A129 Analysis of Taphonomic Changes to Juvenile Pig Bone Exposed to a Marine Environment Using Non-Destructive Raman Spectroscopy

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After attending this presentation, attendees will understand how a shallow and inter-tidal marine environment affects juvenile bone preservation and will learn the benefits of using Fourier Transform (FT) -Raman spectroscopy to enhance bone analysis, without the need for time-consuming preparation or destruction of samples.

This presentation will impact the forensic science community by adding to the limited research currently available on time-dependent taphonomic changes to juvenile bone (pig) in a marine environment.

The ability to determine immersion time from bone condition is a critical forensic tool, but marine studies have lagged behind terrestrial ones and, in both cases, juvenile bones are far less studied than adult bones.

As forensic research seeks increasingly to exploit the information contained in bone, age-specific knowledge of taphonomic alteration in a marine environment is crucial. Alterations can occur as soon as the early postmortem period, so it is important to be able to distinguish and understand differential bone preservation. The objective of this study was to explore how the chemical composition of juvenile bone alters over time, using FT-Raman spectroscopy. Immersion time and level of submersion (full or partial) were the measured variables. Pig bone was used in this study as a proxy for human subadults, as both pig and juvenile human bone exhibit the presence of Haversian and plexiform bone. This is not a perfect model, but it is useful in examining the effect water has on bony substrate in lieu of the availability of human samples.

Piglet carcasses (*n*=40) were placed in the inter-tidal or sub-tidal zone, at the University of Otago Portobello Marine Laboratory located on Otago Harbour, Dunedin, New Zealand, for six months. This experiment was replicated to control for seasonality with pigs being placed at the start of the summer (January) and winter season (July) (total *n*=80). Every six weeks, five samples were collected from each zone; the tibia and femur were retrieved and air dried. To ensure consistent and comparable observations, the central bone shaft was chosen as the primary study area because the diaphyseal ends of many bones sustained significant damage. Each sample was scanned three times with an FT-Raman spectrometer, using 1,064nm excitation (1mm spot size, 250mW power). For analysis, particular attention was paid to the five main spectral peaks known to be associated with bone: PO_4^{3-} (960cm^{-1}); CO_3^{2-} (1,070cm^{-1}); CH_2 (1,450cm^{-1}); amide I (1,668cm^{-1}); and amide III (1,246-1,270cm^{-1}).

Using Principal Component Analysis (PCA) and linear discriminant analysis, from the spectral output, quantifiable differences were found between all variables, suggesting that there are both environment and time-specific changes occurring in the surface chemistry of the bone. Environment (inter-tidal and sub-tidal) could be separated with 88%-92% accuracy. In addition, separation by exposure time (6,12,18, and 24 weeks) was possible with 42%-70% accuracy when environment was known. PC loadings showed shifting and broadening of the PO_4^{3-} peak and an increase in CO_3^{2-} substitution into the hydroxyapatite, over time. An increase in CO_3^{2-} substitution creates disorder in the hydroxyapatite. Over time, the amide bands became less defined, indicating the breakdown of collagen. The change in the ratio of organic and mineral components was shown to be a key contributor for differentiating time. The presence of a carotenoid peak (1,525cm^{-1}) in inter-tidal, but not sub-tidal, samples appears to be a significant determinant in separating samples from the two environments and is indicative of algae growth. These results are a major step in better understanding how a marine environment affects juvenile bone and provides important information on the preservational trajectories of juvenile bone in a marine context.

Marine Decomposition, Juvenile Bone, Taphonomy

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