Smithsonian Institution
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Department of Anthropology

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Dear Mr. Pulliam:

Previously we have discussed the value of completing a histomorphometric analysis of a rib fragment in order to refine the age determination of Kennewick Man. I consider this an essential, final piece of information in the plaintiffs' analysis of this skeleton. Age estimates vary among the different scientists, both government and plaintiff. Based on consultation with Dr. Sam Stout, who will conduct this study, I believe that this analysis will provide an independent line of evidence that will heavily influence our final assessment of Kennewick Man's age.

I am in the process of collecting research reports completed by the plaintiff study team members. Ten drafts have been submitted to me, and seven to nine manuscripts are to be submitted. I have stepped up my call to receive the remaining manuscripts to ensure that they are in hand shortly. From my perspective, the information to be obtained from Sam Stout is essential, and will enable completion of my component of the Kennewick Study. Following receipt of the sample requested below for analysis, and by summer 2009, I will forward copies of all manuscripts received that have been completed by the scientists' study team.

This letter requests permission to perform a histological analysis on a rib bone fragment from the Kennewick skeleton. The objective is to provide an independent estimation of the age at death for this individual. The analysis involves consideration of several histomorphometric, or quantitative histomorphological, variables that will assist in the age determination of this individual. Age indicators using this method include counting the number of secondary osteons and osteon fragments versus primary bone and the size of the osteons, which decrease with age.

The morphological characteristics of the skeleton lead to different suppositions about Kennewick Man's age at death. James Chatters provided two estimates of age based on these characteristics of the skeleton. Chatters (2000) estimated the age at death of the Kennewick man at 35 to 45 years while Chatters (2001) estimated death at 40 to 55 years. Powell and Rose (1999) suggest an age at death of 45 to 50 years based on the

morphology of the pubic bones. The histomorphological analysis could define his age to a higher degree of certainty.

The analysis would require obtaining a small rib fragment from the skeleton. A sample approximately 1 to 2 cm in length that includes the complete cross-section of the bone is necessary. Ideally the sample should be from rib number 6, but any rib other than 1, 11, or 12 would also be acceptable. It is important that the sample is taken from the middle third of the shaft. Should it happen that rib preservation makes this impossible the midshaft of a clavicle could be used. However, during our inventory of the skeleton, we identified three rib fragments that could serve this purpose and these were photographed in preparation for this work: right sixth rib (97.I.12d(10)); left sixth rib (97.I.12f(11)); left fifth rib (97.I.12c(4)). The analytical process would be minimally invasive and the remaining bone sections would be returned so that they can be reassociated with the remains.

The following describes in detail the process through which the sample would be tested. The rib sample will be vacuum embedded in a plastic resin to maintain its integrity during the processing to make thin sections for histological analysis. Several transverse wafers with parallel surfaces and approximately 1 - 2 mm in thickness are removed using a Buehler Isomet Petrographic saw. The sections are then ground to a final thickness of approximately 80 - 100 micrometers, and mounted and cover slipped for histological analysis.

METHODS

VARIABLES: The histological analysis involves determining the following histomorphometric (quantitative histomorphological) variables.

1. INTACT OSTEON DENSITY (N.On) in #/mm^2, the total number of osteons per unit area (Sa.Ar) that have their Haversian canal perimeters intact or unremodeled. Half or more of an osteon's area must fall within the Merz grid to be counted.

The entire cross section of a rib is read in a checkerboard pattern.

2. FRAGMENTARY OSTEON DENSITY (N.On.Fg) in #/mm^2, the total number of osteons per unit area (Sa.Ar) that lack a Haversian canal or for which the perimeters of their Haversian canals, if present, have been remodeled by subsequent generations of osteons. Half or more of the fragmentary osteon must fall within the Merz grid to be counted.

3. MEAN OSTEONAL CROSS-SECTIONAL AREA (On.Ar) in mm^2, the average area of bone contained within the cement lines of structurally complete osteons for each rib specimen. Osteons are considered to be structurally complete if their reversal lines were intact. Complete osteons with Haversian canals that deviated significantly from circular were excluded. Mean area is calculated as the average cross-sectional area of a minimum of 25 complete osteons per cross-section.

4. OSTEON POPULATION DENSITY (OPD) in #/mm^2, the sum of N.On and N.On.Fg.

$$OPD = N.On + N.On.Fg$$

5. TOTAL SUBPERIOSTEAL AREA (Tt.Ar), total cross-sectional area or the area under the subperiosteum including the marrow cavity, or endosteal area.

6. CORTICAL AREA (Ct.Ar), the amount of cortical bone in a cross-section of bone excluding the endosteal area.

7. ENDOSTEAL AREA (Es.Ar), the area of the marrow cavity obtained by subtracting cortical area from total area.

$$Es.Ar = Tt.Ar - Ct.Ar$$

8. RELATIVE CORTICAL AREA (Ct.Ar/Tt.Ar), the relative amount of cortical bone in cross-sectional area of bone, or the ratio of cortical bone area (Ct.Ar) to total area (Tt.Ar) of a rib cross-section.

Total subperiosteal area and cortical area are directly computed by scanning the rib thin section on a flatbed scanner and using image analysis software. Endosteal area (Es.Ar) and relative cortical area (Ct.Ar/Tt.Ar) are derived from cortical area and total area measurements.

AGE ESTIMATION: Age at death will be estimated using two histomorphometric age estimation methods developed for the human rib: the original method of Stout and Paine (1992),

$$L_n Age = 2.343 + 0.050877 \times OPD_{rib}$$

and the more recent method developed by Cho et al. (2002).

$$Age = 29.524 - 1.560(OPD_{rib}) - 4.786(Ct.Ar/Tt.Ar) - 5.92.899(On.Ar)$$

In addition to the age estimate resulting from the above two formulas, relative cortical area, cortical area, and osteon area for Kennewick will be compared with data on age associated values for these variables available for modern and several North American archaeological skeletal samples ranging in antiquity from about 7000 years ago to Mississippian, and representing a number of subsistence strategies and cultures. The final age estimate will be based upon a combination of the results from histomorphometric formulas and relative cortical area measurements, a similar process to the way an age estimate was calculated for the Mayan ruler Hanab-Pakal from the site of Palenque (Stout and Streeter in press).

Thank you for your time and consideration. I would be happy to answer any questions you may have about this request.

Sincerely,

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cc: Alan L. Schneider
Dr. Sam Stout

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Kennewick Man: Scientific Analysis of an Ancient American Skeleton

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