Results and Discussion

Figure 4A shows a bivariate plot of C/C vs IRSF relative to previously obtained FTIR data. It indicates whether the bones were burned (absent or reduced in the samples with higher C/C and IRSF values). Diagenetic contamination (such as rare earth elements and uranium) are absent or reduced in the samples with higher C/C and IRSF values.

The comparison of the spectra can be seen in Figure 2 by the stacked IR spectra. The three highlighted areas show differences in the cyanamide, carbonates, and phosphate groups indicating that there are only minor differences between the bone types measured in this study.

The first box notes the cyanamide peak (NH stretching) which has a higher presence in calcined bone but this is not a significant presence.

The second box notes the ratio between the carbonate A and B groups (C/C). As the FTIR indices and the ratio can be used to identify the burned bones vs non-burned bones, this results in a higher C/C ratio (which is correlated with burning at higher temperatures).

The last two boxes highlight the cranium groups: the calcined bones show a larger presence of multiple peaks compared to the non-calcined bones. These peaks can indicate the ways in which the bones may have been burned (burned vs unburnt), how hot and long they were burned, and crystallinity changes.

The measurement of the C/C ratio as seen in Figure 3A shows that calcined bones of both the crania and post-crania were higher than non-calcined samples, indicating higher burning temperatures. This difference was statistically significant between calcined and non-calcined post-cranial bones according to a student’s T-test.

The measurement of IRSF (Crystallinity Index) is shown in Figure 3B. Similar to 3A, calcined post-cranial bones show the highest values; however, unlike the C/C ratio it is not statistically significant according to a student’s T-test.

Figure 4A shows a bivariate plot of C/C vs IRSF relative to previously published data by Haasc et al. and similar values were obtained by Sneed et al. 2014. The C/C data indicates that a majority of the bones were burned at temperatures around 700°C. The two samples that had the lowest C/C values were non-calcined samples. The C/C data were not statistically significant, and we used a better fit line than the regression line.

While our data does not match very well with the experimentally burned animal data, they are similar to the archaeological samples presented in Sneed et al. The major peaks in the bone crystal structure around 700°C similar to where we have noted a significant change in C/C ratios, a primary component of the lattice structure.

Conclusions & Future Research

- FTIR results from this study show that a majority of the bones selected for analysis (calcined and non-calcined) were cremated at relatively high temperatures, between 600 and 800°C. While major chemical and structural changes between our four bone categories were not observed: calcined post-cranial bones had the highest values for both FTIR indices. This may indicate that calcined post-cranial bones make the best candidates for future chemical analysis as compared to calcined crania and non-calcined postcranial bone.

- To evaluate whether temperature and crystallinity make cremated bone more resistant to diagenesis, future research will analyze the trace element composition between calcined and non-calcined post-cranial bones. The goal of this work will be to determine whether elements commonly associated with diagenetic contamination (such as rare earth elements and uranium) are absent or reduced in the samples with higher C/C and IRSF values.

Acknowledgements

We would like to thank Dr. László Pája and Dr. Jaime Ullinger from the BAKOTA project for help with bone identification, and Dr. Gary Gray from UAB for the use of his lab equipment. This lab equipment would not have been possible without funding from the National Science Foundation - Research Experience for Undergraduates program and a travel grant provided by the UAB Department of Anthropology.