrival of European explorers, irrespective of when a particular group may have begun to reside in this area, and, irrespective of whether some or all of these groups were or were not culturally affiliated or biologically related to present-day Indian tribes.")

## A Cultural and Historical Context for Kennewick Man

** Bear with me as I conjure up a scene that I believe is borne out in factual evidence about Kennewick Man from various interpretations provided by our experts.:

1. Somewhere not far from here in the Pacific Northwest more than 9,000 years ago, a young man, perhaps only a teenager, received a nearly fatal injury.

2. A thin, sharpened stone point, similar to the stone points in the display case in this museum's lobby, made and used for hundreds of years here in the Pacific Northwest, struck the young man in the back of his hip. It was thrown with such force that it imbedded itself into the bone.

3. Alone with this wound, he might have died, or been finished off by his attackers. But he lived, probably maybe rescued and helped to recover by his family and friends.

4. This young man was one tough hunter/gatherer! He lived long after recovering from his wound. His hipbone grew and molded completely around the stone point that remained embedded there.

5. From his bones, we believe that he lived a vigorous life; his stature was robust and remained strong right up to his death at about 45-55 years old. He wasn't affected by arthritis, and he didn't walk with a limp.

6. When he died, his bones were covered almost immediately – before any scavenging animal could gnaw any up or carry any part off.

7. His body might have been covered naturally by flood-borne sediments or other natural event, but it also is possible that he was buried by his family and friends in the abundant hunting and fishing land around the confluence of the Columbia and Snake Rivers.

** We believe that Kennewick Man was born, lived out his life, and died in this part of the country about 9,000 years ago. His ancestors almost certainly were Asian. These distant ancestors were part of the initial movement of people from northeastern Asia that gradually crossed the Bering Land Bridge or paddled along its shoreline when the land bridge was exposed, thousands of years before their descendent lived along the Columbia River. Other relatives of these same distant ancestors of Kennewick Man moved south into what is now Japan, coastal China, and on to the islands of the Pacific.

**The C14 Results**

** Radiocarbon dating, particularly of ancient bones, is a complex process. For this reason, we're putting the actual reports from the laboratories on the National Park Service's Kennewick Man site on the Web (www.cr.nps.gov/aad/kennewick) and you have them to take with you today.

** Bone is a difficult material to radiocarbon date. It is very porous and susceptible to intrusion by exogenous carbon from other organic material in soils where it has been buried, from ground water, even from handling during or after recovery. Since the advent of radiocarbon dating in the early 1950s, scientists have improved methods and

techniques for removing exogenous carbon from bone samples before dating them, but the problem is a persistent one that must be evaluated in each case.

** Four C14 dates (Table 1) have been reported for the samples extracted by the Department of the Interior and Corps of Engineers in September, 1999. The samples were processed and dated by Beta Analytical, Inc. (BA), of Miami, Florida, the Radiocarbon Laboratory of the University of California, Riverside (UC-R), and the NSF-Arizona AMS Facility of the University of Arizona (UA). Two of the four new dates show a strong similarity to an initial radiocarbon date of the portion of the metacarpal submitted by Benton County in 1996 (see Table 1). All the carbon samples showed very low carbon content and this is consistent with very old bone.

**The Next Steps**

** So what are the next steps? Can "cultural affiliation" be established reasonably? The procedures of the law require us to determine whether or not we can establish a "cultural affiliation" between this set of ancient remains and any modern Indian tribe. We are under a tight time constraint to do this. Again, we have enlisted top-drawer experts to complete studies on information we need to evaluate the "cultural affiliation" determination. They are: Professor Ken Ames (Portland State University), Professor Daniel Boxberger (Western Washington University), Professor Steven Hackenberger (Central Washington University), and Professor Eugene Hunn (University of Washington). These are the members of the cultural affiliation team that are helping us answer this complex question.

** DNA Testing—we have an experts' report that is being evaluated by officials at the Department of the Interior. The difficulties of finding collagen in the bone that would provide good DNA and the difficulties of contamination with modern or other DNA in the laboratory or in the atmosphere are among the matters being considered in this decision-making. We expect to make this decision within the next month and will release the experts' report on the Web.

**Summary**

** We now have answered the first question of two that the COE asked the DOI to answer in 1998. Yesterday afternoon, Department of Justice attorneys filed with the Federal court in Portland a copy of the memorandum that we are distributing here today which describes the basis for the determination that the Kennewick skeletal remains are considered "Native American", as defined by NAGPRA.

** It has taken a longer time than usual to answer this first question due to the very disturbed context within which the remains were discovered and collected. You all will recall that this retrieval was not from a standard archeological excavation where everything is painstakingly recorded in detail, but from a totally eroded secondary context below the surface of the Columbia River. Another factor that has extended the time needed to reach this answer has been the exceptionally contentious debate, including formal court proceedings, about the appropriate treatment.

** I would like to emphasize how much has been accomplished since we began working with the Corps of Engineers on this matter about 2 years ago:

1. Detailed documentation using appropriate scientific methods and techniques;

2. Participation of distinguished archeologists, physical anthropologists, anthropologists, conservators, and geologists to provide the best available documentation and analysis;

3. Consultation with five local Indian tribes and efforts to incorporate their concerns into the necessary recording, analysis, and treatment;

4. Publication and distribution of results in public electronic and paper formats for anyone with access to the Web to see and use.

5. Kindling the interest of so many people in the United States, really all over the world, in what we can learn about the peopling of our hemisphere, the first Americans and in archaeological discoveries.

** NPS assistance role in the Kennewick case is an example of the professional and technical assistance that the NPS provides to other public agencies, preservation organizations, Indian tribes, and others outside the National Park system. NPS has archeologists, historians, historical architects, conservators, and curators, among others who are engaged in these kinds of professional assistance and technical support activities.

** In this case, NPS and DOI are assisting the COE in reaching a decision about the appropriate way to proceed in treatment of this set of ancient human remains from Kennewick, Washington. I and others at the NPS and DOI appreciate the confidence and support we have received from COE officials at the Walla Walla District, the Division office in Portland, the Center for Curation in St. Louis, and the headquarters office in DC. We all have benefited from the close working relationship that has developed among the offices and departments involved in this matter. I also want to express my professional and personal appreciation and thanks to Dr. Karl Hutterer and the staff at the Burke Museum, in particular: James Nason, Laura Phillips, and Sherry Boyer.

** Thanks also to the reporters and journalist who have followed this story and striven to provide their readers, listeners, and viewers with accurate and informative summaries of this important, interesting subject.

# FAX

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# NEWS

U.S. DEPARTMENT OF THE INTERIOR

**OFFICE OF THE SECRETARY**

FOR IMMEDIATE RELEASE
January 13, 2000

Stephanie Hanna (O) 202/208-6416

## KENNEWICK MAN OVER 9000 YEARS OLD AND NATIVE AMERICAN ACCORDING TO NAGPRA LAW

### Cultural Affiliation Studies underway to analyze evidence of Shared Group Identity with present day American Indian Tribes

The Department of the Interior today announced its conclusions on the first of two questions Interior is answering for the U.S. Army Corps of Engineers: whether the human skeletal remains found in the Columbia River (known as Kennewick Man) are to be considered Native American.

The Department of the Interior considers the Kennewick remains "Native American" for the purposes of the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA). The decision is based upon recent radiocarbon dating, analysis of a lithic point embedded in the left hip and other anthropological and sediment analysis performed in February, 1999.

In early September, 1999, two small bone samples were extracted from the metacarpal and tibia of the skeletal remains. These samples were divided in half and four samples were then sent for independent analysis and dating to three radiocarbon laboratories: the University of California at Riverside; Beta Analytical in Miami, Florida; and the National Science Foundation Accelerated Mass Spectometry Facility at the University of Arizona in Tucson.

Two of the dates from the three laboratories produced radiocarbon dates that closely matched an original radiocarbon date done in 1996. The date from Beta Analytical of 8410 +/- 40 B.P., adjusted or calibrated on scientific formulas taking into consideration changes in atmospheric carbon, yields a likely chronological age of the bones between 9510 and 9320 B.P.

"We believe that these are the bones of an ancient man who lived most of his life and died in the Pacific Northwest more than 9000 years ago," said Dr. Francis P. McManamon, Chief Archaeologist for the National Park Service and Chief Consulting Archaeologist for the Department of the Interior. "His age shows that he was here more than 8,000 years before the arrival of European exploration of our hemisphere. The sediment adhering to his bones and the shape of the Cascade point in his hip provide additional evidence consistent with the radiocarbon dates. For these reasons, Kennewick Man is to be considered Native American for the purposes of the NAGPRA."

As defined in NAGPRA, "Native American" refers to human remains and cultural items relating to tribes, peoples or cultures that resided within the area now encompassed by the United States prior to the historically documented arrival of European explorers. This definition exists irrespective of when a particular group may have begun to reside in a particular area, and irrespective of whether any or all of these early indigenous Americans were or were not culturally or biologically affiliated with present day Indian tribes.

The Interior Department is now in the midst of studies to address the issue of cultural affiliation or shared group identity between Kennewick Man and any present day tribes that have historically inhabited the area in the State of Washington around the confluence of the Columbia and Snake Rivers, where Kennewick Man's remains were found. At the present time, five tribes: the Umatilla, Colville, Wanapum, Nez Perce and Yakama have claimed the human remains as their ancestor.

The months taken in providing radiocarbon dating results were attributable to very low amounts of human collagen detectable in the bone samples. This phenomenon is consistent with very ancient human bone. Both the University of California at Riverside and the National Science Foundation Accelerated Mass Spectometry Facility at the University of Arizona found it necessary to run repeated tests in order to verify results and have noted that the level of collagen was below normal levels considered optimal by their laboratories. It should also be noted that it is likely that other carbon intruded into the tibia bone, yielding an ancient date that was more recent than the radiocarbon dates of the metacarpal bone tested in 1996 or the metatarsal samples from 1999.

The chronological date now accepted will be an important aspect of cultural affiliation studies that are now underway. During December and January, the National Park Service contracted four experts to report on archaeologic, linguistic, ethnographic, bio-archaeologic and traditional historic information. These experts are:
- Dr Kenneth Ames: archaeological information. Dr Ames is a Professor of Anthropology at Portland State University in Portland, Oregon.
- Dr Steven Hackenberger: bio-archaeological and mortuary archaeological information. Dr Hackenberger is Chairman of the Department of Anthropology at Central Washington University in Ellensberg, Washington.
- Dr Eugene Hunn: linguistic information. Dr Hunn is a Professor of Anthropology at the University of Washington in Seattle, Washington.
- Dr Daniel Boxberger: traditional historic and ethnographic information. Dr Boxberger is a Professor of Anthropology at Western Washington University in Bellingham, Washington.

"The Department of the Interior is very grateful to the four experienced professionals who have so graciously agreed to add these important studies to their existing workload at their universities," Dr McManamon said. "Under normal circumstances, the National Park Service would expect to have at least a year to gather and analyze the information they will provide. We have been ordered by the District Court in Oregon to come to conclusions based on these studies by March 24, 2000, and we will do everything possible to meet this deadline."

The Department of the Interior has not yet determined whether DNA testing is possible,

given the low levels of collagen in the bones, or would be necessary to do on the Kennewick remains.

**-DOI-**

# United States Department of the Interior

NATIONAL PARK SERVICE
1849 C Street, N.W.
Washington, D.C. 20240

IN REPLY REFER TO:

Memorandum

To: Assistant Secretary, Fish and Wildlife and Parks

Through: Director

From: Departmental Consulting Archeologist

Subject: Determination That the Kennewick Human Skeletal Remains are "Native American" for the Purposes of the Native American Graves Protection and Repatriation Act (NAGPRA)

Background

The interagency agreement between the Department of the Army (DOA) and the Department of the Interior (DOI), signed in March, 1998, delegated responsibilities to the DOI for certain decisions related to the set of human skeletal remains recovered from land managed by the Corps of Engineers (COE) near Columbia Park, Kennewick, WA. The agreement calls for the DOI to investigate and resolve two basic issues. First, we must determine whether or not the remains meet the definition of "Native American" according to the definition in the Native American Graves Protection and Repatriation Act (NAGPRA), as interpreted by DOI. Second, if the remains are Native American, the DOI will determine their disposition under the requirements of NAGPRA.

This memorandum describes the basis for the determination of the first of these actions, that is, whether or not the Kennewick skeletal remains are considered "Native American", as defined by NAGPRA.

As defined in NAGPRA, "Native American" refers to human remains and cultural items relating to tribes, peoples, or cultures that resided within the area now encompassed by the United States prior to the historically documented arrival of European explorers, irrespective of when a particular group may have begun to reside in this area, irrespective of when a particular group may have begun to reside in this area, and, irrespective of whether some or all of these groups were or were not culturally affiliated or biologically related to present-day Indian tribes.

If this set of remains is found to fit within the category of "Native American," issues related to cultural affiliation will be highly relevant to how disposition of the remains should be accomplished. However, this will be a subsequent step in our assistance to the DOA and is not addressed further in this memorandum. We currently are investigating the possible cultural affiliation of these remains.

The Kennewick Skeletal Remains are "Native American" as Defined by NAGPRA

We now have sufficient information to determine that these skeletal remains should be considered "Native American" as defined by NAGPRA. The results of recent radiocarbon dating of small samples of bone extracted from the remains were given significant weight in making this determination. This interpretation is supported by other analyses and information regarding the skeletal remains themselves, sedimentary analysis, lithic analysis, an earlier radiocarbon date on a bone recovered with the other remains, and geomorphologic analysis (summarized in McManamon 1999).

A series of radiocarbon dates now available from the Kennewick skeletal remains indicate a clearly pre-Columbian date for the remains (Table 1 and discussed below). It is reasonable to conclude that the human remains from Columbia Park in Kennewick, WA, are "Native American" as defined by the Native American Graves Protection and Repatriation Act.

A variety of additional scientific information support this chronological placement and determination. Geomorphologic and sedimentary investigations of the river bank near the discovery site (Wakeley et al. 1998; Huckleberry et al. 1998) indicate that sediment layers consistent with these dates exist in the alluvial terrace where we believe the remains were buried originally. The documentation, examination, and analysis of the skeletal remains themselves (Powell and Rose 1999) suggest a pre-Columbian context for the remains. Comparison of sediments adhering to the skeletal remains and sediments from the river bank profile are consistent with the skeletal remains having been buried in sediments stratigraphically dated pre-7000 BP (Huckleberry and Stein 1999). Information from the analysis of the lithic artifact lodged in the ilium of the skeletal remains also is consistent with an ancient date for the remains themselves (Fagan 1999). In all, information derived using the methods and techniques of archeology, geomorphology, physical anthropology, sedimentology, and other scientific disciplines support this determination

Our determination that the Kennewick skeletal remains are "Native American" is based upon the scientific information that we have available. As explained in subsequent sections, this a reasonable determination based upon such information now on hand.

Summary of the Radiocarbon Results

Four C14 dates have been reported for the samples extracted by the Department of the Interior and Corps of Engineers in September, 1999. The samples have been processed and dated by Beta Analytical, Inc. (BA), of Miami, Florida, the Radiocarbon Laboratory of the University of California, Riverside (UC-R), and the NSF-Arizona AMS Facility of the University of Arizona (UA). Two of the four new dates show a substantial conformance with the initial radiocarbon date of the portion of the metacarpal submitted by Benton County in 1996 (see Table 1). All the carbon samples showed very low carbon content and this has slowed the processing of the samples and extended the time required to develop our interpretation of the C14 dates.

The BA date (Beta-133993) gave a conventional radiocarbon age of 8410 +/- 40 BP (Hood 1999a and Attachment 1). The equivalent calibrated radiocarbon age (using the two sigma, 95% probability) in years BP is cal BP 9510 to 9405 and cal BP 9345 to 9320. The bone sample used for this date was approximately half of the right metatarsal, one of the load-bearing bones of the foot (Sample DOI 1a). Analysis and processing of the sample at Beta indicated that the amount of organic carbon remaining in the sample was very low. The Laboratory Director of BA, Mr. Darden Hood, reported that "the original weight of the bone was 9.1 grams. The amount of collagen extracted was 0.030 grams (30.0 mg). This relates to a percent concentration of 0.3%. The value is very low due to the high mineral content of the submitted bone. 9.5 mg. Of the collagen was used for the analysis. This provided us with 3.2 mg. of carbon. The percentage of carbon is then calculated as 33.7% carbon within the collagen (Hood 1999b and Attachment 2)." Mr. Hood also reported that "by our standards, the collagen extract looked free of intrusive elements...It was vitreous in texture and golden in color as expected. It was free of visible contamination or deterioration. However, this does not preclude the presence of secondary [i.e., intrusive] environmental proteins (Hood 1999c)."

The Radiocarbon Laboratory of the UC-R processed and dated two of the Kennewick bone samples (Taylor 1999 and Attachment 3). Like the BA sample, both of these were very low in carbon content. Due to the low carbon content and the lack of clear collagen-like characteristics of the extracted carbon, the dates were reported as "the apparent C14 ages" for each sample (see Table 1). One of the samples (Sample DOI 1b) was dated as 8130 +/- 40 BP (UCR-3806/CAMS-60684), slightly different from the BA date for Sample DOI 1a, but not inconsistent with it. These two samples, in fact, are from the same bone, the right first metatarsal.

Both of these dates (Beta-133993) and (UCR-3806/CAMS-60684) are consistent with the earlier C14 date obtained from a portion of the 5th left metacarpal (Taylor et al 1998). The BA date, in fact is almost identical to the first C14 date.

DOI 06049

The other UC-R date is also old, an apparent C14 age of 6940 +/- 30 BP (UCR-3806/CAMS-60683), but more recent than the other dates. This sample (Sample DOI 2b) from the left tibial crest also is more deteriorated than Sample DOI 1b. Sample DOI 2b contains only 2.3% of the carbon relative to the UC-R modern bone standard while Sample DOI 1b contains 14.3% of the modern standard.

The UA laboratory dated the second subsample from the left tibial crest (Sample DOI 2a). The date they obtained is also old, 5570 +/- 100 BP (AA34818). This date is more or less consistent with the UC-R 3806/CAMS-60683 date and together they suggest that exogenous "new carbon" is pronounced in the left tibia from which these two samples were taken. The UA laboratory also reported a low carbon content for Sample DOI 2a (Donahue 2000a and b and Attachment 4). They recorded a carbon yield of .05 %, that is, the final mass of carbon based upon the initial mass of the bone. UA's analysis of this level of carbon content was that they could not determine the source of the carbon, i.e., whether it was inherent or exogenous.

Low Carbon and Possibility of Intrusive Contamination

One problem with dating bone samples with low carbon is that exogenous or intrusive carbon may have infiltrated the bone and become mixed with the endogenous or inherent carbon. If treatment of the sample before dating is not able to remove the intrusive carbon, any date from the sample will be distorted by the intrusive carbon. In most cases, it is younger carbon that is intrusive, for example, carbon from plant roots, soil microorganisms, or humic organic compounds in the soil. Usually such sources of exogenous carbon post-date the death and burial of the bone being dated. The effect of such mixing of "new carbon" with the original carbon in the bone is to make the date of the bone appear more recent than the true date.

In the case at hand, this may be the reason for the date from Sample DOI 2b. Taylor suggested this in his report on the C14 dating of the samples done by UC-R. "One interpretation [of the difference between the original date and the dates from these samples] is that the age offsets reflect varying percentages of more recent and/or modern contamination in both UCR-3806 and UCR-3807, with the percentage contribution of contamination increasing as a function of the decreasing residual collagen protein content (Taylor 1999a:1-2)."

If the only probable risk of intrusion by exogenous carbon is from more recent or modern carbon, as seems likely, the dates for the Kennewick bone samples indicate strongly that the remains definitely are pre-Columbian, and therefore "Native American" as defined by NAGPRA.

In certain geomorphologic circumstances, bone can be infiltrated by older carbon. If such "old carbon" is not removed in treatment prior to dating, dates will be distorted by appearing older than the bone itself. The geomorphic context in which we believe the Kennewick skeleton was buried and rested for many centuries is unlikely to have been affected by such contamination. There appears not to be an accessible and likely source for such carbon. Limestone, a common source of old carbon, is not prevalent in the watershed. Nor has there been much of an opportunity for such intrusion to have occurred through groundwater immersion of the bone by old carbon saturated water (Huckleberry et al. 1998; Wakeley et al. 1998) .

Difference with the 1996 C14 Sample

The low amounts of carbon detected in the DOI samples extracted from the right metatarsal and left tibia of the Kennewick remains differ substantially from the carbon content of the bone sample (portion of the fifth left metacarpal) submitted to the UC-R Archaeology Lab by the Benton County Coroner's office in August, 1996. The carbon content of this sample (UCR-3476/CAMS-29578) has been reported by UC-R as "...68.8% of our modern reference sample and the relative concentrations of amino acids was similar to that observed in our modern bone standard...(Taylor et al. 1998:1171-1172)"

This discrepancy between the carbon content observed in the 1996 sample and the samples analyzed in 1999 calls into question the relationship of the earlier sample to the rest of the human remains. It is unexpected and unusual, although not impossible, for an individual human skeleton to exhibit widely different concentrations of collagen in bones from different parts of the body.

Prior to the detailed examination of the Kennewick human remains in February, 1999, reported by Powell and Rose (1999) there were questions concerning whether the skeletal elements collected during July and August, 1996, were from a single individual. Powell and Rose demonstrated that the remains obtained from the original collector by the Corps of Engineers and curated since September, 1996, by them indeed were from a single individual. Also arguing for these bones being from the same individual is the fact that three independent radiocarbon dates consistently show the bones to date between about 8000 and 8500 BP.

We have received a more detailed description by the archeologist who originally collected the remains in 1996 (Egan 2000). This information indicates that the bone used for the 1996 C14 date was similar to other bones in appearance and might have been better protected from long term deterioration. There appears to be a photograph of the bone fragment to compare with the other bones. We shall verify this information using the photograph as best we can.

Conclusion

The chronological information needed to make the determination that the Kennewick skeletal remains are "Native American" as defined by NAGPRA has been provided by the additional C14 testing conducted by the Department of the Interior and three radiocarbon laboratories. All the dates obtained predate 6000 BP and are clearly pre-Columbian. Two of the dates match closely the C14 date obtained in 1996 on another bone fragment believed to be from the skeleton.

Results of the earlier documentation, examination, and analysis of the remains themselves, sediment analysis comparing the sediment on the bones with sediment from the soil profile near where they were recovered, analysis of the lithic point embedded in the left ilium of the remains, and geomorphologic studies near the discovery site also support this determination.

Concur: Donald J. Barry 1/11/00

Donald J. Barry, Assistant Secretary (date)
Fish and Wildlife and Parks, Department of the Interior

Attachments:

List of References Mentioned in Text

Table 1: C14 Samples and Radiocarbon Dates from Kennewick Skeletal Remains

Attachment 1. Hood, Darden (1999a) Report of sample processing and dating. Letter to Dr. Francis P. McManamon, 17 October 1999.

Attachment 2. Hood, Darden (1999b) Additional information regarding Beta Analytic's radiocarbon dating analysis of Kennewick bone sample CENWW.97.R.24(Mta)/DOI1a. Letter to Dr. Francis P. McManamon, 18 November 1999.

Attachment 3. R. E. Taylor (1999) Results of the UCR Radiocarbon Analysis of two Kennewick Bones Compared with the Earlier Results. Fax to Dr. Francis P. McManamon, 20 December 1999.

Attachment 4. Donahue, Douglas (2000a) Carbon-isotope measurements on the Kennewick bone. Letter to Francis P. McManamon, 10 January 2000; and Donahue, Douglas (2000b) Results of measurements, equipment preparation, sampling procedure, and the pretreatment procedure. Letter to Francis P. McManamon, 9 January 2000.

References Mentioned in Text

Donahue, Douglas (2000a) Results of the carbon-isotope measurements on the Kennewick. Letter to Francis P. McManamon, 10 January 2000. Included here as Attachment 4. On file, Archeology and Ethnography, National Park Service, Department of the Interior.

Donahue, Douglas (2000b) Results of measurements to date on the Kennewick bone, equipment preparation, sampling procedure, and the pretreatment procedure. Letter, 9 January 2000. Included here as Attachment 4. On file, Archeology and Ethnography, National Park Service, Department of the Interior.

Egan, James E. (2000) Letter to Allison B. Rumsey, Department of Justice, January 10, 2000.

Fagan, John L. (1999) Analysis of Lithic Artifact Embedded in the Columbia Park Remains. Report at <http://www.cr.nps.gov/aad/kennewick/fagan.htm>, visited December 8, 1999. Archeology and Ethnography Program, National Park Service, Department of the Interior.

Hood, Darden (1999a) Report of sample processing and dating. Letter to Dr. Francis P. McManamon, 17 October 1999. Included here as Attachment 1. On file, Archeology and Ethnography Program, National Park Service, Department of the Interior.

Hood, Darden (1999b) Additional information regarding Beta Analytic's radiocarbon dating analysis of Kennewick bone sample CENWW.97.R.24(Mta)/DOI1a. Letter to Dr. Francis P. McManamon, 18 November 1999. Included here as Attachment 2. On file, Archeology and Ethnography Program, National Park Service, Department of the Interior.

Hood, Darden (1999c) Background about the Kennewick C14 Samples. E-Mail to Dr. Francis P. McManamon, 9 December 1999. Included here as Attachment. On file, Archeology and Ethnography Program, National Park Service, Department of the Interior.

Huckleberry, Gary, Thomas W. Stafford, and James C. Chatters (1998) Preliminary Geoarchaeological Studies at Columbia Park, Kennewick, Washington, USA. Report Submitted to U.S. Army Corps of Engineers, Walla Walla District, March 23, 1998.

Huckleberry, Gary and Julie K. Stein (1999) Analysis of Sediments Associated with Human Remains Found at Columbia Park, Kennewick, WA. Report at <http://www.cr.nps.gov/aad/kennewick/huck_stein.htm>, visited December 8, 1999. Archeology and Ethnography Program, National Park Service, Department of the Interior.

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Powell, Joseph F. and Jerome C. Rose (1999) Report on the Osteological Assessment of the "Kennewick Man" Skeleton (CENWW.97.Kennewick). Report at <http://www.cr.nps.gov/aad/kennewick/powell_rose.htm>, visited December 8, 1999. Archeology and Ethnography Program, National Park Service, Department of the Interior.

R. E. Taylor (1999) Results of the UCR Radiocarbon Analysis of two Kennewick Bones Compared with the Earlier Results. Fax to Dr. Francis P. McManamon, 20 December 1999. Included here as Attachment 3. On file, Archeology and Ethnography Program, National Park Service, Department of the Interior.

R. E. Taylor, D. L. Kirner, J. R. Southon, and J. C. Chatters (1998) Letter to Science, "Radiocarbon Dates of Kennewick Man." Science 280:1171-1172.

Wakeley, Lillian D., William L. Murphy, Joseph B. Dunbar, Andrew G. Warne, Frederick L. Briuer, and Paul R. Nickens (1998) Geologic, Geoarchaeologic, and Historical Investigation of the Discovery Site of Ancient Remains in Columbia Park, Kennewick, Washington. Prepared for U.S. Army Engineer District, Walla Walla, WA (Technical Report GL-98-13), September 1998.

Table 1: C14 Samples and Radiocarbon Dates from Kennewick Skeletal Remains

| Radiocarbon Lab/Sample Number | Radiocarbon Age | Calibrated Radiocarbon Age |
|---|---|---|
| **Beta Analytical Inc.** | | |
| Beta-133993<br>Sample Catalog #: CENWW.97.R.24(MTa)<br>Sample #: DOI 1a<br>Portion of right first metatarsal | 8410 +/- 40 BP | cal BP 9510-9405<br>and cal BP 9345-9320 |
| **University of California at Riverside Radiocarbon Laboratory** | | |
| UCR-3807/CAMS-60684<br>Sample Catalog #: CENWW.97.R.24(MTa)<br>Sample #: DOI1b<br>Portion of right first metatarsal | 8130 +/- 40 BP[1] | |
| UCR-3806/CAMS-60683<br>Sample Catalog #: CENWW..97.L.20b<br>Sample #: DOI2b<br>Portion of left tibial crest | 6940 +/- 30 BP[1] | |
| UCR-3476/CAMS-29578<br>Sample #: APS-PS-01<br>5th left metacarpal | 8410 +/- 60 BP<br>[original C14 date from 1996 analysis] | |
| **University of Arizona NSP-Arizona AMS Facility** | | |
| AA-34818<br>Sample Catalog #: CENWW.97.L.20b<br>Sample #: DOI2a<br>Portion of left tibial crest | 5750 +/- 100 BP | |

[1] Reported by UC-R as "apparent C14 age"

ATTACHMENT 1

# BETA ANALYTIC INC.

RADIOCARBON DATING SERVICES

Mr. DARDEN G. HOOD
Director

RONALD E. HATFIELD
Laboratory Manager

CHRISTOPHER PATRICK
TERESA A. ZILKO-MILLER
Associate Managers

October 17, 1999

Dr. Francis P. McManamon
Dept. of Interior
National Park Service
Archeology And Ethnography Program
1849 C Street N.W. (NC 340/2275)
Washington, DC 20240

Dear Dr. McManamon:

Please find enclosed the radiocarbon dating result for one bone sample "CENWW.97.R.24(MTa)/DOI1a" which was received on September 10. It was very small, requiring us to convert the sample carbon to graphite and then to count the radiocarbon atomically using an accelerator mass spectrometer (AMS). It provided plenty of carbon for reliable measurements and all analytical steps went normally. The quoted errors represent 1 sigma statistics. Since these errors cannot include uncertainties outside of those which can be quantified during measurement, it is best to consider them as minimum quotes.

Note that we notified your office upon beginning the analysis with an observation that the "R" in the submitter number on the sample package was not listed on the sample datasheet. Since it was listed on the sample package, we have used it in the reported sample designation number.

The bone sample was highly encrusted and in-filled with non-calcareous minerals. These minerals were physically eliminated with grinding, prior to demineralization of the apatite fraction with hydrochloric acid. The resultant protein extracted was subjected to alkali in high enough concentration to eliminate any secondary organic acid contamination. SEM analysis (photo-micrographs enclosed) were examined prior to pretreatment and after pretreatment (but prior to AMS analysis) to establish the integrity of the sample material.

The report sheet contains calibration results which enhance the accuracy of the radiocarbon dating. A hard-copy is enclosed showing the radiocarbon year/calendar year correlation curve segment associated with the radiocarbon date, along with explanation sheets. You will notice the X axis (cal BC age) that multiple two sigma ranges are possible for the radiocarbon date. This is discussed on the report sheet.

The results are reported in three formats; the Conventional Radiocarbon Age (BP) which is systematic with radiocarbon dates quoted without calendar calibration, calibrated calendar age (cal BC) which is corrected for true half life and atmospheric fluctuations and reported in calendar years, and calibrated Conventional Radiocarbon Age (cal BP), where the same half life and atmospheric fluctuation corrections are applied to provide a corrected BP format result (BP = before present, present being AD 1950). The cal BC and cal BP results are reported using the

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two sigma, 95% probability limitation. As noted on the report sheet, if other lines of evidence give you confidence to use the one sigma range on the calibrated results, you may use that range instead (which is listed on the hard-copy calibration print-out). In summary, the results are:

| | |
|---|---|
| Conventional Radiocarbon Age: | 8410 +/- 40 BP |
| Calibrated Calendar Age (2 sigma): | cal BC 7560 to 7455 and cal BC 7395 to 7370 |
| Calibration Radiocarbon Age (2 sigma): | cal BP 9510 to 9405 and cal BP 9345 to 9320 |

Also enclosed is a Quality Assurance report showing the expected and measured ages for standards and a blind measured in the AMS. As I previously mentioned, we only rely on the AMS for the measurement. The machine is provided with our own standards, blanks, and blinds, already loaded in the target holder. The machine simply makes a measurement for us, which we verify. The QA report shows the measurement of two secondary standards (TIRI wood and TIRI turbidite). These two targets are international standards, with known consensus values. The "expected values" listed on the report are those consensus values. The "blind" listed on the QA report is a sample which had been previously analyzed by us. The AMS facility did not know the previous result for this blind.

A photo-documentary of the analysis is enclosed. Given the sensitivity of this analysis, each step of the analysis was carefully documented. Notes were taken by each individual involved in the analysis which consisted of myself Mr. Darden Hood, Director (20 years experience), Mr. Ronald Hatfield, Laboratory Manager (18 years experience), Mr. Christopher Patrick, Associate Manager (15 years experience), Ms. Teresa Zilko-Miller (12 years experience), Ms. Lethia Cerda, Office Coordinator (8 years experience), and Mr. David Miller, Staff (6 years experience). The sample graphite along with the necessary standards, already pressed into the target holder under our control, was sent to the AMS facility at Lawrence Livermore National Laboratory for measurement, and the result verified through our QA program.

One comment on the results is the 13C/12C ratio result. The value is elevated, indicating the individual had a C4 plant, or marine diet. Corn is the staple diet of most individuals with an elevated 13C/12C ratio. Since corn was not present 9000 years ago (to our knowledge), it suggests the likelihood of a marine diet. If this is the case, the presence of a "reservoir effect" in the diet may need to be considered. This effect may make the radiocarbon dating "too old" by some amount, perhaps by several hundred years.

The cost of the analysis was charged to your MASTERCARD. A receipt is enclosed. Also enclosed is excess poor quality bone which was not used in the analysis and the remaining protein extracted from the sample. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood

DOI 06058

BETA

**BETA ANALYTIC INC.**

DR. M.A. TAMERS and MR. D.G. HOOD

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# REPORT OF RADIOCARBON DATING ANALYSES

Dr. Francis P. McManamon

Report Date: October 17, 1999

Department of Interior

Material Received: September 10, 1999

| Sample Data | $^{13}C / ^{12}C$ Ratio | Conventional Radiocarbon Age |
|---|---|---|
| Beta-133993 | -12.6 o/oo | 8410 +/- 40 BP |

SAMPLE #: CENWW.97.R.24(MTa)/DOI1a
ANALYSIS: Standard-AMS
MATERIAL/PRETREATMENT:(bone collagen): collagen extraction with alkali

COMMENT:

The above noted Conventional Radiocarbon Age can be calibrated to enhance the accuracy of the result. Our calendar calibrations are now calculated back to about 19,000 years using the newest calibration data as published in *Radiocarbon*, Vol. 40, No. 3, 1998 using the cubic spline fit mathematics as published by Talma and Vogel, *Radiocarbon*, Vol. 35, No. 2, pg 317-322, 1993: A Simplified Approach to Calibrating C14 Dates. Results are reported both as cal BC and cal BP. It is important to quote the original Conventional Radiocarbon Age, 13C/12C ratio and the calibration references in your publications for future reference by other researchers.

The equivalent calibrated calendar age (using the two sigma, 95% probability) in years BC is;

"cal BC 7560 to 7455 and cal BC 7395 to 7370"

The equivalent calibrated radiocarbon age (using the two sigma, 95% probability) in years BP is;

"cal BP 9510 to 9405 and cal BP 9345 to 9320"

Two ranges are possible due to "wiggles" in the calibration curve in this time region. A graphical representation of this calibration is enclosed. The two sigma range is quoted to encompass the delineation between separate radiocarbon events. One sigma ranges may be more appropriate for your research if other lines of evidence allow the use of higher precision. The one sigma ranges are "cal BC 7535 to 7480 and cal BP 9485 to 9430".

These calibration results are unique to the single Conventional Radiocarbon Age. Multiple measurements of the sample would provide statistically indistinguishable radiocarbon ages, each with its own unique calibrated range. For this reason, it is recommended that the calibration results be used in general terms.

When comparing the statistical agreement between radiocarbon dates, it is best to compare Conventional Radiocarbon Ages, as the calibration results may vary depending on the calculation format and time of calibration (ie calibration tables have changed through the years). The best average for muliple dates is to calculate a weighted average for Conventional Radiocarbon Ages and then do the calibration.

DOI 06059

**Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By international convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.**

**Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.**

# BETA ANALYTIC INC.

RADIOCARBON DATING SERVICES

Mr. DARDEN G. HOOD
Director

RONALD E. HATFIELD
Laboratory Manager

CHRISTOPHER PATRICK
TERESA A. ZILKO-MILLER
Associate Managers

## Quality Assurance Report

This report provides the results of reference materials used to validate AMS radiocarbon dating results on unknown materials, prior to reporting. Unknowns and reference materials were chemically converted to graphite at Beta and then sent to CAMS for C14 content measurement.

---

Reference standard results for Beta-133993

| | |
|---|---|
| Report date: | October 17, 1999 |
| Submitter: | Dr. Francis McManamon |
| CAMS report: | October 4, 1999 |

Secondary oxalic acid reference standard.

| | |
|---|---|
| Expected value: | 103.9 % modern |
| Measured value: | 103.9 % +/- 0.3% |
| Agreement: | good |

TIRI wood standard (international standard)

| | |
|---|---|
| Expected value: | 4503 +/- "6" BP |
| Measured value: | 4510 +/- 30 BP |
| Agreement: | good |

TIRI carbonate standard (international standard)

| | |
|---|---|
| Expected value: | 18,155 +/- "34" BP |
| Measured value: | 18,390 +/- 70 BP |
| Agreement: | good |

Blind sample (measured radiometrically at Beta Analytic and sent to CAMS without their knowledge of the previous result).

| | |
|---|---|
| Radiometric age at Beta: | 1160 +/- 60 BP |
| AMS age at CAMS: | 1150 +/- 40 BP |
| Agreement: | good |

Background material:

(double-spar calcite)
Expected value: greater than 50,000 BP
Measured value: 56500 +/- 600 BP
Agreement: good

(Miocene Coal)
Expected value: 50,000 BP
Measured value: 47000 +/-270 BP
Agreement: good

Validation: Darden Hood : Date October 17, 1999

DOI 06060

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# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-12.6:lab. mult=1)

**Laboratory number:** **Beta-133993**

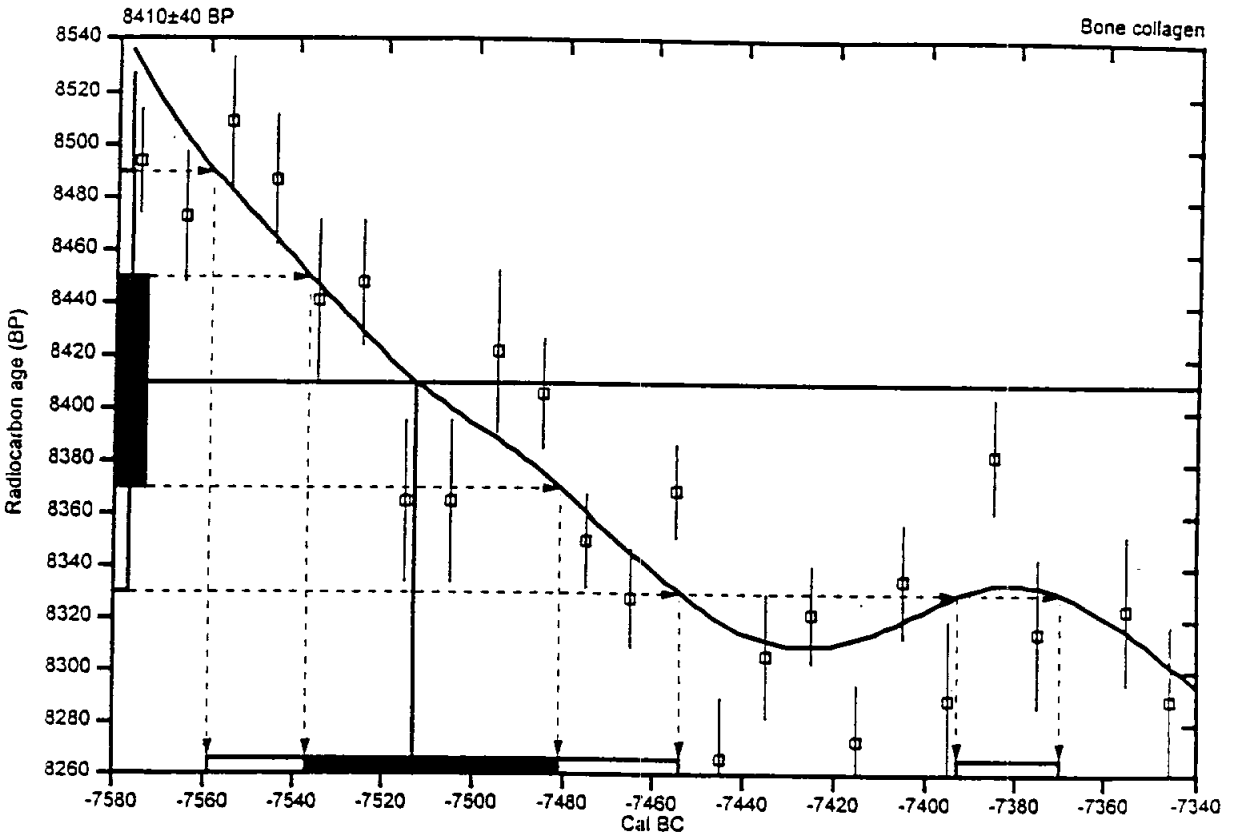
**Conventional radiocarbon age:** **8410±40 BP**

**2 Sigma calibrated results:** **Cal BC 7560 to 7455 (Cal BP 9510 to 9405) and**
**(95% probability)** **Cal BC 7395 to 7370 (Cal BP 9345 to 9320)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 7515 (Cal BP 9465)

1 Sigma calibrated result: (68% probability) Cal BC 7535 to 7480 (Cal BP 9485 to 9430)




References:

*Database used*

*Calibration Database*
*Editorial Comment*
*Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii*
*INTCAL98 Radiocarbon Age Calibration*
*Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083*
*Mathematics*
*A Simplified Approach to Calibrating C14 Dates*
*Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322*

DOI 06061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# BETA ANALYTIC INC.

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CHRISTOPHER PATRICK
TERESA A. ZILKO-MILLER
Associate Managers


## ANALYTICAL PROCEDURES AND FINAL REPORT

### FINAL REPORT

This package includes the final date report, this statement outlining our analytical procedures, a glossary of pretreatment terms, calendar calibration information, billing documents (containing balance/credit information and the number of samples submitted within the yearly discount period), and peripheral items to use with future submittals. The final report includes the individual analysis method, the delivery basis, the material type and the individual pretreatments applied. Please recall any correspondences or communications we may have had regarding sample integrity, size, special considerations or conversions from one analytical technique to another (e.g. radiometric to AMS). The final report has also been sent by fax or e-mail, where available.

### PRETREATMENT

Results were obtained on the portion of suitable carbon remaining after any necessary chemical and mechanical pretreatments of the submitted material. Pretreatments were applied, where necessary, to isolate $^{14}C$ which may best represent the time event of interest. Individual pretreatments are listed on the report next to each result and are defined in the enclosed glossary. When interpreting the results, it is important to consider the pretreatments. Some samples cannot be fully pretreated making their $^{14}C$ ages more subjective than samples which can be fully pretreated. Some materials receive no pretreatments. Please read the pretreatment glossary.

### ANALYSIS

Materials measured by the radiometric technique were analyzed by synthesizing sample carbon to benzene (92% C), measuring for $^{14}C$ content in a scintillation spectrometer, and then calculating for radiocarbon age. If the Extended Counting Service was used, the $^{14}C$ content was measured for a greatly extended period of time. AMS results were derived from reduction of sample carbon to graphite (100 %C), along with standards and backgrounds. The graphite was then sent for $^{14}C$ measurement in an accelerator-mass-spectrometer located at one of six collaborating research facilities, who return the results to us for verification, isotopic fractionation correction, calendar calibration, and reporting.

### THE RADIOCARBON AGE AND CALENDAR CALIBRATION

The "Conventional C14 Age (*)" is the result after applying C13/C12 corrections to the measured age and is the most appropriate radiocarbon age (the "*" is discussed at the bottom of the final report). Applicable calendar calibrations are included for organic materials and fresh water carbonates between 0 and 10,000 BP and for marine carbonates between 0 and 8,300 BP. If certain calibrations are not included with this report, the results were either too young, too old, or inappropriate for calibration.


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# PRETREATMENT GLOSSARY

Pretreatment of submitted materials is required to eliminate secondary carbon components. These components, if not eliminated, could result in a radiocarbon date which is too young or too old. Pretreatment does not ensure that the radiocarbon date will represent the time event of interest. This is determined by the sample integrity. The old wood effect, burned intrusive roots, bioturbation, secondary deposition, secondary biogenic activity incorporating recent carbon (bacteria) and the analysis of multiple components of differing age are just some examples of potential problems. The pretreatment philosophy is to reduce the sample to a single component, where possible, to minimize the added subjectivity associated with these types of problems.

"acid/alkali/acid"

The sample was first gently crushed/dispersed in deionized water. It was then given hot HCl acid washes to eliminate carbonates and alkali washes (NaOH) to remove secondary organic acids. The alkali washes were followed by a final acid rinse to neutralize the solution prior to drying. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of the sample. Each chemical solution was neutralized prior to application of the next. During these serial rinses, mechanical contaminants such as associated sediments and rootlets were eliminated. This type of pretreatment is considered a "full pretreatment". On occasion the report will list the pretreatment as "acid/alkali/acid - insolubles" to specify which fraction of the sample was analyzed. This is done on occasion with sediments (See "acid/alkali/acid - solubles"

Typically applied to: charcoal, wood, some peats, some sediments, textiles

"acid/alkali/acid - solubles"

On occasion the alkali soluble fraction will be analyzed. This is a special case where soil conditions imply that the soluble fraction will provide a more accurate date. It is also used on some occasions to verify the present/absence or degree of contamination present from secondary organic acids. The sample was first pretreated with acid to remove any carbonates and to weaken organic bonds. After the alkali washes (as discussed above) are used, the solution containing the alkali soluble fraction is isolated/filtered and combined with acid. The soluble fraction which precipitates is rinsed and dried prior to combustion.

"acid washes"

Surface area was increased as much a possible. Solid chunks were crushed, fibrous materials were shredded, and sediments were dispersed. Acid (HCl) was applied repeatedly to ensure the absence of carbonates. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of each sample. The sample, for a number of reasons, could not be subjected to alkali washes to ensure the absence of secondary organic acids. The most common reason is that the primary carbon is soluble in the alkali. Dating results reflect the total organic content of the analyzed material. Their accuracy depends on the researcher's ability to subjectively eliminate potential contaminants based on contextual facts.

Typically applied to: organic sediments, some peats, small wood or charcoal, special cases

"collagen extraction"

The material was first tested for friability ("softness"). Very soft bone material is an indication of the potential absence of the collagen fraction (basal bone protein acting as a "reinforcing agent" within the crystalline apatite structure). It was then washed in de-ionized water and gently crushed. Dilute, cold HCl acid was repeatedly applied and replenished until the mineral fraction (bone apatite) was eliminated. The collagen was then dissected and inspected for rootlets. Any rootlets present were also removed when replenishing the acid solutions. Where possible, usually dependant on the amount of collagen available, alkali (NaOH) was also applied to ensure the absence of secondary organic acids.

Typically applied to: bones

BETA ANALYTIC INC.
RADIOCARBON DATING LABORATORY
CALIBRATED C-14 DATING RESULTS

Calibrations of radiocarbon age determinations are applied to convert BP results to calendar years. The short term difference between the two is caused by fluctuations in the heliomagnetic modulation of the galactic cosmic radiation and, recently, large scale burning of fossil fuels and nuclear devices testing. Geomagnetic variations are the probable cause of longer term differences.

The parameters used for the corrections have been obtained through precise analyses of hundreds of samples taken from known-age tree rings of oak, sequoia, and fir up to about 10,000 BP. Calibration using tree-rings to about 12,000 BP is still being researched and provides somewhat less precise correlation. Beyond that, up to about 20,000 BP, correlation using a modeled curve determined from U/Th measurements on corals is used. This data is still highly subjective. Calibrations are provided up to about 19,000 years BP using the most recent calibration data available (Radiocarbon, Vol 40, No. 3, 1998).

The Pretoria Calibration Procedure (Radiocarbon, Vol 35, No. 1, 1993, pg 317) program has been chosen for these calendar calibrations. It uses splines through the tree-ring data as calibration curves, which eliminates a large part of the statistical scatter of the actual data points. The spline calibration allows adjustment of the average curve by a quantified closeness-of-fit parameter to the measured data points. A single spline is used for the precise correlation data available back to 9900 BP for terrestrial samples and about 6900 BP for marine samples. Beyond that, splines are taken on the error limits of the correlation curve to account for the lack of precision in the data points.

In describing our calibration curves, the solid bars represent one sigma statistics (68% probability) and the hollow bars represent two sigma statistics (95% probability). Marine carbonate samples that have been corrected for δ 13/12C, have also been corrected for both global and local geographic reservoir effects (as published in Radiocarbon, Volume 35, Number 1, 1993) prior to the calibration. Marine carbonates that have not been corrected for δ 13/12C are adjusted by an assumed value of 0 ‰ in addition to the reservoir corrections. Reservoir corrections for fresh water carbonates are usually unknown and are generally not accounted for in those calibrations. In the absence of measured δ 13/12C ratios, a typical value of -5 ‰ is assumed for freshwater carbonates.

(Caveat: the correlation curve for organic materials assume that the material dated was living for exactly ten years (e.g. a collection of 10 individual tree rings taken from the outer portion of a tree that was cut down to produce the sample in the feature dated). For other materials, the maximum and minimum calibrated age ranges given by the computer program are uncertain. The possibility of an "old wood effect" must also be considered, as well as the potential inclusion of younger or older material in matrix samples. Since these factors are indeterminant error in most cases, these calendar calibration results should be used only for illustrative purposes. In the case of carbonates, reservoir correction is theoretical and the local variations are real, highly variable and dependant on provenience. Since imprecision in the correlation data beyond 10,00 years is high, calibrations in this range are likely to change in the future with refinement in the correlation curve. The age ranges and especially the intercept ages generated by the program, must be considered as approximations.)

# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Variables used in the calculation of age calibration → (Variables: est. C13/C12=-25:lab. mult=1)

**Laboratory number:** Beta-123456

**Conventional radiocarbon age[1]:** 2400±60 BP ← The uncalibrated Conventional Radiocarbon Age (± 1 sigma)

The calendar age range in both calendar years (AD or BC) and in Radiocarbon Years (BP) →

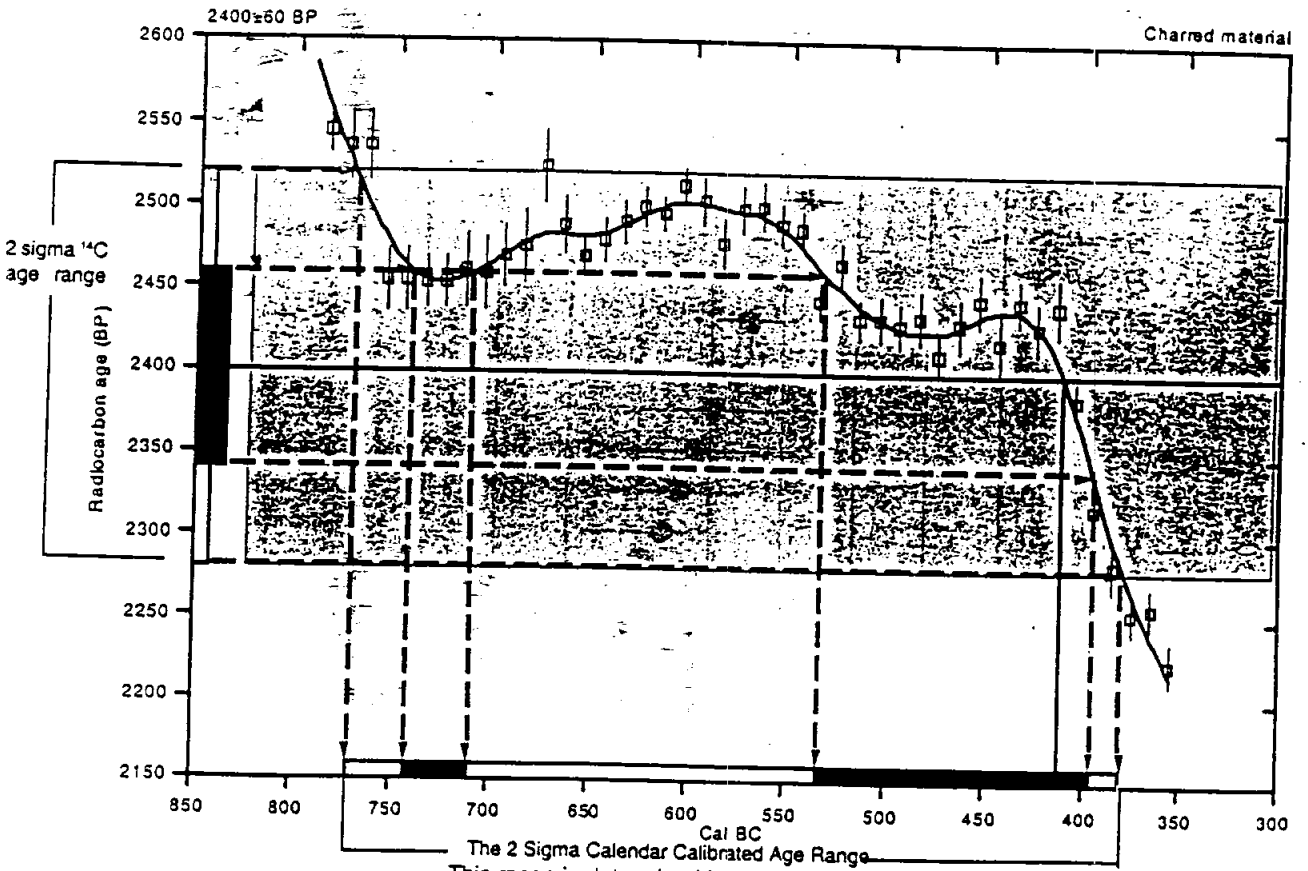
**2 Sigma calibrated result:** Cal BC 770 to 380 (Cal BP 2720 to 2330)
**(95% probability)**

[1] *C13/C12 ratio estimated*

Intercept data ← The intercep: between the average radiocarbon age and the calibrated curve time scale. This value is illustrative and should not be used by itself.

**Intercept of radiocarbon age with calibration curve:** Cal BC 410 (Cal BP 2360)

**1 Sigma calibrated result:** Cal BC 740 to 710 (Cal BP 2690 to 2660) and
**(68% probability)** Cal BC 535 to 395 (Cal BP 2485 to 2345)




This range is determined by the portion of the curve that is in a "box" drawn from the 2 sigma limits on the radiocarbon age. If a section of the curve goes outside of the "box", multiple ranges will occur as shown by the two 1 sigma ranges which occur from sections going outside of a similar "box" which would be drawn at the 1 sigma limits.

References:


*Database used*
*Intcal 98*
*Calibration Database*
*Editorial Comment*
*Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii*
*INTCAL98 Radiocarbon Age Calibration*
*Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083*
*Mathematics*
*A Simplified Approach to Calibrating C14 Dates*
*Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322*


References for the calibration data and the mathematics applied to the data. These references, as well as the Conventional Radiocarbon Age and the 13C/12C ratio used should be included in your papers.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DOI 06065

# BETA ANALYTIC INC.

RADIOCARBON DATING SERVICES

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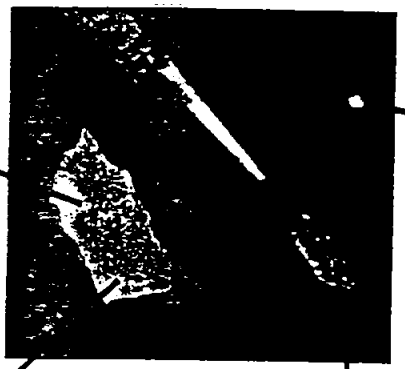
Associate Managers

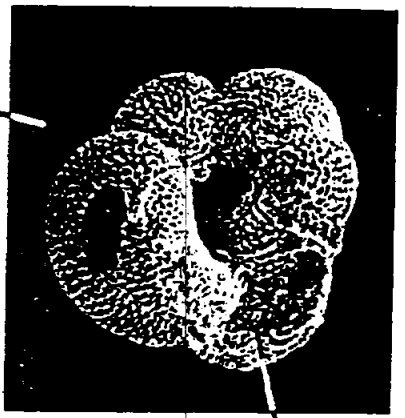
## SCANNING ELECTRON MICROSCOPY (SEM)
of materials submitted for radiocarbon dating

Scanning Electron Microscopy (SEM) can be used to magnify objects up to 10,000 times. SEM photographs showing microscopic details provide very useful information in the interpretation of radiocarbon dates. For instance, SEM can be used to distinguish primary vs. secondary shell structure and to identify very small wood, charcoal, and carbonate samples. SEM micrographs are also an excellent addition to reports and theses. We highly recommend this analysis through your own sources, or if not available, by our services.

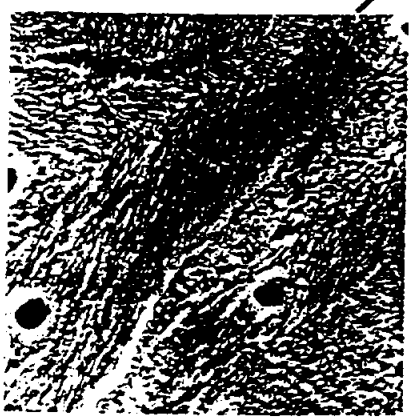
Primary $CaCO_3$, 690x, SEM



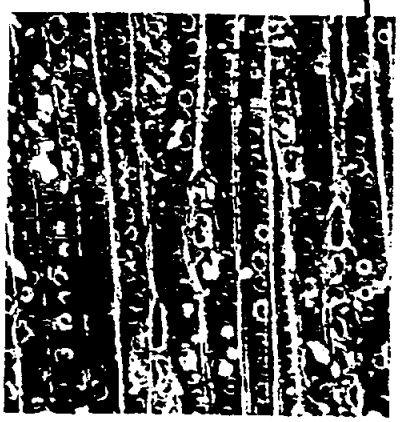
Samples and pencil point
6x, light photo



Planktonic foraminifera, 95x, SEM



Secondary $CaCO_3$, 690x, SEM



Cedar or cypress, 180x, SEM

$CaCO_3$ foram infilling, 1360x, SEM

APPROPRIATE MATERIALS: SEM is especially useful for AMS samples. It is recommended for: (1) very small carbonates which cannot be pretreated (forams, ostracods, coccoliths); (2) unidentified macro-fossils concentrated from sediments; and (3) wood or charcoal for which some taxon identification is useful.

THE SERVICE & COST: Three (3) micrographs of various angles and/or magnifications are provided for each sample. Micrographs are obtained on a representative portion of the material submitted for radiocarbon dating, not on the dated material itself. The technician will usually be able to choose the angles and magnifications which are most appropriate. The service does not include identification or characterization, but wherever possible, some will be provided.

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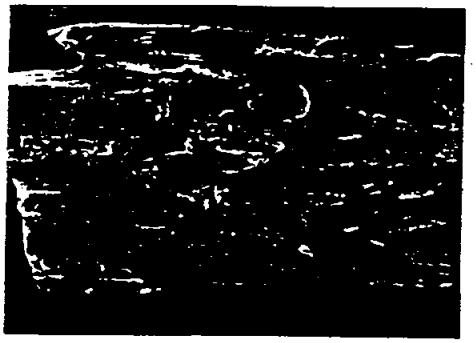
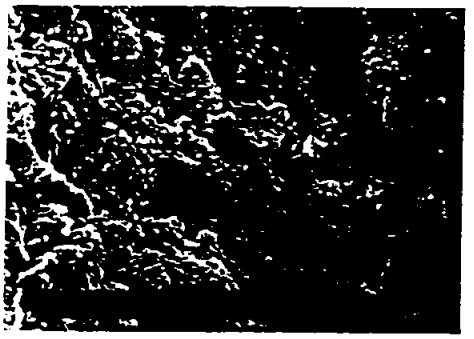
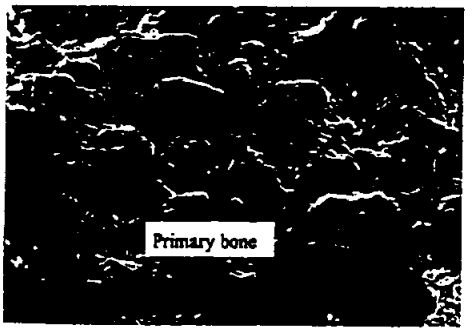
SEM photo micro-graphs prior to chemical pretreatments.



23. Freshly broken bone surface.



24. Crystalline bone structure in un-pretreated sample.




25. Sediment in-filling, prior to removal (non-calcareous) with visible primary bone material.

Four views of the pretreated protein extract. No calcium or phosphorus phase remaining (ie the apatite was effectively removed) and no visible organic contaminants were observed. Only secondary component observed was a trace amount of alumino-silicate minerals, possibly K-feldspar.

26.

27.

28.

29.

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ATTACHMENT 2



November 18, 1999

Dr. Francis P. McManamon
Dept. of Interior
National Park Service
Archaeology And Ethnography Program
1849 C Street N.W. (NC 340/2275)
Washington, DC 20240

Dear Dr. McManamon:

We received a telephone call from Jason Roberts requesting additional information regarding our radiocarbon dating analysis of your bone sample " CENWW.97.R.24 (Mta)/DOI1a".

The questions were:

1. **What was the collagen content of the originally submitted bone?**

   The original weight of the bone was 9.1 grams. The amount of collagen extracted was 0.030 grams (30.0 mg). The relates to a percent concentration of 0.3%. The value is very low due to the high mineral content of the submitted bone.

2. **What was the carbon concentration within the extracted collagen?**

   9.5 mg of the collagen was used for the analysis. This provided us with 3.2 mg of carbon. The percentage carbon is then calculated as 33.7% carbon within the collagen.

If I can answer any further questions, please do not hesitate to contact me.

Sincerely,

Darden Hood
Director