A122 Strontium Isotope Ratios of Hair for Human Provenancing

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After attending this presentation, attendees will gain an understanding of how the distribution of strontium isotopes in human hair is related to geography and how this information can be used to answer questions regarding human origins and movement. Attendees will gain specific knowledge on how strontium is incorporated into hair, how strontium isotope profiles within hair can be used to reconstruct regions-of-residence and travel movements, and how strontium isotopes can be combined with other isotopes to refine human movement histories.

This presentation will impact the forensic science community by demonstrating that the innate chemical composition of human tissues reflects an individual's origin and travel history.

This presentation focuses on the application of strontium isotope analysis to human hair to aid in the identification of individuals of unknown origin or travel history. Reconstructing the travel-movement history of individuals of unknown origins reveals pertinent information for forensic investigations, spanning from nationwide homeland security issues to investigations of unidentified decedents by local agencies. Analysis of stable isotopes in human scalp hair has shown to be a useful tool for reconstructing the recent geographic-movement histories of individuals because hair proteins (i.e., keratin), and the stable isotopes contained within keratin, are fine-scale recorders of an individual's geographical environment.

As an example, the oxygen (O) isotope values ($\delta^{18}O$) of human hair keratin can provide travel/geographic origin information and guide criminal investigations. This is due to the well-established relationship between the $\delta^{18}O$ values of human hair and an individual's drinking water. Since the $\delta^{18}O$ values of drinking water vary predictably across landscapes, the $\delta^{18}O$ values of human hair correlate to specific geographic regions. These geographic projections of isotope values across landscapes are termed "isoscapes." While $\delta^{18}O$ isoscapes provide a valuable tool for describing geographical spaces where an individual may have originated, the estimated geographical regions can be broad. To refine these broad region-of-origin predictions, investigators need a complementary isotopic approach that reflects different geographic information.

Strontium (Sr) isotope ratios ($^{87}Sr/^{86}Sr$) of human hair have attracted interest as a complement to $\delta^{18}O$ values, because geographic variations in $^{87}Sr/^{86}Sr$ reflect local geology. While it has been previously established that the $^{87}Sr/^{86}Sr$ ratios of human hydroxyapatite tissues (e.g., bones and teeth) relate to geography, the application of Sr isotope analysis to keratinous human tissues (e.g., hair and fingernails) had been avoided to date due to low Sr concentrations within these tissues; however, recent analytical advances have made analysis of keratin-based tissues possible, which have proven useful in reconstructing animal geospatial histories. As human hair is structurally similar to non-human keratinous tissues, $^{87}Sr/^{86}Sr$ values of human hair should also provide geospatial information.

To understand the linkages between the Sr in keratinous tissues and an individual's geographical environment, human hair and tap waters were collected from 55 cities throughout the contiguous United States; the $^{87}Sr/^{86}Sr$ ratios were measured on paired hair-water samples. Paired tap water and hair $^{87}Sr/^{86}Sr$ ratios were significantly correlated and displayed a 1:1 relationship, indicating no Sr isotope fractionation between water and hair. These results indicate Sr isotope signals from water are reflected in the isotope ratios of the individual's hair and, in turn, the $^{87}Sr/^{86}Sr$ ratios of human hair provide geographic information relating to the locality where an individual resides. As O and Sr isotope ratios within human hair are both geographically controlled, but reflect different physical and chemical environmental processes, the paired analyses of both O and Sr isotope ratios would allow for a finer resolution reconstruction of the travel-movement history of an individual than analysis of either O or Sr alone.

Geography, Origin, Movement