Distinguishing diagenetic tracer element uptake from biological incorporation in bone for reconstructing archaeological life histories is important, but not well understood aspect of bioarchaeology. Previous experiments by the authors and others have hinted at the difficulty in determining the route of element incorporation in bone 1-4. Some of this research has specifically focused on the level of arsenic (As) in archaeological bone as a method of distinguishing individuals working in Brass Age copper smelting activities 5. In order to establish whether arsenic detected in archaeological remains is a result of biological incorporation as opposed to diagenetic alteration, bone char has been suggested as an appropriate analogue for diagnostically altered bone, simulating the expected degradation over archaeological time frames 6. Understanding the potential for alteration of bone char, compared to unaltered bone, is important in evaluating the use of this material as a proxy for diagenetic alteration over archaeological time frames 7.

**BACKGROUND**

**HYPOTHESES**

This experimental investigation tests the hypothesis that bone char will respond differently to unaltered modern bone in a simulated diagenetic environment with respect to element uptake and exchange. The rate at which alteration takes place will be accelerated in bone char compared to that of unaltered bone, the gross differences in structure between the two materials will influence the rate and extent of alteration, and smaller size classes of both materials will be altered at an accelerated rate due to increased surface area. Finally, the modern sample is expected to alter the chemical properties of the simulated burial environment solution differently than bone char due to the organic component.

**MATERIALS & METHODS**

Sample material consists of corneous bone char and Saxony (pig) bone (long bone and rib elements) to represent modern unaltered bone. In order to effectively examine the influence of sample size on the rate and amount of elemental alteration, the experiment also included three different size classes of bone char and pig bone that were each sampled at select time intervals for just over 10 weeks to assess the rate of solution alteration (Table 1). A 250 ppb multi-element solution was used to simulate the burial environment (Table 2). Samples of both materials were dissolved to compare the concentrations of elements in the materials before being altered. All of the solutions was monitored throughout the experiment. Any alteration by uptake and/or exchange between the solution and the bone material is determined by sampling aliquots of the solution analyzed by liquid aspiration ICP-MS. The influence of structural morphology on potential uptake and exchange of the simulated burial solution was analyzed using SEM to determine any overall structural differences between bone char and modern bone.

**RESULTS**

The concentrations of As, Be, Ca, Cr, La, Sr, and U in both the bone char and pig bone samples indicate an overall pattern of rapid uptake during the first 48 hours (Table 3). Some data are removed from the solution (Figures 3 and 4). This initial drop in the concentration of these elements is followed by a plateau, particularly in samples removed following the 203 hour time interval, or roughly 11 days into the experiment (Figure 3 and 4).

The greatest amount of As uptake (i.e. the lowest solution concentration) is seen in the bone char solutions, where the low average value was 13.27 ppb (Table 5). In concentrations in the pig bone solutions are much higher (i.e. the highest solution concentrations), with a low average value of 41.73 ppb (Table 3). U concentrations show the opposite of As, shown by higher levels in the bone char solutions, indicating the lowest amount of uptake (i.e. the highest solution concentration), with a low average value of 24.50 ppb (Table 3) and pig bone solutions showing the highest amount of uptake (i.e. the lowest solution concentration) with a low average value of 3.80 ppb (Table 5).

The concentrations of Ba in the bone char and pig bone solutions show this element behaving in much the same way. The most variation for Ba in both solutions (the other three listed). Note the smaller variation for the Char compared to the bone. Given the data presented we conclude that bone char does not provide a reasonable proxy for archaeological bone. Bone char does not interact with a simulated burial environment in a way consistent with modern pig bone. The alteration of the solution is markedly different between the two samples tested.

**DISCUSSION & CONCLUSIONS**

The examination of solution element concentrations for bone char and pig bone shows the way different elements behave in two sample materials. The concentration levels of As and U in bone char and bone solutions show that these elements are behaving contrary to each other, with U adsorbed in greater quantities than As in pig bone, and As adsorbed in greater quantities than U in bone char. Past research by the author has focused on the different modes of transportation into bone and teeth, indicating the difference in behavior between As and U in modern bone (Figure 5). In contrast Ba and REE's such as La and Ce behave in the same way in both of the materials tested. Size class was originally considered as a crucial factor in element uptake. The results demonstrate that the influence of size class on the amount of uptake varies considerably between elements, suggesting that size class affects elements differently, while the larger four size classes behaved almost identically. In an archaeological context, bone material in the 0.4 mm size range would probably not be recovered and more emphasis should be put on the larger size classes.

**FUTURE RESEARCH**

Future research plates include: longer soak times for similar material types (does the modern bone continue to interact?), different size classes as well as varying types of modern bone (i.e. weathered and steamed bone), increased sampling during the first 12 hours (one hour or half hour), and examining a range of cleaning methods proposed by several researchers as accepted methods for reducing diagenetic signals in altered bone and comparing these methods to altered and unaltered bone to determine a possible error in biogeochemical assessments.