A76 Conservation of Isotope Ratios in Burned Bones of Pigs and Humans

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Learning Overview: After attending this presentation, attendees will understand that isotope analysis can provide accurate inferences concerning diet and geographic origins in cases in which remains have been burned.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating that isotope analysis can assist in identifying unknown remains that have been burned, but also constrain when the analysis may be less reliable.

Stable and radiogenic isotope analysis of unidentified human remains can assist forensic investigations by providing inferences about the individual's dietary and geographical life history. Understanding the effects of various postmortem processes on isotopic signatures is an important, but understudied, knowledge gap. Using two sample types and burn methods, this study was designed to replicate body disposal attempts by: (1) leaving surrounding tissues intact, (2) burning in an open flame, (3) introducing an accelerant, (4) comparing experimental samples to a control from the same individual, and (5) incorporating a control group from a single population to provide context for the magnitude of isotope differences.

This research hypothesized that isotope signatures of most isotope systems in modern bones are comparable before and after burning, focusing on commonly used isotope systems including carbon, nitrogen, oxygen, and radiogenic strontium, as well as lesser-studied isotope systems of sulfur and mass-dependent strontium. Fifteen racks of pig ribs, each rack providing one control and three to four experimental samples, originated from the same herd, ensuring the same isotope source for individuals. Leaving surrounding tissues intact, rib racks were sectioned and burned outdoors in a fire for a preassigned time (25min, 40min, or 55min) and accelerant treatment (none or diesel) while temperatures were recorded in 1min intervals (max. temp.=566°C). For human skeletal samples, two rib and two femur samples were taken from each of four dry skeletons. One rib and femur pair for each individual was kept as a control, and the other pair was burned in a furnace until temperatures reached 200°C, 400°C, 600°C, and 800°C. Isotope ratios were compared in unburned and burned samples from the same individual, which excluded inter-individual variation. Bone collagen, carbonate, and strontium were analyzed by Elemental Analysis-Isotope Ratio Mass Spectrometry (EA-IRMS), Gas Bench-IRMS, and Multiple Collector-Inductively Coupled Plasma/Mass Spectrometry (MC-ICP/MS), respectively.

For the unburned controls (pigs), the range of each isotope system was $\delta^{13}C_{Collagen}$=2.54‰, $\delta^{15}N$=2.62‰, $\delta^{34}S$=4.0‰, $\delta^{13}C_{Carbonate}$=2.16‰, $\delta^{18}O$=8.64‰, $^{87}Sr/^{86}Sr$=0.00097, and $\delta^{88/86}Sr$=0.28‰. For the pigs, the largest standard deviation (1σ) seen within an individual, including burnt samples, for each isotope system was $\delta^{13}C_{Collagen}$=0.24‰, $\delta^{15}N$=0.22‰, $\delta^{34}S$=2.4‰, $\delta^{13}C_{Carbonate}$=0.41‰, $\delta^{18}O$=2.85‰, $^{87}Sr/^{86}Sr$=0.00011, and $\delta^{88/86}Sr$=0.16‰. For the humans, the largest standard deviation (1σ) seen within an individual for each isotope system was $\delta^{13}C_{Collagen}$=0.14‰, $\delta^{15}N$=0.18‰, $\delta^{34}S$=0.9‰, $\delta^{13}C_{Carbonate}$=1.05‰, $\delta^{18}O$=7.92‰, $^{87}Sr/^{86}Sr$=0.00011, and $\delta^{88/86}Sr$=0.06‰. Overall, the variation for each isotope system between burnt and control samples was less than the range seen in the herd of pigs, except for $\delta^{13}C_{Carbonate}$ and $\delta^{18}O$ in human samples, which showed a decrease at 800°C and 400°C, respectively.

In cases such as body disposal attempts within the parameters explored in this study, it is likely that isotopic signatures will provide accurate dietary and geographical history inferences from bone, especially if surrounding tissues remain intact post-burn. Extreme burn cases, such as cremation or prolonged furnace heating of skeletal components, will likely alter the collagen and carbonate constituents.

Isotope Analysis, Burned Bones, Forensic Geochemistry