



### A123 Refining Hydrogen and Oxygen Isoscapes for the Identification of Human Remains in Mississippi

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After attending this presentation, attendees will understand the importance of conducting regional refinement of hydrogen ( $\delta^2\text{H}$ ) and oxygen ( $\delta^{18}\text{O}$ ) isoscapes for the United States when assessing the variability in stable isotope signatures of tap water.

This presentation will impact the forensic science community by increasing the accuracy of isotope baseline data for the utility of identifying human residential origin and will provide encouragement to conduct regional studies of  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  isoscape refinement on a national level.

Isoscapes are maps created to visualize large-scale geographic distributions of isotopes in environmental systems.<sup>1</sup> Baseline isoscapes are generated from the collection of stable isotope data and modeled for large-scale regions using geo-statistical programs. They provide an additional resource for forensic investigators to determine residential origin when assigning human isotope signatures to geolocation. Isoscapes, although accurate, provide imperfect estimates for certain regions with less isotope coverage. For instance, the United States  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  tap water isoscapes have insufficient isotope sample coverage for Mississippi (n=4). This research project refines the  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  isoscapes for Mississippi to determine whether increased sampling significantly alters the isotope patterns previously reported for the state.

The  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  isoscapes for Mississippi were generated from tap water samples collected across the state (n=58). Sample locations were selected by physiographic region and population density to account for diverse water sources. Tap water samples were collected from public restrooms in March and April 2014 and recorded with a Global Positioning System (GPS) unit.  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  was measured using a Thermo™ Finnigan™ Isotope Ratio Mass Spectroscopy (IRMS) coupled with an elemental analyzer, and data was normalized to the Vienna Standard Mean Ocean Water-Standard Light Antarctic Precipitation (VSMOW-SLAP) scale. Isoscapes and spatial analyses were conducted with ArcGIS® 10.2, using precipitation and temperature priors from IsoMAP®.  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  data were classified into Jenks natural breaks and interpolated using ordinary Kriging. The isoscape data was calibrated using a linear regression model and incorporated into each isoscape using raster math. These isoscapes were compared to the national tap water isoscapes presented in Bowen et al. to evaluate any spatial refinement.<sup>2</sup>

$\delta^2\text{H}$  values ranged from -18.4‰ to -33.1‰, and the  $\delta^{18}\text{O}$  values ranged from -4.10‰ to -5.70‰. These data coincide with those presented in Bowen et al., with the exception of one  $\delta^{18}\text{O}$  sample falling between -3.9‰ and -2.0‰ in the coastal region.<sup>2</sup> Distinct differences were observed between the  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  values in east and west Jackson, which may relate to available city water sources. A gradual enrichment of  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  values was observed from the northern state boundary toward the Gulf coast suggesting stronger correlation with hydrology rather than physiographic region. Both isoscapes exhibit non-random spatial autocorrelation. The  $\delta^{18}\text{O}$  isoscape had significant clustered spatial autocorrelation (Moran's I=0.3568; Z=2.004; p<0.05) with notable patterns in the Mississippi Delta. Isoscapes for various Rare Earth Elements (REEs) will also be presented, which provide a means to cross-reference isotope data for more accurate residential origin estimates.

Increased tap water sampling on a regional scale is warranted for  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  isoscape refinement to improve the utility of isotopes for accessing human residential origin. Sample size should be increased in cities with large populations to consider multiple water sources. When utilizing  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  isoscapes in forensic anthropology,  $\delta^{18}\text{O}$  may be the more reliable indicator due to the increased spatial refinement results presented here. These results will be tested on skeletal remains from Mississippi in the next phase of research using these new assignment models.



# Anthropology Section - 2015

## References:

1. Bowen GJ, West JB. 2008. Isotope landscapes for terrestrial migration research. Tracking animal migration with stable isotopes (KA Hobson and LI Wassenaar, eds):79–106.
  2. Bowen GJ, Ehleringer JR, Chesson LA, Stange E, Cerling TE. 2007. Stable isotope ratios of tap water in the contiguous United States. Water Resources Research 43.
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## Isoscape, Residential Origin, Spatial Refinement