Radiocarbon age of human bone: Deciphering the fine line between forensics and archaeology

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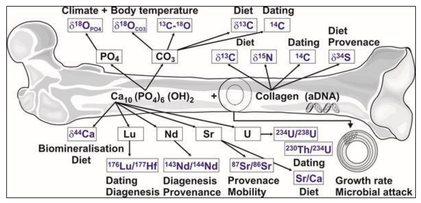
Introduction

When human bones are discovered with no context, it can be a challenge to determine if they should be treated as an **archaeological artifact or as evidence in a crime scene**. A missing person's case in the Yukon Territory was recently solved, but during the search, a human sacrum containing DNA that did not match the missing person was identified near the Donjek River. **This project uses radiocarbon (^{14}C) dating to determine if the sacrum is younger (forensic) or older (archaeological) than AD1955.** Radiocarbon dating is very effective starting in AD1955 as aboveground nuclear weapons testing dramatically increased the tropospheric ^{14}C content[1]**. The results of the radiocarbon analysis tell us whether or not the person was alive during the last fifty years.**

Methodology

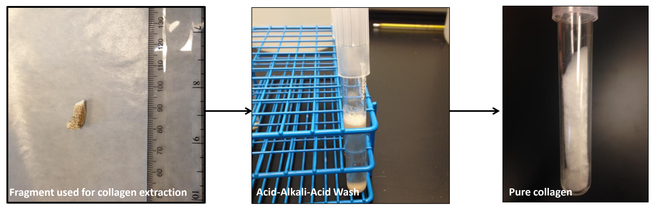
1.Cleaning and decalcification[2]:

- Separating the organic component of the bone
- Collagen lies in trabecular component (spongy bone

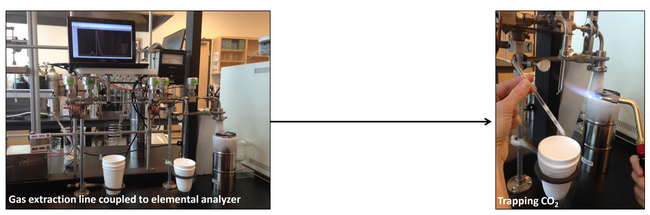


2. Collagen extraction[2,3]:

- Stable isotope analysis (δ^{13}C and δ^{15}N) on collagen by IRMS

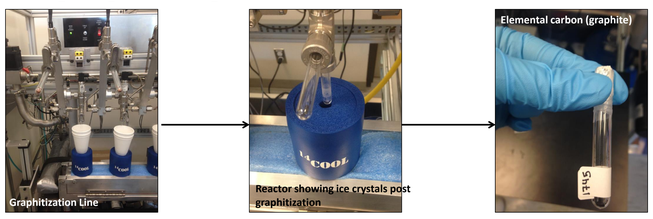


3. Combustion of sample, purification of gas to CO_2, and trapping pure CO_2 in break seal:



4. Graphitization[4]:

- $CO_2 + H_2 \rightarrow C + H_2O$



5. Accelerator Mass Spectrometry:

- Measurement of ^{12,13,14}C

$$F^{14}C = \frac{\left(\frac{^{14}C}{^{13}C}\right)_{S[-25]}}{\left(\frac{^{14}C}{^{13}C}\right)_{1950[-25]}} = \frac{A_{SN}}{A_{ON}}$$

$$^{14}C\ age = -8033 ln(F^{14}C)$$

Where A_{SN}= specific activity of the sample, A_{ON}= normalized sample activity

Equation 1

Results and Discussion

Table 1: Radiocarbon results. Calibration was performed using OxCal v4.2.4.[6] as shown in Figure 1

Lab ID	^{14}C yr BP	F^{14}C	±	Cal AD
UOC-1745	Modern	1.0493	0.0085	AD1956-1957 or AD2005+

Because the calculation of a radiocarbon date [EQ1] assumes a constant production of ^{14}C in the atmosphere, radiocarbon dates must be calibrated to reflect the actual ^{14}C content in the atmosphere. ^{14}C is produced by the cosmic ray bombardment of ^{14}N and therefore fluctuates with solar cycles and other extraterrestrial factors. However, due to aboveground nuclear testing from AD1955-AD1970, there was a large increase in tropospheric ^{14}C content[1]. Since this caused a spike in atmospheric ^{14}C, the calibration curve is very steep, thus allowing precise calibration of radiocarbon ages during this time period.

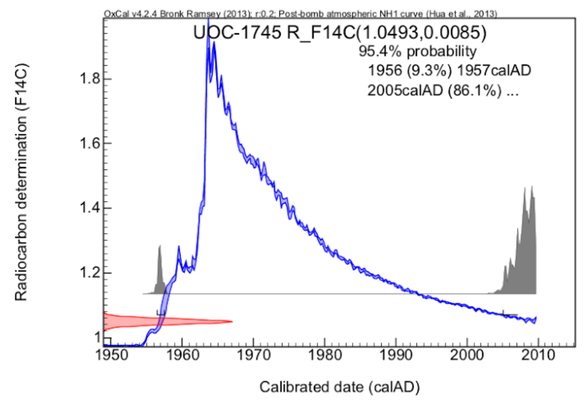


Figure 1: Calibration of the radiocarbon date (pink) using the post-bomb calibration curve (blue). The grey multi-modal probability distribution shows the calibrated date.

Stable isotopes (δ^{13}C and δ^{15}N):
The results of the stable isotope analysis were δ^{13}C=-20 and δ^{15}N=10. Figure 2 shows these results in the context of different diets.

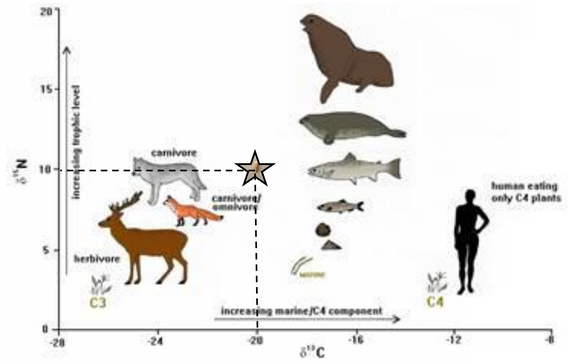


Figure 2: Graph illustrating the δ^{13}C and δ^{15}N values that correspond with various diets.

δ^{13}C and δ^{15}N analysis provide information about diet. As shown in Figure 2, the Donjek bone has δ^{13}C and δ^{15}N values similar to a carnivore or someone eating modern supermarket food in the Yukon Territory (Dr. Michael Richards, *personal communication*). While this information is vague, in order to decipher where this human may have originated from, the stable isotope results can help us eliminate certain cultural groups as they are not indicative of certain costal archaeological humans that have a strong marine signature.

Conclusion

In conclusion, the Donjek bone shows a post-bomb radiocarbon signature and therefore the bone is of modern origin. In addition, the stable isotope analysis results are in agreement with the radiocarbon interpretation as the δ^{13}C and δ^{15}N values are indicative of the signatures of a modern human consuming supermarket food.

References

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