H102 Isotopes and the Future of Region of Origin Identification: Geochemical Boundaries, Political Boundaries, and Modeling Methods with a Mexican Sample Population

Chelsey Juarez, PhD, University of California Santa Cruz, Department of Anthropology, UCSC Social Science 1, 1156 High Street, Santa Cruz, CA 95064*

The goal of this presentation is to discuss the latest methodologies currently in use in the creation of isotope-based databases for identification. Using examples from a Mexican population, this presentation will identify when and where each database methodology can be practically and successfully applied. This presentation will investigate identification databases consisting of "authentic known samples" and discuss the statistical success of political/state groupings versus geochemical separations. In addition, this presentation will compare databases consisting of "authentic known samples" with those based on predictive models. After attending this presentation attendees will, understand the two major types of isotope databases currently in use (authentic sample, and predicative model), and be able to identify when and where these database types will be most successful.

The use of isotopic analysis for the purposes of forensic identification has become a focus in recent years. As more isotope databases are constructed it is critical to understand the pitfalls and limitations of different types of databases and to recognize the influence that country of origin may have on successful identification. This presentation will impact the forensic science community by opening a dialog on isotope databases to maximize the creation of successful isotopic identification and encourage the increased use of this powerful identification tool.

Isotope ratios in teeth, bones, hair and nails have been analyzed by archaeologist and forensic scientists to investigate patterns of residential mobility and region of origin. Much of the isotope work coming out of the forensic anthropology community has utilized samples of known origin for identification comparison (Juarez, Regan).[1,2] In 2011, a comparative isotope database documenting (∂18O, ∂13C, 87/86Sr) for 10 states in Mexico was completed. In its initial form, this database focused on political separations for samples of known origin as a comparative method.

Recently, the focus on isotope identifications has begun to turn towards predictive modeling (Ehleringer).[3] Ehleringer initiated the development of a model to predict the geographic region of origin for humans living in the United States based on the ∂18O and ∂2H values of scalp hair.[3,4] The most recent results from this research suggest that database comparison studies have limited predictive power when compared to predictive model studies (Ehleringer).[3] In principle, this claim has significant merit when the robustness of available models are analyzed and compared. The Ehleringer *et al*. predictive model achieved an overall 86% correct success rate between observed and predicted region of origin locations for training samples.[4] This is compared to a variable rate of success for the comparative model of modern Mexican populations, which achieved 46-86%. In practice, the difference in robusticity between the predictive and the comparative models and the sample regions suggests some interesting trends that merit further analysis. First, the predictive model based on U.S. populations suggests that oxygen and hydrogen isotopes alone have the power to discriminate between different regions of origin even for contiguous areas. This is in contrast to the results from the comparative Mexican data set, where d18O values alone separate the Mexican states involved into only two major groups, with d18O values contributing only minimally to the discriminant function. Individuals that had a close relationship to the local water mainly represented the samples in predictive model. This relationship was not naturally occurring in the Mexican population studied, and it is clearly documented that Mexican populations have the highest bottled water consumption in the world. In addition, the possible range of tap water δ18O values in the predictive model was much larger (-5 to -20‰) than the range of precipitation values in the Mexico sample (-2.9 to -10). This suggests that the sample areas themselves may not be of equal quality and that Mexico may not be an ideal location for region of origin discrimination on the basis of oxygen.

Second, the Mexican comparative model had a more significant problem with misclassifications than the predictive model. The Ehleringer model is a predictive isoscape model. Isoscapes provide expected isotope values for a given geographic coordinate. This method is useful for studying processes that lead to changes in isotope values over space. Essentially this model type can provide a sense of the extent to which distributions of isotope values from different locations are the same. This is something that does not happen with a comparative model.

This presentation will impact the forensic science community by opening a dialog on isotope databases to maximize the creation of successful isotopic identification and encourage the increased use of this powerful identification tool. As more isotope databases are constructed it is critical to understand the pitfalls and limitations of different types of databases and to recognize the influence that country of origin may have on successful identification. In certain locations like Mexico were the relationship between local food and water intake is complicated by the pervasive use of bottle water comparative models offer valuable insight. The study comparison suggests that the best models take into consideration the unique limiting factors in each given situation and push for careful analysis of a given situation and the creation of a flexible hybrid database when and where appropriate.

References:

 ** Presenting Author*

1. Juarez CA. Strontium and geolocation, the pathway to identification for deceased undocumented Mexican border-crossers: a preliminary report. J Forensic Sci 2008;53(1):46-9.
2. Regan L. Isotopic determination of region of origin in modern peoples: applications for identification of U.S. war-dead from the Vietnam Conflict [dissertation]. Gainesville: University of Florida, 2006.
3. Ehleringer JR, Thompson AH, Podelesak DW, Bowen GJ, Chesson LA, Cerling TE, Park T, Dostie T, Scharcz H. A framework for the incorporation of isotopes and isoscapes in geospatial forensic investigations. In: West JB, Bowen GJ, Dawson TE, editors. Isoscapes. Netherlands:Springer, 2010;357-87.
4. Ehleringer JR, Bowen GJ, Chesson LA, West DW, Podelesak DW, Cerling TE. Hydrogen and oxygen isotope ratios in human hair are related to geography. PNAS 2008;105(8):2788-93.

Isotope, Database, Identification

 ** Presenting Author*