Effects of Soft Tissue on the Crystallographic Changes to Bone Mineral upon Heating

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Identifying the species of origin of burnt, fragmented bone is one of the most challenging and subjective tasks faced by anthropologists. Due to the degradation of the organic matrix of bone upon heating, visual and biological techniques often render futile and so attention is drawn to the final surviving component, the mineral hydroxyapatite. Exploring the physicochemical modifications that occur to hydroxyapatite has identified species differentiating characteristic changes within the crystal lattice parameters and thermal decomposition products [1]. However, the effect soft tissue has on these crystallographic alterations is not fully understood. It is of paramount importance to understand the variation between defleshed and fleshed bone to establish if current protocols can be reliably incorporated into forensic and archaeological investigations – particularly as most bodies in such scenarios are intact, not skeletonised, prior to burning.

Femoral cortical bone was taken from bovine specimens and varying weights of porcine soft tissue were wrapped around each specimen. Muscle, fat, and skin were tested separately to understand their individual affect, and a combination of the three components were tested for an additive affect. The samples were heated for 1 hour at either 400°C or 700°C. The specimens were analysed using X-ray diffraction and Fourier transform infrared spectroscopy to measure the "crystallinity" of hydroxyapatite, the relative amount of carbonate impurities within the crystal lattice, and to identify the presence of thermal decomposition products.

The results demonstrated that the defleshed specimens had an increased "crystallinity" and a lower relative amount of carbonate impuritie, characteristics of mineral crystallisation whereby hydroxyapatite crystals become larger, more ordered, and less strained. These findings suggest that defleshed bone crystallises either a faster rate, or at an earlier temperature, compared to specimens which are fleshed. This is likely due to the soft tissue components initially providing insulation to the bone, prolonging the crystallisation process and delaying thermal decomposition. Furthermore, no additional mineral phases were identified in these samples, most likely due to the duration of heating.

This was a preliminary, proof of concept study which will be advanced on through measuring a wider temperature range and heating for a longer duration to explore further differences in the crystallisation process and thermal breakdown of hydroxyapatite.

[1] Beckett, S., Rogers, K. D., Clement, J. G. (2011). *Inter-Species Variation in Bone Mineral Behavior upon Heating*. Journal of Forensic Sciences, **3**, 571-579.

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