H123 Initiating the Mexican Water Isoscape: Using Water Isotopes for Region of Origin Identification

Chelsey A. Juarez, PhD, Dept of Soc & Anthro NCSU, 334 1911 Bldg, Campus Box 8107, Raleigh, NC 27695-8107*

After attending this presentation, attendees will better understand issues surrounding the use of water isotopes for region origin identification in Mexico.

This presentation will impact the forensic science community by presenting data on the relationship between bottled and tap waters and the utility of these water types as predictors of region of origin and/or migration.

Despite a drop in apprehensions since 2006 and the Pew Hispanic Center's report of zero net migration from Mexico for 2012, the yearly death toll for undocumented migrants along the border region was 477 individuals for 2012.[1] Identification of undocumented populations that reach the U.S is complicated by many factors including the multiplicity of sending areas and the lack of traditional forms of identification or records.

The use of oxygen and hydrogen isotopes in human drinking water, hair, bone, fingernails and teeth has demonstrated the ability to track movement and identify the region of origin for modern populations in the United States, Europe, and Asia.[2,3] Mexicans have the highest bottle water consumption in the world, drinking four times more bottle water than United States residents.[4] Bottle water consumption from non-local sources weakens the ability of oxygen and hydrogen isotopes to generate predictive trends identifying region of origin from human tissues.

The purpose of this study is to: (1) explore the relationship between oxygen and hydrogen isotopes in tap water and the various bottled water sources available to Mexican populations; and, (2) Establish the precision with which this relationship can identify region of origin and/or migration within Mexico. The samples consist of 43 samples of bottled water collected from seven states in Central and Southern Mexico and the Federal District, 49 samples of tap water collected from nine states in Central and Southern Mexico and the Federal District, and hair samples collected from 13 separate locations spanning four states. GPS information was recorded for all tap water and hair samples. Purchase location was noted for all bottled water samples and birthplace information was recorded for all tooth samples. Bottled waters came from 15 different companies selling bottle water in Mexico. Hydrogen and oxygen water isotopes were measured for tap water samples and bottled waters samples for all locations using laser absorption spectroscopy at the University of Utah Stable Isotope Ratio Facility for Environmental Research (SIRFER) laboratory. All statistical analysis was completed using SPSS version 20 for Mac®.

All reported data has been calibrated to the Vienna Standard Mean Ocean Water-Standard Light Antarctic Precipitation (VSMOW-SLAP) scale. Bottle water values spanned a range from -11.45‰ to +4.36‰ and -79.79‰ to +26.34 for $\partial^{18}O$ and $\partial^{2}H$, respectively. Tap water values spanned a range from -11.86‰ to -3.90‰ and -83.3‰ to -20.14‰ for ∂18O and $\partial^{2}H$, respectively. The most ^{2}H and ^{18}O depleted tap water samples were distributed over the inland regions of Mexico City, Puebla, Hidalgo, and Morelos. The $\partial^{18}O$ and $\partial^{2}H$ data were strongly correlated for both tap r= .987 and bottled water samples r=. 990. The local meteoric water line for tap waters was $\partial 2H=8.688X\ \partial^{18}O+14.945$ $r^{2}=0.975$. The local meteoric water line for bottle waters was $\partial^{2}H=6.797X\ \partial^{18}O-2.856$ $r^{2}=0.97$. The slope of the LMWL for tap waters is similar to that of the Global Meteoric Water Line (GMWL) which has a slope of 8; however, the LMWL for bottled waters has a slope of ~6. This difference in slope may indicate that the waters included in the bottled water samples originated in regions that were: (1) different or more restricted than the tap water samples; and, (2) were more arid. Independent *t*-test demonstrated a statistically significant difference between mean $\partial^{18}O$ values between tap and bottled waters t (61)=-3.007, p=0.004. The $\partial^{18}O$ mean value for bottle waters was -9.5‰, which was on average 1.93‰ ± .65‰ more depleted in ^{18}O than tap water values, supporting the previous assertions. Region of origin for hair data were analyzed using the predictive model developed by Ehleringer *et al.* for United States populations. An independent *t*-test confirmed that the generated values for source tap waters were not significantly different from the mean values for source location p=0.001. Due to the small sample size of this preliminary work caution should be taken in the interpretation; however, results suggest that Mexican tap water can be used to predict Mexican region origin based on hair samples.

References:

1. Anderson S. (2013). How many more deaths? The moral case for a temporary worker program. National Foundation for American Policy (NFAP) Policy Brief. March 2013.
2. Ehleringer JR, Bowen GJ, Chesson LA, West AG, Podlesak DW, Cerling TE. Hydrogen and oxygen isotope ratios in human hair are related to geography. PNAS 2008;105(8)2788-2793.

 ** Presenting Author*

3. Thompson AH, Chesson LA, Podlesak DW, Bowen GJ, Cerling TE, Ehleringer JR. Stable isotope analysis of modern human hair collected from Asia (China, India, Mongolia and Pakistan). Am J Phys Anthropol 2010;141:440-451.
4. Malkin, E. Bottled water habit keeps tight grip on Mexican. New York Times. New York: July 17 2012.

Water Isotopes, Region of Origin, Mexico

