Elemental Analysis of Human Cremains Using Inductively-Coupled Plasma Optical Emission Spectroscopy (ICP-OES) to Distinguish between Legitimate and Contaminated Cremains

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The purpose of this project is to develop an objective and more definitive means of identifying whether human cremains are legitimate or contaminated. The need for this information has arisen from dissatisfaction and limitations in the current methods of cremains analysis available to forensic scientists. The most common methods of cremains analysis employed by forensic anthropologists are visual inspection, x-ray analysis, and microscopic analysis. Visual inspection is useful to determine whether or not the cremains contain identifiable bone fragments. X-ray analysis is helpful to detect radiopaque objects that may be helpful to the examination. Microscopic analysis is useful to examine not only small bone fragments, but also other non-bone items such as contaminate inclusions. Contaminate inclusions are burned or non-burned items including, but not limited to, small rocks, textiles, sand, staples, screws, or durable clothing items like metal buttons. These items provide even more clues as to the history of the cremains. Unfortunately, the laboratory hours needed to completely examine a set of cremains by microscopic means could take weeks or months. We should expect some contaminate inclusions due to the construction of cremation boxes, how retorts are built and swept out, and how ashes are processed. Only in rare instances has any examiner made a positive identification of cremains. This project does not purport to be able to identify a person from the ashes, only whether or not the cremains given to a family are legitimately human or not. Nor does this project intend to supplant existing analytical techniques, but rather enhance the analysis with advanced technology. Our goal is to develop a technique to analyze human cremains that is relatively affordable in forensic investigations and available at many different laboratories and universities, instead of relying on exotic and expensive machinery.

To determine what survives the cremation process, this project has tested the technologies of Gas Chromatography–Mass Spectrometry (GC/MS), Total Attenuated Reflectance Infrared Spectroscopy (IR), and Inductively-Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Organic extractions of the cremains were analyzed by GC/MS, but no organic compounds were detected. Additionally, the cremains analyzed by IR only exhibited absorption due to the phosphorous/oxygen bond found in phosphate. Due to the elevated temperatures of the cremation process (1625º F, or 885º C), residual organic residues were not expected. Therefore, an in-depth elemental analysis was undertaken using ICP-OES.

Five sets of cremains were tested using ICP-OES: two human cremations (one embalmed, the other not embalmed) performed by the author (TEB) and a professional crematory; a cremated dog as a mammalian comparison; a set determined to be questionable by current analytical methods; and a set known to be questionable by its medicolegal context. Results show the elemental profiles (inorganic metals) of the two known human cremains were consistent with one another, indicating that it is possible to develop expected concentration ranges and mean values using this technology. There was no apparent difference between the embalmed cremains and non-embalmed cremains, which we expected because modern embalming fluid is a hydrocarbon molecule that completely combusts at cremation temperatures. Problems to be addressed in this study include calibration issues with the ICP-OES instrument, sample preparation and variation, and sociocultural obstacles in obtaining known human samples (to increase sample size). Following recent crematory controversies, many families question whether the cremains returned to them are human or not, and this project hopes to offer an objective method to distinguish between legitimate and contaminated human cremains.