



## Physical Anthropology Section - 2014

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### H4 Trace Element Analysis of Human Tooth Enamel by LA-ICP-MS for Estimating Region of Origin

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After attending this presentation, attendees will have an understanding of the geologic and anthropogenic origins of trace elements in tooth enamel as well as their utility in estimating region of origin. A method of non-matrix-matched calibration for analyzing human tooth enamel using Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS) will also be described.

This presentation will impact the forensic science community by contributing to new techniques for estimating the region of origin of unidentified individuals, which may increase the likelihood of identification. It may be particularly important in mass fatality situations.

Tooth enamel is among the most durable substances in the human body and as such has high recoverability in forensic anthropology cases. Its crystalline hydroxyapatite matrix, though primarily composed of calcium, has a slightly variable chemical composition in which substitutions are the result of biologically available trace elements. The trace elements are derived from an individual's diet and the water they consume during the period of enamel formation. Enamel formation of permanent teeth occurs mostly during early childhood, though crown formation of the third molars is not complete until late adolescence. Thus, the trace elements present in an individual's permanent teeth reflect the geology of the area in which they resided during this period; for fairly sedentary populations, this can be assumed to approximate an individual's birthplace. Anthropogenic sources of trace element uptake such as imported foods, contaminants from cookware, and dental restorations must also be considered. Once anthropogenic sources and natural variation in the elemental composition of tooth enamel are accounted for, the remaining variation can be used to distinguish teeth originating from different individuals, and may be useful in estimating an individual's birthplace.

This research examines a sample of teeth from the Antioquia Modern Skeletal Reference Collection in Medellin, Colombia. The sample has known demographic information including sex, birthplace, and age. For this study, 71 teeth from 61 individuals from areas throughout northwestern Colombia were analyzed; 36 of these individuals were born in the city of Medellin, while the remaining 25 were born in surrounding areas. This sample includes 54 males and 7 females with a mean age-at-death of 35 years and a standard deviation of 17 years. It consists of an assortment of types of teeth based on availability in the collection and ease of extraction. The teeth were analyzed LA-ICP-MS, a minimally destructive, semi-quantitative technique. The exterior surfaces of whole and fragmented teeth were used. LA-ICP-MS analysis was performed at the Center for Archaeology, Materials, and Applied Spectroscopy at Idaho State University.

Due to the nature of LA-ICP-MS analysis, quantitation requires the use of matrix-matched standards to calibrate for the effects of the matrix on the instrument. Since no matrix-matched standard is available for human tooth enamel, Scanning Electron Microscopy-Energy Dispersive Spectrometry (SEM-EDS) was utilized for non-matrix-matched calibration. This allows for semi-quantitation of the elemental concentrations in the sample. A suite of up to 44 elements was examined: sixteen of these show variation across the sample and six (Li, Al, Cu, Sr, Sn, Ba) may potentially be useful for estimating region of origin. For example, among the individuals born in Medellin, aluminum has an average concentration of 2 ppm and a standard deviation of 2ppm; for the other individuals, the mean is 4ppm with a standard deviation of 8ppm. Barium has a mean concentration of 4ppm and a standard deviation of 2ppm among the Medellin subsample, while among the remaining individuals the mean concentration is 14ppm with a standard deviation of 39ppm. This illustrates that the 36 individuals born in Medellin have a more similar compositional profile than do those born in other areas. These results suggest that trace element analysis of permanent tooth enamel may be of some use in estimating an individual's region of origin in forensic anthropological contexts.

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#### **Tooth Enamel, Region of Origin, LA-ICP-MS**