A50 Scanning Electron Microscopy/Energy Dispersive X-Ray (SEM/EDX): A Rapid Diagnostic Tool to Aid the Identification of Burnt Bone and Contested Cremains

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After attending this presentation, attendees will have a new appreciation for the value of SEM/EDX analysis for forensic anthropological investigations, particularly for the analysis of burnt remains.

This presentation will impact the forensic science community by detailing how the SEM/EDX can act as a quick and minimally destructive "fingerprinting" tool depicting a sample's elemental composition, thus aiding in the identification of burnt bone and contested cremains.

Having been recognized as a valuable tool to forensic anthropologists since the 1980s, the SEM has found application in a variety of different anthropological scenarios. SEM lends itself to the analysis of osseous material for numerous reasons; it has a superior resolution of 3D structures and a greater depth of field than light microscopy as well as being able to achieve higher magnification. When combined with EDX analysis, an insight into the gross elemental distribution of the sample can be directly related to a visual image of the assessed specimen. This makes it a useful screening tool when the osseous origin of a sample is in question, as was the case in the 2002 Tri State crematory incident. Although this technique has sporadically found application to burnt bone investigations, there has to date been no published, systematic study evaluating the change of EDX spectra over different exposure temperatures or whether the presence or absence of soft tissue during incineration plays a role.

Fresh sheep (O*vis aries*) ribs were divided into two experimental groups, defleshed and fleshed, with fleshed samples retaining the abdominal wall, circa 2cm subcutaneous fat and skin. Triplicates of each sample group were burned in an electric muffle furnace for 45 minutes at temperatures between 100°C and 1,100°C in 100°C increments. All remaining soft tissue was removed post burning. Samples were subsequently analyzed on a tabletop SEM, using a Backscatter Electron (BSE) detector, fitted with an EDX spectrometer for elemental analysis. Use of the variable pressure setting eliminated the need for sample coating. Morphological information was obtained using the BSE detector at 50x and 100x magnification. EDX measurements were taken at a live time of 50sec with a voltage of 20kV, mapping all detectable elements. For each experimental condition, nine EDX measurements were taken. Some trace elements such as Si and Al were removed from the spectra prior to analysis as they did not appear uniformly throughout samples and represented bones of one individual rather than elemental abundance, which was investigated in this study. A three-factor Analysis of Variance (ANOVA) was performed on the atomic percentage of each element in the sample.

Visual analyses of the external bone surface did not find any discernable differences between bones which were burnt with and without soft tissue present. Contrary to the findings of other researchers, curved "thumbnail" fractures were observed in defleshed as well as fleshed bones at high temperatures. Results of the 3-factor ANOVA showed that neither the exposure temperature nor whether the bones had been burned with or without soft tissue present made any significant influence on the bone's overall elemental makeup ($p>0.05$). The Calcium to Phosphorus (Ca/P) ratio, which several researchers refer to as the most characteristic elemental signature of bone, lay within the literature-quoted values of between 1.6 and 2.58 for both fleshed and defleshed bones when calculated using their weight percentage. There was no trend or pattern in these values at different temperatures.

This study has demonstrated that, even when faced with high temperatures, the overall gross elemental content and atomic percentage of elements in bone remains more or less stable, thus creating a unique "fingerprint" for osseous material, even after having been exposed to extreme conditions. The presence of soft tissue during burning does not change this. SEM/EDX has been found to be a valuable tool in the analysis of burnt bone and lends itself as a fast and minimally destructive method to identify burnt bone from other non-osseous material, which may otherwise appear morphologically similar.

SEM/EDX, Burnt Bone, Forensic Anthropology