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# Cremation and Secondary Burial Practices among Umm an-Nar Communities in Bronze Age Arabia

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## Abstract

Understanding the ways in which the living processed their dead is a vital component to the field of bioarchaeology, so the purpose of this research is to provide insight into funerary practices for a Bronze Age community in southeastern Arabia and demonstrate a possible difference in mortuary treatment between one generation and the next. By using the Munsell color chart to assign color codes to five areas of testable distal humeri from two Bronze Age Umm an-Nar tombs (Unar 1 and Unar 2) located in the Shimal necropolis in the United Arab Emirates, a statistically significant difference between the articular surfaces of bones from both tombs as well as between the non-articular surfaces was detected, indicating that there was indeed a change in mortuary practices over the speculated 200-year span between the usage of both tombs. All in all, this change could point to a fluctuation in the materials used to perform these funerary rites or, as suspected, it could indicate a shift on a much larger scale of the ideology that drove Umm an-Nar mortuary practices.

## Introduction

Cremation is the process by which human remains are typically reduced to bone and ash through burning. Approaches to cremation have varied culturally across many different periods in pre/history, from placing a body on a pyre over open flames to inserting the corpse in a specialized furnace commonly found in modern, western societies. However, in many of these contexts, cremation is a multistep process used to guide the dead from one metaphysical state to another, and such variations in the motivation behind this practice often make a general definition of cremation nearly impossible to obtain (Ubelaker, 2015). For this reason, both macroscopic and microscopic heat-induced changes to bone have been carefully observed by bioarchaeologists for over three decades (Shipman et al., 1984; Mery et al., 2004; Schmidt et al.,

2015; Symes et al., 2015; Ullinger and Sheridan, 2015), and much research has been done in order to analyze the underlying significance behind these mortuary practices. Through these studies, we now better understand that cremated remains provide a vast amount of information about how the dead were treated.

Though there has been a growing interest in cremated remains among archaeologists and bioarchaeologists recently (e.g., Schmidt et al., 2015; Symes et al., 2015; Soltysiak and Fazeli 2016; Ubelaker, 2015), many skeletal collections have yet to be analyzed due to the challenges of dealing with burnt and fragmentary bone, including numerous Umm an-Nar (ca. 2700-2000 BCE) tombs spread across southeastern Arabia (Blau, 2001). These tombs are comprised of decorated stone blocks organized in a circular formation that often contained an assortment of burned and unburned bones (Blau, 2001). It is from this period that two collections of bones will be analyzed. Distal humeri from two Umm an-Nar tombs dubbed Unar 1 and Unar 2 have been collected, cleaned, sorted, labeled, and curated, and now – in order to understand how the Bronze Age people of the Arabian Peninsula may have processed their dead – color changes associated with cremation (or lack thereof) will be analyzed and documented. In sum, by closely examining the bones available in this collection, this research aims to understand why and how the ancient peoples who would have made use of these tombs cremated their dead.

**The Umm an-Nar Period in Southeastern Arabia**

The Bronze Age in the Arabian Peninsula consisted of three distinct eras: the Hafit (ca. 3100-2700 BCE), Umm an-Nar (ca. 2700-2000 BCE), and Wadi Suq (ca. 2000-1300 BCE) periods. The practice of cremation as a way to process the dead did not become prevalent until the Umm an-Nar period, as prior Hafit and later Wadi Suq tombs have yet to exhibit any

evidence of cremation as an established mortuary practice (Benton, 2006; Potts, 2001; Vogt, 1998). The discovery of these Umm an-Nar tombs was accidental in nature, initially found by Danish oil prospectors working in Abu Dhabi in the 1950s (Blau, 2001). Geographically speaking, Umm an-Nar tombs vary tremendously, as some can be found in inland desert locations while others are found along coastal regions. Nevertheless, they all share a similar architectural structure in terms of an inner ring of unworked stones surrounded by an outer ring of carved, white limestone (**Figure 1**) (Blau, 2001).

**Figure 1**: *Reconstruction of an Umm an-Nar tomb found at Hili. Here, the outer limestone wall can be observed. For examples of the double-ring walls as well as the internal chambers, see Figure 3 and Figure 4.*

In terms of Umm an-Nar funerary practices, for most tombs, bodies were initially placed in areas where they would have been allowed to decompose but were later pushed aside within the tombs to make room for more individuals, resulting in the commingling and fragmentary bones of hundreds of individuals that we see today (Blau, 2001; Mery et al., 2004). However, variation in these practices was evident, particularly with regards to cremation, which was

practiced to varying degrees throughout this period. For instance, pyre debris, cremation pits, and multilayered tombs meant to house both burned and unburned individuals can be found at the site of Al Sufouh in the Emirate of Dubai (Benton, 2006; Blau, 2001; Mery et al., 2004; Guy et al., 2013). These same multi-storied tombs can be found at the site of Shimal in the Emirate of Ras al-Khaimah, and are the focus of this thesis (Figure 2). These tombs and the cremated individuals within them will be discussed in further detail below.


**Figure 2**: *The Emirate of Ras al-Khaimah in the United Arab Emirates.*

The size of some Umm an-Nar tombs (up to 14.5 m in diameter), along with the large number of individuals entombed within them (exceeding 500 individuals in some of the bigger tombs like that found at Hili in what is now the Emirate of Abu Dhabi), have led archaeologists to believe that the people who made use of these tombs lived a sedentary lifestyle, as resources may have been more plentiful through date palm horticulture, domesticated herds of sheep, goat,

and cattle, a vast amount of marine life available for consumption, and the trade of copper ore with the Indus and Mesopotamia, thereby supporting larger group dynamics over longer periods of time (Gregoricka, 2016; Mery et al., 2004; al-Jahwari, 2009; Guy et al., 2013). It also stands to reason that with increased population size, monumental architecture, and economic complexity, there would have been the development of more social hierarchies amongst the Umm an-Nar people (Gregoricka, 2016).

Though there is little research on the domestic spaces of the Umm an-Nar period due to their scarcity in the archaeological record, those few structures left behind offer great insight into how the living functioned on a day-to-day basis. As archaeologically visible structures besides tombs include large fortification towers and remnants of domestic settlements, it is clear that there was an increase in social stratification during this time (al-Jahwari, 2009). This stratification can be seen as a possible result of an increase in the trading of copper ore with Mesopotamia and the Indus Valley and an increased reliance on agriculture from earlier periods (Cleuziou and Tosi, 2007; al-Jahwari, 2009; Gregoricka, 2016). Archaeologists have also made note of an increase in warehouse-like structures intended to store a large amount of goods at sites such as Tell Abraq and Hili 8 (al-Jahwari, 2009). Various other artifacts such as fishhooks, netting, and a great deal of pottery have helped to establish an idea of Umm an-Nar communities as comprised of sedentary people who thrived off the resources from the nearby coast as well as agricultural and pastoral products; these developments permitted the building of a more complex economic system that would not have been present during previously nomadic generations (al-Jahwari, 2009; Guy et al., 2013). This growth in economic complexity also led to an economic independence of household units, as evidenced by the construction of these dwellings around their agricultural land (Swerida, 2017).

**Materials**

Unar 1 and Unar 2 represent the only Umm an-Nar (ca. 2700-2000 BCE) tombs located at the Shimal Necropolis in the northern Emirate of Ras al-Khaimah in the United Arab Emirates, a necropolis that was otherwise dominated by later Wadi Suq (ca. 2000-1300 BCE) tombs (Blau, 2001; Gregoricka, 2016). The Shimal region contains one of the richest prehistoric burial grounds in the Arabian Peninsula, likely because the population that inhabited the area during the Bronze Age made use of its close proximity both to the sea and to oases at the foothills of the Hajjar Mountains (Gregoricka, 2016). The plethora of shell deposits found with human remains at both Unar 1 and Unar 2 speak to the importance of the ocean to these communities, while the oasis they inhabited would have provided both dates for consumption and shade to grow domesticated foods in gardens.

*Tomb Unar 1.* As is common of all Umm an-Nar tombs, Unar 1 was an above-ground, circular stone structure that harbored both the burned and unburned remains of Bronze Age people interred over multiple generations (Blau, 2001; Gregoricka, 2016). It measured about 11.5 m in diameter and had eight internal chambers containing at least 438 individuals during its 200 years of use (**Figure 2**) (Gregoricka, 2016). Grave goods recovered from these tombs were comparable to other Umm an-Nar tombs in the region, including both local and non-local ceramic and softstone vessels, beads, and pins (Blau, 2001). Using these grave goods, archaeologists came up with a period of usage from approximately 2400-2200 BCE (Blau, 2001).

**Figure 3**: *The inner and outer ring walls of Unar 1 as well as the internal chambers, Shimal Necropolis, Emirate of Ras al-Khaimah, United Arab Emirates.*

*Tomb Unar 2.* Utilizing the same method of analyzing grave goods, archaeologists placed the usage of Unar 2 as slightly later than that of Unar 1, between 2300-2100 BCE (Blau, 2001). However, stones that once formed the doorway of Unar 1 were found as foundation stones for Unar 2, (Christian Velde, personal communication). This looting in antiquity suggests that there was likely no overlap between the usages of these two tombs as the communities housing their dead here would have likely been finished using one tomb (Unar 1) before they began to disassemble parts of one structure to complete the other (Unar 2). While maintaining the signature inner ring wall of unworked stone surrounded by an outer ring wall of smooth limestone indicative of an Umm an-Nar tomb, the tomb of Unar 2 (**Figure 3**) differed from Unar 1 in that it possessed a diameter of 14.5 meters (making it the largest Umm an-Nar tomb on record), contained 12 internal chambers, and was estimated to have held 431 individuals (Blau, 2001).

**Figure 4**. *Foundations of the tomb walls and internal chambers of Unar 2, Shimal Necropolis, Emirate of Ras al-Khaimah, United Arab Emirates. Photograph courtesy of Christian Velde.*

Unlike most other Umm an-Nar tombs at renowned sites like Tell Abraq (Emirate of Sharjah), Umm an-Nar Island (Emirate of Abu Dhabi), and elsewhere, it is believed that for Unar 1 and Unar 2, the inhabitants of Shimal initially placed the unburned corpses of the dead into the lower level of the tomb (primary interment) to go through a period of decomposition before they were removed from the tomb, cremated, and then placed into the tomb again, but this time on a second level, as their final resting place (secondary interment) (Blau, 2001; Christian Velde, personal communication). This is because a handful of unburned, articulated skeletons were found at the base of the tomb, covered by fallen stones (that likely represented the floor of the second story of the tomb) as well as fragmentary remains that had been cremated to various degrees sitting on top of these stones. A similar two-storied construction and associated mortuary practices can only be seen at two other Umm an-Nar sites in the region, including Hili Tomb A in the Emirate of Abu Dhabi and Al Sufouh in the Emirate of Dubai (Mery et al., 2004). These secondary burial practices may speak to an extended period of time in which the living interacted with the dead, using ritual to transform them from individuals into a collective of ancestors.

The resources used to cremate these individuals represent an important area of inquiry as well. Although evidence such as wood and other organic materials tend to not survive well in arid environments like this, the manner in which the Umm an-Nar people cremated their dead can still be speculated upon based on the resources available to them. With the growth of agricultural and pastoral products in conjunction with these communities' close proximity to the coast, for instance, resources such as acacia shrubs, Ghaf trees, mangrove trees, and dried animal dung were likely incendiary materials used in their process of cremation (al-Jahwari, 2009; Benton, 2006). Acacia and jujube (a fruit domesticated in Arabia during the early Umm an-Nar period) wood in particular burn at extremely high temperatures (J. Mark Kenoyer, personal communication).

## Anatomy of the Distal Humerus

The distal humerus was selected for this study because humeri tend to better survive commingled collections than other bones. In order to properly analyze the effects of cremation on the distal humerus, it is imperative to first understand the bony features and soft tissues that comprise this anatomical region, given that the presence of the latter can determine the macroscopic and microscopic effects of cremation on the former. The distal humerus possesses a variety of distinctive features, including the lateral and medial supracondylar ridges, medial and lateral epicondyles, radial and coronoid fossae, capitulum, and trochlea (**Figure 4)**.

*Bony landmarks.* Sites of articulation and attachment points can often have the most direct influence on cremation patterns given the potential for shielding, whether that be from soft tissue or direct bone-on-bone contact (Schmidt et al., 2015; Symes et al., 2015). The lateral supracondylar ridge is the attachment site for the tendons of the brachioradialis muscle (m.), the

extensor carpi radialis longus m., and the triceps brachii m. Both the medial supracondylar ridge and the

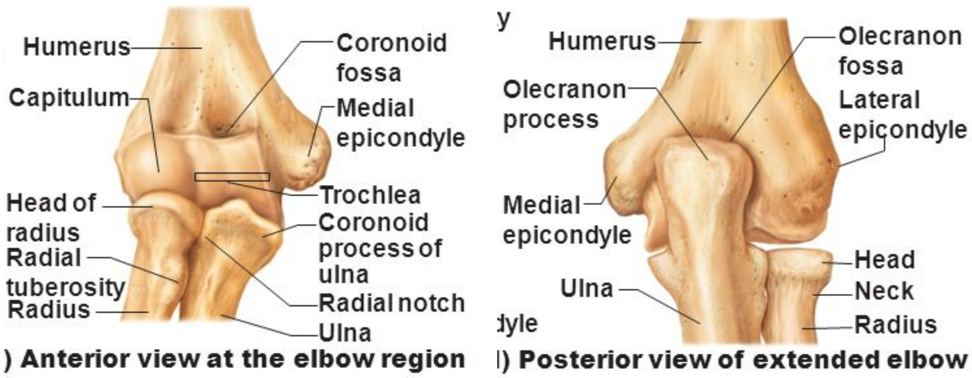



**Figure 5**. *Skeletal anatomy of the distal humerus (from Marieb and Hoehn, 2015: Fig. 7.28).*

medial epicondyle are the attachment sites for the pronator teres m., which primarily rotates the forearm posteriorly; the medial epicondyle is also the site of attachment for the ulnar collateral ligament and numerous flexor muscles in the forearm (White and Folkens, 2005). The lateral epicondyle is the attachment site for radial collateral ligament, the supinator m., and the extensor mm. of the forearm (White and Folkens, 2005). The radial fossa cradles the head of the radius when the arm is in a flexing position, similar to the manner in which the coronoid fossa frames the coronoid process of the ulna in a flexing position (White and Folkens, 2005). The capitulum is the site of articulation for the head of the radius, and the trochlea for the trochlear notch of the ulna (White and Folkens, 2005). The posterior distal humerus also includes the olecranon fossa, which receives the olecranon process of the ulna while the arm is extended (White and Folkens, 2005).

*Muscles.* Soft tissues like muscles can also have a direct influence on cremation patterns, and the muscles associated with the distal humerus include the brachioradialis, extensor carpi radialis longus, and triceps brachii mm. (Marieb and Hoehn, 2015). The brachioradialis is a flexor muscle that runs from the lateral supracondylar ridge to the distal radius and works to pull the forearm in an upward motion, bending the arm anteriorly (Marieb and Hoehn, 2015). The extensor carpi radialis longus muscle is an extensor muscle that attaches to the lateral supracondylar ridge and the lateral epicondyle, which is also the attachment site for all of the extensor muscles in the forearm; it runs across the posterior forearm to the back of the hand and is in charge of unclenching the hand and pulling the wrist posteriorly (Marieb and Hoehn, 2015). The triceps brachii can also be found on the posterior humerus above the spinal groove and helps to straighten a flexed arm (Marieb and Hoehn, 2015). The supinator rotates the arm outward and upward while the extensor muscles all extend the forearm, and the flexor muscles pull the forearm upward and inward (White and Folkens, 2005).

*Ligaments.* Ligaments are perhaps the most important soft tissues to take into consideration when analyzing cremated remains, as their density of cartilage permits them to remain long after other parts of the body have decayed (Marieb and Hoehn, 2015). This delay in decomposition is often directly responsible for macroscopic observations of tissue shielding, thereby producing different temperature-dependent colors on the same bone (Schmidt et al., 2015; Symes et al., 2015). Both the lateral and the medial epicondyle are attachment sites for such ligaments, two of which – the radial collateral ligament and the ulnar collateral ligament – act as stabilizers for the elbow (White and Folkens, 2005).

The distal humerus belongs to a category of joints known as synovial joints, as the epiphyses (ends of bones) that form these joints are coated with an articular cartilage known as

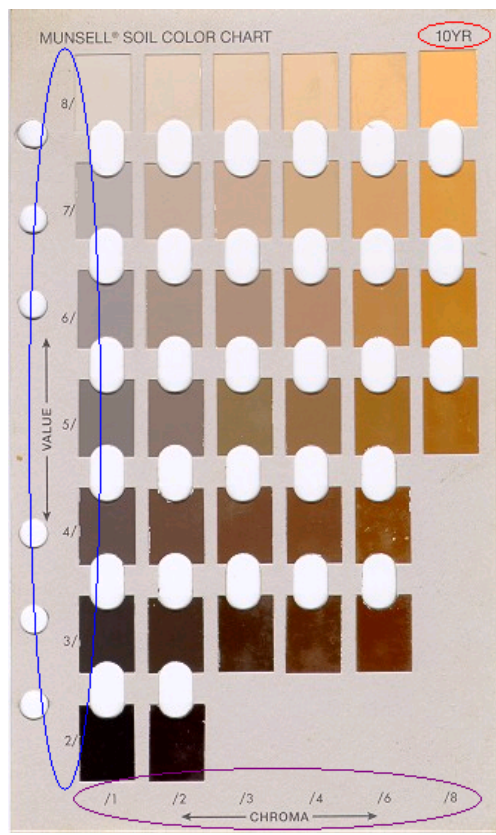
hyaline cartilage (Marieb and Hoehn, 2015). Along with ligaments, the cartilage located at these joints is often some of the last soft tissue to leave the body during decomposition due to the densely packed chondrocytes that form this connective tissue (Schmidt et al., 2015; Symes et al., 2015). Following funerary practices such as cremation, the lasting presence of cartilage may shield the articular surfaces of synovial joints like the elbow, causing macroscopic color changes that may differ from other non-articular features on the humerus without such shielding. Given the better preservation of distal humeri at cremated and commingled sites, observing left humeri apart from right humeri would thus provide a deeper understanding of the positions of the bodies at the time of cremation.

**Methods**

This research focuses on color changes associated with cremation between five different areas on the distal humerus: the capitulum, trochlea, and olecranon fossa (articular surfaces), as well as the anterior distal third of the diaphysis and the medial epicondyle (non-articular surfaces). Articular surfaces on a bone refer to those areas that interact with other bones, often covered in cartilage as part of a joint capsule, while non-articular surfaces do not interact with other bones and are typically not protected by soft tissues like cartilage. Only distal humeri with at least four out of these five areas present and able to be scored were included. The purpose of this research experiment was to determine the degree of decomposition before they were cremated, as color differences between these five surfaces could indicate the presence of soft tissue and/or articulated skeletal elements at the time of cremation, while a lack of color differentiation could indicate that the remains were allowed to decompose completely before being cremated.

The minimum number of individuals, or MNI, was determined for each tomb by counting the most numerous distal humeri from one side of the body. Humeri from both Unar 1 (MNI=110) and Unar 2 (MNI=164) were evaluated for color changes. A sample of distal humeri recovered from both Unar 1 and Unar 2 with at least four of these five features was separated from the rest of the humeral fragments and marked for analysis. Following this, color differences between the capitulum (designated as Area 1), trochlea (Area 2), medial epicondyle (Area 3), anterior distal third of the diaphysis (Area 4), and olecranon fossa (Area 5) were documented using a Munsell color chart (**Figure 5**). The Munsell color chart is a system used to measure the hue (overall color), value (light to dark), and chroma (saturation) of all documented colors. In anthropology, it often serves numerous purposes: to determine the color of soil in which archaeologists

**Figure 6**: *A page from the Munsell Color Chart demonstrating the range in hue (top right, circled in red), value (circled in blue), and chroma (bottom, circled in purple) typically used to scientifically analyze the color of soil during an archaeological dig, or in this case, the color of burned and unburned human skeletal remains.*



The Munsell color chart is a system used to measure the hue (overall color), value (light to dark), and chroma (saturation) of all documented colors. In anthropology, it often serves numerous purposes: to determine the color of soil in which archaeologists find their artifacts or, as is the case with this research project, to assess the color of each surviving skeletal feature in order to assign a temperature-related stage of cremation (Shipman et al., 1984; Ullinger and Sheridan, 2015).

Following Ullinger and Sheridan (2015), Munsell scores were condensed into six major color categories associated with cremation temperatures (measured in degrees Celsius) in bone (**Figure 6** and Appendix A):

1. Pale brown/yellow at up to 285°C (includes unburned bone)
2. Dark brown at up to 360°C
3. Black just before 525°C
4. Grey up to a temperature of 645°C
5. Blue-grey between temperatures of 645 and 800°C
6. White (calcined) at temperatures above 800°C

In order to statistically compare these areas and articular/non-articular surfaces to one another, this research made use of Chi square calculations. The chi-square test is commonly used to analyze the likelihood of a set of results being due to chance, and in this case, it was applied to the data in order to define a relationship between the color categories. Three factors comprise a chi-square analysis: Chi-square statistic (used to show a relationship between two variables), df (degrees of freedom), and the p value, a number between 0 and 1 that determines the actual significance of the data (Statistics How-To, 2018). Significance levels for p were defined at 0.05.

**Figure 7**: *Distal humeri across the cremation color spectrum, including Color Category 1 (unburned, top left). Category 2 (dark brown, top right), Category 3 (black, bottom left), Category 5 (grey-blue, bottom middle), and Category 6 (white/calcined, bottom right).*

**Hypothesis**

It is evident that the Umm an-Nar people at Shimal implemented cremation to process their dead, but it is unclear at which stage of decomposition that cremation took place, or how these practices may have changed over time. Based on the original archaeologist's interpretation of the site and the two-storied construction of both tombs, this study hypothesized that soft tissue was not present at the time of cremation on the Unar 1 and Unar 2 bones. As such, the articular surfaces of the distal humeri were expected to exhibit similar colors when compared to non-articular surfaces. This hypothesis was tested by examining heat-induced color changes to the distal humerus using a Munsell color chart.

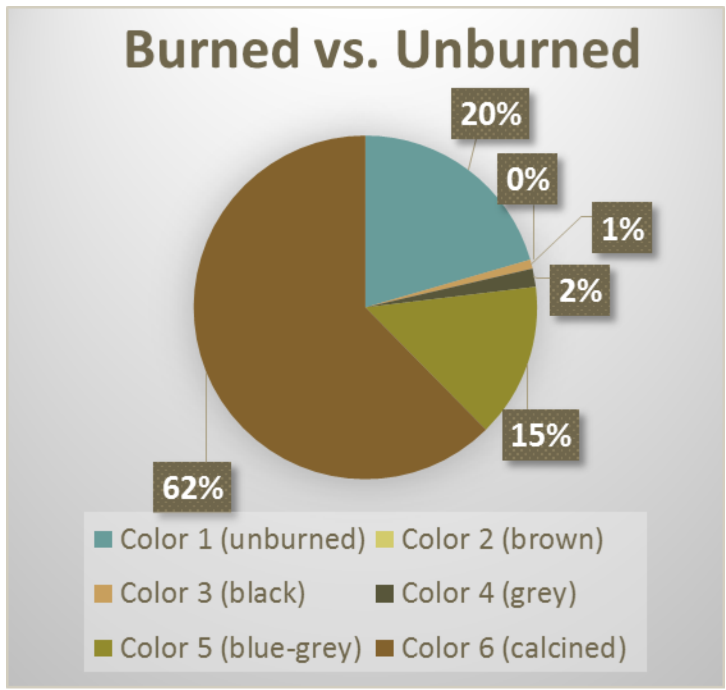
**Results**

A counted total of all the scored features (Areas 1-5) by color (Color Categories 1-6) of distal humeri from Unar 1 and Unar 2 can be found in Appendix B, organized by side (left (L) vs. right (R)). These data were further categorized into counts of the total scored articular (Areas 1+2+5) and non-articular (Areas 3+4) features for Unar 1 as well as for Unar 2 (see Appendix C), also organized by side. Results of Chi-square statistics utilized in order to determine possible significant differences between area and color combinations were included in Appendices C-H. Intra-observer error (measured by re-scoring color for 10% of the samples at a later date) was tested using the non-parametric Mann-Whitney U test, as the color categories evaluated represent an ordinal data set. Results were not statistically significant for Unar 1 (U = 58.5; z = 0.1X; p = 0.92), Unar 2 (U = 135.5; z = -0.26; p = 0.80), or a combination of the tombs (U = 364.5; z = 0.01; p = 0.99). This suggests that the data I collected were evaluated accurately, and that almost no variation existed between the color categories (1-6) I assigned on two separate dates for the same specimens.

*Tomb Unar 1.* After closely examining the 24 distal humeri (n=13 left; n=11 right) of tomb Unar 1, only 20% of people interred in Unar 1 remained unburned, while 77% of the remains were found to be calcined (62%) or grey/blue (15%), the stage just before calcination (**Figure 7**). This suggests that the majority of those interred in the tomb were not only cremated, but were cremated at temperatures exceeding 940°C. Further, the bones exhibited no statistically significant differences in degree of burning between articular and non-articular surfaces when comparing Colors 1 vs. 6 ($\chi^2$=0.01, df=1, p=0.92) as well as Colors 1 vs. 5 vs. 6 ($\chi^2$=3.83, df=2, p=0.15) for all sides (lefts and rights). These comparisons were possible due to the number of humeri in each color category; other categories (e.g., Colors 2 (dark brown) and 3 (black)) could

not be statistically compared using Chi Square tests due to having sample sizes below five, indicating that few bones were burned at these mid-range temperatures. Similar results were obtained when only comparing lefts ($\chi^2$=0.05, df=1, p=0.82) or rights ($\chi^2$=0.01, df=1, p=0.92) for Colors 1 vs. 6, and when using only lefts ($\chi^2$=2.12, df=2, p=0.35) or rights ($\chi^2$=1.69, df=2, p=0.43) for Colors 1 vs. 5 vs. 6. There were also no significant color differences between the left and right humeri within this tomb ($\chi^2$=3.83, df=2, p=0.15) for Colors 1 vs. 5 vs. 6.

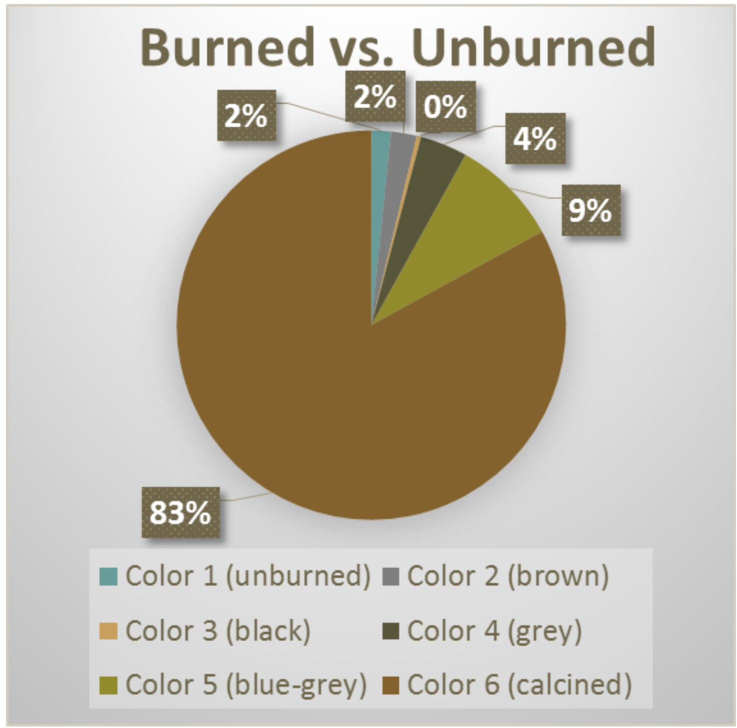
**Figure 8***: Unar 1 pie chart. This chart depicts the percentages of colors represented throughout the cremated remains of Unar 1.*




*Tomb Unar 2.* The 122 observed humeri (n=59 left; n=63 right) showed differential patterns of burning relative to Unar 1. 83% now exhibited complete calcination, and another 9% grey-blue, while only a very small percentage of individuals (2%) remained unburned (**Figure 8**). However, as with Unar 1, the bones exhibited no statistically significant differences in degree of burning between articular and non-articular surfaces when comparing Colors 1 vs. 6 ($\chi^2$=0.05, df=1, p=0.82) as well as Colors 1 vs. 5 vs. 6 ($\chi^2$=0.14, df=2, p=0.93). Similar results were obtained when only comparing lefts ($\chi^2$=0.06, df=1, p=0.81) for Colors 1 vs. 6 (sample sizes

were not large enough to compare rights), and when using only lefts ($\chi^2$=0.06, df=2, p=0.97) or rights ($\chi^2$=0.06, df=2, p=0.97) for Colors 1 vs. 5 vs. 6. Additionally, there were no statistically significant differences between left and right sides ($\chi^2$=0.14, df=2, p=0.93) for Colors 1 vs. 5 vs. 6.

**Figure 9**: *Unar 2 pie chart. This chart depicts the percentages of colors represented throughout the cremated remains of Unar 2. Notice the difference of calcined remains as well as the difference of unburned remains between Figures 8 and 9.*




When tombs contrasted against one another, however, there were statistically significant differences in color between Unar 1 and 2 articular (Colors 1 vs. 6: $\chi^2$=42.23, df=1, p<0.0001) and non-articular (Colors 1 vs. 6: $\chi^2$=27.37, df=1, p<0.0001) surfaces. Consequently, while calcined remains (Color Category 6) indicative of the hottest burning temperatures dominated both tombs (62% and 83%, respectively), a greater number of individuals remained unburned in the earlier Umm an-Nar period within Tomb Unar 1 (20%) than in the latter period within Tomb Unar 2 (2%).

**Discussion**

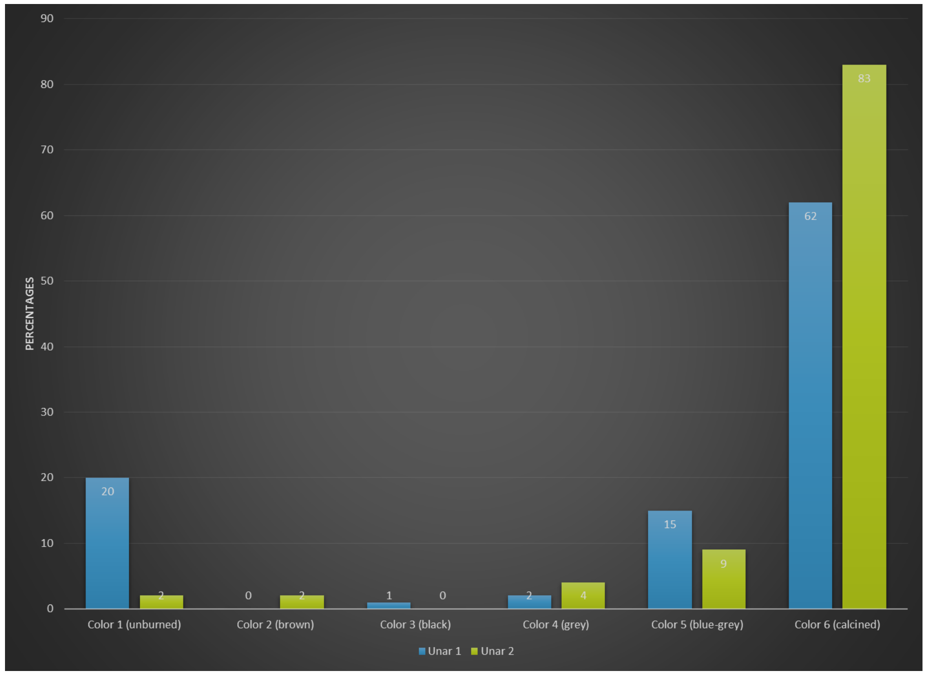
*Tomb Unar 1*. A lack of significant differences in color between the articular and non-articular surfaces for bones within Unar 1 indicates that there was not any soft tissue present to shield the bodies during the time of cremation. Instead, mortuary practices implemented during this time called for the dead to be fully decomposed before they could move on to secondary processing via cremation. The results also revealed that the bodies were all placed in similar positions before cremation, perhaps on their posterior (back) or anterior (front) surfaces, and were equally exposed to cremation fire temperatures, as there were no significant differences in degree of cremation between the right and left humeri. As bodies appear to have already decomposed prior to cremation, it's also possible that these skeletons were no longer articulated, and that bones were gathered, commingled, and then evenly burned. As only 62% of remains from this collection were completely calcined (Color Category 6), and as 20% of these bones appear unburned, it seems as though achieving thorough cremation at high temperatures was not as important a funerary practice during this time as in later periods. Because Tomb Unar 1 represents the mid-Umm an-Nar period, these results could also indicate a growing interest in full calcination for those late Umm an-Nar period communities utilizing Tomb Unar 2.

*Tomb Unar 2*. The overall absence of significant differences in color between articular and non-articular surfaces within this tomb suggests that all surfaces were equally exposed to the same temperatures during cremation. This implies that no soft tissue or articulated segments of the skeleton were present, and correspondingly, that tissue shielding did not take place. There was also no variation in the level of decomposition between the right and left sides of the body. These data suggest that these communities – like those who used Unar 1 – allowed their dead to fully decompose prior to cremating them. This degree of decomposition also indicates that burial

rites were not single events occurring soon after death, but rather lengthy rituals that involved handling the remains of the long dead as part of complex secondary and multi-layered mortuary procedures (e.g., see also Benton, 2006; Blau, 2001; Soltysiak and Fazeli, 2016).

*Tombs Unar 1 & 2 Together*: Results comparing both tombs against one another (Figure 10) indicate a change in the treatment of the dead over time, with cremation becoming increasingly common between Unar 1 and Unar 2. In addition, most individuals from both the mid- and late Umm an-Nar period were burned at temperatures so hot that their remains became completely calcined, suggesting that extensive and not simply partial cremation was an important part of mortuary ritual. Access to aforementioned resources used for burning (e.g., acacia), along with the more consistent color patterns throughout the human remains for both tombs, suggest that the Umm an-Nar people made use of funeral pyres, leaving the remains open and exposed to a consistent air supply, and not closed kilns, which would yield irregular color patterns (Benton, 2006). This change in funerary practices might be the result of a change in ideology in terms of transforming a deceased individual into an ancestor (Cleuziou and Tosi, 2007). It is possible that the dead may have had to endure various rites of passages in order to join this ancestor collective, just as the living often have to endure rites of passages to proceed throughout numerous stages of life or the established social order (van Gennep, 1909; Turner, 1969). Rites of this nature often give way to liminal or transitional periods throughout these particular processes in a way that levels a society into an egalitarian network (van Gennep, 1909; Turner, 1969), which could also explain why bioarchaeologists are able to see all members of the community buried in these tombs (females and males, adults and children) despite evidence of growing social differentiation among the living throughout the Umm an-Nar period.

**Figure 10**: *Unar 1 and Unar 2 cluster column graph. This graph visually compares the percentages of humeri under each category from one tomb to another. Notice the dramatic increase of calcined remains from Unar 1 to Unar 2 in comparison to the decrease in unburned remains.*




How might this specifically apply to populations living and dying in southeastern Arabia during the Early Bronze Age? With a growth in sedentary lifestyle, these populations could have pushed for ways to tie them to their particular land, and one way to make claim over such resources is to create ancestors (Cleuziou and Tosi, 2007). Perhaps these communities viewed secondary burial practices including cremation and commingling as one long, liminal process to gradually transform their dead into a collective of ancestors, and the time between initial interment and secondary mortuary practices involving cremation could have represented that rite of passage for ancestors (Cleuziou and Tosi, 2007; Tung, 2016). This may have required a physical commingling of the remains of hundreds of people to remove an individual's identity; however, in addition to commingling, cremation would have also served to further process these remains into a collective (Tung, 2016).

In addition, the appearance of monumental architecture as well as extensive trade networks during the Umm an-Nar period suggests an increase in social differentiation between

members of local communities (al-Jahwari, 2009). At the same time, however, all members of the community were buried in these tombs – males and females, young and old (Blau, 2001; Cleuziou and Tosi, 2007). As differences in social status became more apparent following the emergence of oasis agriculture, the construction of monumental architecture, and more intense trade relations, it remains possible that egalitarian treatment of the dead reflected a political strategy used by the living as a visible reminder of equality. Some have even speculated that it was this growing social stratification that contributed to the collapse of the Umm an-Nar period around 2000 BCE, as proponents of more traditional, kin-based forms of social organization dispersed rather than continue to support the development of such hierarchies (al-Jahwari, 2009; Cleuziou and Tosi, 2007; Potts, 2001; Magee, 2014).

**Conclusions and Future Directions**

In sum, analyzing the mortuary practices of these Umm an-Nar communities can greatly enhance our understanding of life and death during periods of change. It was initially hypothesized that there would be few differences between the articular and non-articular surfaces within each tomb, and in that sense, the results supported the overall hypothesis. However, such large differences between the number of cremated versus unburned individuals between tombs Unar 1 and Unar 2 were not anticipated; this offers further insight into how the living community may have dealt with increasing stratification through the creation of an ancestor collective comprised of all tomb members (Cleuziou and Tosi, 2007). Beyond the cremation-based bone color patterns, future studies will include an analysis of thermal fracture patterns, which can also shed light on whether cremation occurred before or after decomposition took place. By analyzing more bones than just the humeri, it is also possible that the position in which these bodies were

burned can be pieced together. Finally, age and sex estimations would be useful demographic information to have on hand for the distal humeri, but because cremation causes bone to shrink and warp, this may only be possible for unburnt remains whose measurements remain unaltered (Shipman et al., 1984; Ullinger and Sheridan, 2015), and does not fully allow us to further clarify who was included in these tombs as potential ancestors.

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