D3 Isotope Forensic Evaluation of Modern Human Remains From the University of Tennessee William M. Bass Donated Skeletal Collection

Zheng-Hua Li, PhD, 320 Sparkman Dr, NSSTC 2017, Huntsville, AL 35899; Nicholas P. Herrmann, PhD, Mississippi State Univ, Dept of Anthropology and Middle Eastern Cultures, 206 Cobb Institute, Starkville, MS 39762; Richard Jantz, PhD, Univ of Tennessee, Dept of Anthropology, Knoxville, TN 37996-0720; and Miriam E. Soto, MA, 2615 Skyview Glenn Ct, Houston, TX 77047*

After attending this presentation, attendees will gain a greater appreciation of isotopic patterns in the modern American population derived from enamel, hair, and bone, and also an introduction to novel sample preparation techniques.

The presentation will impact the forensic science community by presenting multiple isotopic values of bone collagen, bioapatite (phosphate and carbonate), and hair keratin from the William M. Bass Donated Skeletal Collection (WBDSC), the largest modern skeletal collection in the United States.

The present study builds on recent advances in isotopic forensic research by examining multiple isotopic variations in the William M. Bass Donated Skeletal Collection (WBDSC). The WBDSC represents the largest modern skeletal collection in the United States and the collection is housed at the University of Tennessee Forensic Anthropology Center (UTK FAC). For this study, the FAC Donations serve as a proxy for modern surface and buried forensic cases.

Multiple constituents including bone collagen, bioapatite (phosphate and carbonate), and hair keratin from 102 donations were prepared for $\delta^{13}C$, $\delta^{8}O$ and $\delta^{2}H$ analysis using refined protocols. The protocols were enhanced by shortening the cycle of each sample preparation period for collagen extraction utilizing a filter-bag method assisted by an ultrasonic water bath, and modifying Thermo TC/EA for improving analysis precision of phosphate $\delta^{8}O$.

Dental enamels were sampled using a NewWave Micromill and analyzed for $\delta^{18}O$ of phosphate. The averaged $\delta^{18}O$ value was 17.50±1.36‰ VSMOW (n=45). Correlation analysis of the dental $\delta^{18}O$ values with meteoric water $\delta^{18}O$ at birth location (modeled) yielded the equation ($\delta^{18}O_{tooth}=0.62\delta^{18}O_{water}+21.74$, r=0.63, n=45), which was very similar to the equation ($\delta^{18}O_{bone}=0.64\delta^{18}O_{water}+22.37$, r=0.98) generated by Longineli (1983).

Non-exchangeable $\delta^{2}H$ of hair keratins were also analyzed using Thermo TC/EA. The averaged $\delta^{2}H$ was -83.35± 6.36‰ VSMOW (n=14). The $\delta^{2}H$ values exhibit a positive correlation with the meteoric water $\delta^{18}O$ at death location (r=0.68), and a negative correlation with altitude (r=-0.73) that is consistent with isotope "Altitude Effect." In addition, 61 bioapatite carbonates were analyzed for $\delta^{13}C$ and $\delta^{18}O$. The averaged value was -9.32±1.31‰ (VPDB) for $\delta^{13}C$, and -6.91± 1.41‰ (VPDB). But there was no meaningful geographical information inferred from these bone apatite samples. Bone collagens (n=77) were extracted for N, C, N/C ratio, $\delta^{13}C$ and $\delta^{15}N$ analysis. The averaged carbon content in human phalanx bone collagen was 34.55±5.20%, 12.60±2.05% for nitrogen content. The averaged C/N ratio was 2.76±0.21. The averaged $\delta^{13}C$ value was -15.72±0.9‰ (VPDB), and 11.12±0.51‰ (AIR) for $\delta^{15}N$.

This study indicates that the dental enamel $\delta^{18}O$ values from the WBSC collections are overall reflective of the individual's birth location, whereas hair keratin $\delta^{2}H$ values are influenced by the individual's death location, which is consistent with several other isotopic studies of forensically derived human samples and suggests that the application of the dual isotope (O, H) could provide better constrain on the residential history by pin-pointing the beginning (tooth) and the ending (hair) of the individual life journey. Although the correlation coefficient of the dental $\delta^{18}O$ with local water is not as high as reported by several other researchers, the relationship; however, does follow the trend of the earlier study.[1] The potential influence of isotopic pattern of tap water will also be discussed to examine the variability seen in the WBDSC sample.[2] It is suspected that the WBDSC does not represent a more geographically heterogeneous sample and it is likely that self- or family-reported residential histories as is the practice at the UTK FAC are more variable.

This project is supported by the National Institute of Justice, Office of Justice Programs, Grant #2008-DN-BX-K193.

References:

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Stable Isotope, Tennessee, Human remains

 ** Presenting Author*