A150 Trace Isotope Analysis of Dental Enamel for Micro Regional Geographic Attribution of Human Remains in Virginia

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The goal of this presentation is to highlight the utility of trace element isotope ratios in bulk and surface dental enamel as a means of enhancing the biological profiles of unidentified remains.

This presentation will impact the forensic science community by providing a method of geographic attribution of birthplace and recent residence of unidentified remains using the presence of certain trace chemical isotope ratios in bulk and surface dental enamel.

Ultimately, this methodology could contribute to the compilation of a database of chemical isotope ratios by locality within Virginia, which could be applied to unidentified remains in long-term storage in the many Offices of the Chief Medical Examiner (OCME) for the Commonwealth of Virginia.

There are currently ca. 165 cases of unidentified human remains in long-term storage in the four Virginia OCME regions. In many of these cases, the remains are severely decomposed or skeletal and do not match any reports of missing persons, and fingerprints, DNA profiles, dental conditions, and facial approximations of these individuals have generated no leads to identification. Dental enamel preserves well despite decomposition and holds promise for the expansion of new forensic identification methods. The bulk enamel composition ceases to change appreciably after a certain age and is thus indicative of an individual's birthplace (or early childhood residence), while the surface enamel composition continues to change due to surface ion exchange and diffusion and is indicative an individual's recent residence.[1]

This study examined the bulk and surface enamel samples of ca. 80 teeth from 44 donors obtained from the Mission of Mercy Project and the Remote Area Medical Project in Wise County and Emporia, VA, respectively, with the Virginia Commonwealth University Institutional Review Board approval. Patients scheduled for an extraction were approached by a researcher and asked for written informed consent; if consent was provided, the patient was asked questions concerning age, sex, city and state of birth, and city and state of residence. Individuals in this study who were born and currently resided in Virginia had a donor age range of 22 to 77 years. The average donor age was 49.5 years with an average donor age of 49.7 years for 24 females and an average donor age of 48.3 years for 20 males. These locations were selected to expand on a pool of 74 samples from 52 donors previously compiled, predominately from central and northern Virginia.[2] After extraction, samples were disinfected in 10% neutral buffered formalin for two weeks. Surface enamel was etched directly using a trace metal-free nitric acid and glycerin solution, while bulk enamel was dissolved in trace metal-free nitric acid after the enamel was ground into a fine powder using a mortar and pestle. Samples were analyzed for the following trace elements via Inductively Coupled Plasma/Mass Spectrometry (ICP/MS): ^{7}Li, ^{11}B, ^{25,26}Mg, ^{27}Al, ^{52}Cr 3^{+}, ^{55}Mn, ^{57}Fe, ^{59}Co, ^{58,60}Ni, ^{63,65}Cu, ^{64,66,68}Zn, ^{69,71}Ga, ^{78}Se, ^{86,87,88}Sr, ^{204,206,207,208}Pb, and ^{209}Bi. Principal component analysis and discriminant function analysis were performed to examine multivariate relationships among samples and determine which trace elements drive compositional differences among the samples and the locality groups.

The results from a one-way Analysis of Similarities (ANOSIM) yielded significant differences ($p \leq 0.00420$) between bulk and surface enamel ratios of individuals by geographic locality. Tooth characteristics (e.g., restorations, caries, debris, discoloration, chipping, cracking, occlusal wear, etc.) did not significantly affect the isotope ratios of either the surface or the bulk enamel. This suggests that geographic determinations based on the isotope ratios of bulk and surface enamel are most likely neither influenced nor obscured by the tooth type and/or tooth characteristics. Significant correlations were found for bulk enamel ratios with the geographic location of an individual's birthplace and surface enamel ratios with recent residence.

In conclusion, trace isotope ratios are useful in determining where individuals were born and currently reside, adding information to the biological profiles of unidentified remains and generating additional leads to the identification of these individuals.

Reference(s):

1. Molleson T. (1988). Trace Elements in Human Teeth. In: Grupe, G. and Hermann, B. (Eds) Trace Elements in Environmental History (*Proceedings in Life Sciences*), pp. 67-82. Springer-Verlag.
2. Stein R., Ehrhardt C., Hankle J., Simmons T. (2017) Trace Element Analysis of Dental Enamel for the Geographic Attribution of Unidentified Remains. *Proceedings of the American Academy of Forensic Sciences*, 69th Annual Scientific Meeting, New Orleans, LA. 2017. P. 77.

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