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Dissertation

MAYA OSTEOBIOGRAPHIES OF THE HOLMUL REGION, GUATEMALA: CURATING LIFE HISTORIES THROUGH BIOARCHAEOLOGY AND STABLE ISOTOPE ANALYSIS

By

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DEDICATION

To my family, my mother, and Chad.

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MAYA OSTEOBIOGRAPHIES OF THE HOLMUL REGION, GUATEMALA: CURATING LIFE HISTORIES THROUGH BIOARCHAEOLOGY AND STABLE ISOTOPE ANALYSIS

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ABSTRACT

This study applies a life history approach to analyzing the identities of 52 Maya individuals who lived between 2000 BC and AD 900 in and around the city of Holmul, within the Petén region of Guatemala. Primary goals were to: (1) identify migrant and local individuals within the urban population; (2) determine $^{87}Sr/^{86}Sr$ isotope ratio signatures for the sites of Holmul, Cival, La Sufricaya, K'o, and Hamontun; (3) compile osteobiographies, personal life histories revealed through skeletal remains, of the individuals in the sample; and (4) evaluate evidence bearing on the identities of inhabitants of the Holmul region and how they were represented within economic, political, and cultural landscapes of the ancient Maya. This work demonstrates how bioarchaeologists can implement osteobiographical analyses to advance the understanding of multifaceted social identities and individual experiences of life and death. By integrating osteological study, stable isotope analysis, and consideration of mortuary context, material culture, inscriptions, and monumental architecture, the individual, rather than the population, becomes the focus. This aggregate approach allows

for an in-depth consideration of human remains as former social beings with complex identities.

The findings of this research suggest that most elite inhabitants in this ancient Maya city were local to the Holmul region, with the few outliers having originated from elsewhere in the Maya lowlands. This conclusion aligns with Maya elite ideologies of establishing lineages and reinforcing power through ancestor veneration. The local $^{87}Sr/^{86}Sr$ ratio signature of the Holmul region is comparable to other archaeological sites in the southern Maya lowlands. The osteobiographies reveal life histories, which personalize prior interpretations that considered the population only as an aggregate. This project also elucidates identities of sacrificed children, elite/royal women, and the local Holmul elite.

Results of the study support the use of the isotopic analysis of human remains as an essential tool for approaching complex archaeological questions and evaluating hypotheses previously addressed primarily using architectural, iconographic, and artifactual evidence. Further, this study demonstrates the benefit of the isotopic analysis of dental enamel, especially in the Maya region and other environments characterized by difficult excavation conditions and the poor preservation of human remains.

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CHAPTER 1: INTRODUCTION

Osteobiographies incorporate the details of an individual's life, as seen through analysis of human skeletal remains, with an understanding of life (and death) within a cultural context (Robb 2002:160). The osteobiographical methodology allows scholars (e.g., Hawkey 1998; Renschler 2007; Mayes and Barber 2008; Boutin 2008; Knüsel et al. 2010; Tourigny et al. 2016) to contextualize the biographical narratives of individuals in order to understand the development and augmentation of identities in the past, as well as the fluidity of lived experiences. Bioarchaeologists working the Maya region (e.g., Buikstra et al. 2004; Tiesler and Cucina 2006; Price, Burton, et al. 2006; Tiesler et al. 2007) are constructing osteobiographies through the integration of skeletal analysis, mortuary analysis, bone chemistry, material culture, inscriptions, and monumental architecture to gain a more complete life history. Encouraged by the holistic approach to Maya life histories advocated by Saul and Saul (1989), and by advancing osteobiographical methods, this study reconstructs past identity profiles, while also considering the theoretical and cultural aspects of life and death. The osteobiographies of 52 ancient Maya individuals who lived between 2000 BC and AD 900 in the Petén region of Guatemala are presented, incorporating stable isotope analysis to add an additional line of evidence to explore their geographic origin, mobility, health, and diet.

The archaeological and osteological materials for this project were excavated at the sites of Holmul, Cival, La Sufricaya, K'o, and Hamontun, in the northeastern Petén district of Guatemala (Figure 1.1). This region is a valuable area for exploring pre-Columbian/pre-Hispanic Maya identities, since centuries of occupation provide evidence

Figure 1.1 Map of the Maya region. The “H” indicates the location of Holmul (Estrada-Belli 2010).

of social complexity, of institutionalized social stratification, and of divine kingship as early as the Middle Preclassic period (Hammond 1992, 1999; McAnany and Harrison-Buck 2004; Saturno et al. 2005, 2006; Estrada-Belli 2011, 2006; Taube et al. 2010). The primary goals of the study are to: (1) identify migrant and local individuals within the sampled urban population; (2) determine the $^{87}Sr/^{86}Sr$ ratios for the Holmul region, and the sites of Holmul, Cival, La Sufricaya, K'o, and Hamontun; and (3) compile the osteobiographies (demographic and biological profiles) of the (migrant and local) populations. By integrating stable isotope analyses, mortuary analyses, and osteological evaluations, this dissertation uses bioarchaeology to compile osteobiographies of the sampled individuals, illuminating the complex identities of the inhabitants of the Holmul region and how they were articulated with the economic, political, and cultural landscapes of the broader ancient Maya world. This research supports the use of the isotopic analysis of human remains as an essential tool for approaching complex archaeological questions and hypotheses, previously addressed primarily using architectural, iconographic, and artifactual evidence.

Since its introduction in the 1970s, bioarchaeologists have used stable isotope analysis in the evaluation of human skeletal remains from archaeological sites. Isotopes can be defined as atoms of one element that have differing atomic masses due to the variation in numbers of neutrons between them (Katzenberg 2008). Unlike radioactive or unstable isotopes, stable isotopes of the same element do not decay over time (Larsen 1997; Katzenberg 2008). These stable isotopes are found in the tissues of plants, animals, and the surrounding environment and are passed on to the consumer. Bone chemistry and stable isotope analysis have endowed bioarchaeologists with the methodology to evaluate the diet, demography, and life histories of past populations from the human skeletal material in archaeological contexts.

Bioarchaeologists studying ancient Mesamerican populations have analyzed dental enamel for strontium and oxygen isotope ratio values to elucidate the geographic origins of specific individuals and test hypotheses of military, political, and economic relationships. These scholars have used this method to: (1) understand the implications of diverse geographic identity within Teotihuacan; (2) realize the influence of Teotihuacan throughout Mesoamerica; and (3) create biographical histories of prominent Maya individuals found in elite tombs. This dissertation integrates stable isotope analyses, mortuary analyses, and bioarchaeological evaluations within osteobiographies to understand the complex identities of 52 Maya individuals, including elites and non-elites interred in varying contexts.

This research demonstrates how bioarchaeologists are advancing the field and integrating diverse lines of evidence to better understand the diverse experiences of life and death within particular contexts of the human past. Further, this study demonstrates the benefit of the isotopic analysis of dental enamel, especially in the Maya region and other global environments where difficult excavation conditions and the poor preservation of human remains previously dissuaded scholars.

Organization of the Dissertation

This dissertation is organized to introduce the cultural-historical context, to provide the theoretical framework, to describe the methods of analysis, and to discuss the significance of the results.

Chapter 2 presents the archaeological and osteological materials excavated at the sites of Holmul, Cival, La Sufricaya, K'o, and Hamontun, in the northeastern Petén district of Guatemala. Special consideration is paid to the explorations and excavations in the early 20th century by Raymond Merwin, as well as recent excavations by the Holmul Archaeological Project (HAP). This chapter not only presents the history of archaeological research but also the cultural history of the region from the Middle Preclassic period (ca. 1000-400 BC) to the end of the Terminal Classic (ca. AD 800-1100).

Chapter 3 reviews three major current discussions in bioarchaeology that frame the bioarchaeological assessment and interpretation of my sample population: (1) the bioarchaeology of identity; (2) the bioarchaeology of health, diet, disease, and stress; and (3) the bioarchaeology of migration and mobility. The bioarchaeology of identity allows for the understanding of the complexities and the variability of identity formation and manipulation by past populations. Bioarchaeologists are employing osteobiographical analysis to approach an individual's identities, often veiled and imperceptible in the archaeological record with a culturally contextualized understanding of life (and death) events. The bioarchaeology of health, diet, disease, and stress contribute the osteobiographical compilations of which elucidate the lifestyle and well-being of past groups or societies. The discussion of the bioarchaeology of migration and mobility provides the theoretical context for stable isotope analysis, used to identify the geographic origin of individuals and thus identity as migrants or locals.

Chapter 4 reviews the applications of the above theoretical frameworks in Mesoamerican archaeology and bioarchaeology, especially within the Maya region. Discussions include how bioarchaeology has elucidated elements of sacrifice and cannibalism, and how the combination of skeletal analysis, mortuary analysis, bone chemistry, material culture, inscriptions, and/or monumental architecture can support further understanding of the Maya life course.

Chapter 5 presents the bioarchaeological methodology of this dissertation. For each skeleton sampled for tooth enamel, a comprehensive osteological evaluation, archaeological examination, and mortuary analysis were undertaken, creating a biological profile of each individual. The osteological evaluation, including estimated age, biological sex, antemortem or perimortem trauma, body modification, pathology, and dental health, followed the guidelines established in *Standards for Data Collection from Human Skeletal Remains* by Buikstra and Ubelaker (1994), as well as those established by the Arizona State Museum (2011). Following the osteological evaluation, the associated documentation and artifacts were examined to elucidate the mortuary behavior of the burial context of each individual (i.e., the burial type, burial construction, burial layout/positioning, and associated burial goods). These data were gathered through investigation of the HAP archives in their Guatemalan laboratory, as well as in the archives of the Peabody Museum. Field notebooks, burial drawings, and photographs were recorded and analyzed to determine the mortuary behavior for each individual. Welsh's (1988) classification scheme of Maya burial contexts acts as the foundation for the mortuary analysis portion of this study. The chapter then expands upon the utility of bioarchaeology, highlighting how the skeletal analysis of human remains can be integrated with evidence of mortuary behavior to understand cultural practices, such as ancestor veneration and human sacrifice, and their relation to the social identity of the deceased.

Chapter 6 outlines how bone chemistry and stable isotope analysis are used by bioarchaeologists to evaluate the diet, residential mobility, and life histories of past populations from the human skeletal remains in archaeological contexts. This chapter presents the comparative baseline information for stable isotope analysis of the Maya region and Greater Mesoamerica, followed by the laboratory methods for preparing the enamel samples and a discussion of the mass spectrometry process.

Chapter 7 presents the results of the stable isotope analysis and their statistical evaluation. Each isotopic dataset, $^{87}Sr/^{86}Sr$, $\delta^{18}O$ and $\delta^{13}C$, is evaluated separately for statistical outliers. Following the removal of $^{87}Sr/^{86}Sr$ ratio outliers, the local ratio signature is presented for the Holmul region, as well as for the sites of Holmul, Cival, La Sufricaya, K'o, and Hamontun. The three lines of isotopic data are combined using bivariate plots to characterize further any outliers previously identified. The statistical outliers are evaluated for their likelihood of being non-local individuals.

Chapter 8 presents the osteobiographies for the 52 individuals excavated from the sites of Holmul, La Sufricaya, Cival, K'o, and Hamontun in the Holmul region. The osteobiographies are organized by archaeological site and then by location within the site. After the osteobiographies of each site, a discussion of those individuals follows, except for Holmul, where the discussions are located after each group is presented due to the large number of individuals from that site. Each osteobiography begins with an individual profile table that summarizes the demographic information of the individual, the associated context, and the stable isotope results. An in-depth discussion follows presenting the osteobiographical narrative of the individual, which is then referred to during each site or group discussion.

Chapter 9 discusses the nuanced identities of those buried in the Holmul region. This chapter focuses on the intersectionality between the identities of regional origin, biological sex, biological and cultural age, political role, social status, and religious purpose. The dissertation closes with a final discussion of the outcomes of the study and future directions.

CHAPTER 2: THE HOLMUL REGION

In this chapter I present a discussion of the geographic and cultural region of Mesoamerica, followed by a brief history of archaeological endeavors in the Maya region. I provide the history of excavations and the cultural history of each archaeological site explored within this project, specifically Holmul, Cival, La Sufricaya, K'o and Hamontun. To contextualize my bioarchaeological research, I elaborate upon the excavations of mortuary contexts and human remains at each site, and previous bioarchaeological research in the Holmul region.

Mesoamerica and the Maya Region

Mesoamerica is a geographical and cultural region that spans from Mexico south through El Salvador and Honduras. The Maya region, including the archaeological sites of the Maya civilization and the modern settlements of the descendants, covers a roughly 324,000 km^2 section of Mesoamerica, today including portions of eastern Mexico, Guatemala, Belize, western Honduras, and northwestern El Salvador (Sharer 2006). The Maya region is divided into three geographic ecozones (Figure 2.1) among which environmental conditions vary significantly: the Pacific coastal plain, the highlands, and the lowlands (including the southern, central Petén, and northern Yucatecan sub regions).

Following the development of agriculture and settlements throughout Mesoamerica in the Early Preclassic period (ca. 2000-1000 BC), the rise of complex society in the Maya region began sometime during the Middle Preclassic period (ca. 1000-400 BC) accompanied by an increased social and political complexity, especially in

Figure 2.1 Map of the Maya region. The "H" indicates the location of Holmul (adapted from Estrada-Belli 2010).

the south. The Late Preclassic period (ca. 400 BC - AD 100) saw rapid growth throughout the Maya region, both in population size and centralized political authority. It was during this period that the famous Maya art, calendrical, and writing systems appeared, mostly in the southern highland and coastal areas, but also at the lowland site of El Mirador (Sharer 2006:223–284). At the end of the Preclassic period, early Maya society experienced a significant decline, paving the way for the new Maya States in the Early Classic period (ca. AD 250-600), especially in the southern and central lowlands.

The Maya experienced their height of population and cultural advances with the rise of powerful polities during the Late Classic period (ca. AD 600-800), which was followed by the Classic Maya "collapse" of the Terminal Classic period (ca. AD 800-1100). The Classic period ends asynchronously, around AD 900 in the southern and central lowlands but extending in the northern lowlands until AD 1100 (also referred to as the Postclassic period). The Maya people persisted, however, although not organized in the form of the Classic polities. Major sociopolitical transformations during the Postclassic period are apparent in the archaeological record and ethnohistoric sources, and the Spanish arrival in the early 16th century began the Colonial period. More than six million individuals who identify as Maya either culturally or linguistically currently reside in the region, reviving Mayan languages, rituals, and other lifeways (McAnany 2016).

While the invading Spanish noticed the architectural remains of the pre-Columbian civilization in the region, it wasn't until the late 18th- early 19th centuries that the ruined cities were investigated and reported. In 1839 and 1841, John Lloyd Stephens and Frederick Catherwood (re)discovered and documented numerous Maya cities, beginning with Copan (Porta 2005). They published the accounts of their explorations throughout the Maya region with detailed lithographic depictions of the monumental sculpture and architecture they found (Stephens and Catherwood 1841). Inspired by their accounts, Alfred Maudslay undertook eight explorations to the Maya region in the late 19th century, carefully documenting his examinations of structural remains, most notably with the new technique of dry-plate photography (Graham 2002). These explorers were the forbearers for the comprehensive and systematic archaeological excavations of institutions such as Harvard University, the Carnegie Institution of Washington, and the University of Pennsylvania in the 20th century.

The Archaeology of the Holmul Region

The Holmul region (Figure 2.2 and Figure 2.3), including the archaeological sites of Holmul, Cival, T'ot, K'o, Hahakab, Hamontun, La Sufricaya, and La Riverona, corresponds to a watershed basin in the karstic environment of the central lowlands, specifically in the northeastern region of the Petén department of Guatemala, a few miles west of the border with Belize. The area is characterized by subtropic hardwood forest vegetation and is located between two east-west escarpments. The Holmul River cuts through a hilly area of the basin as it flows north. Within the region, most of the ceremonial centers are located within 500 m of the river or of swamps located on the outskirts (Estrada-Belli 2009).

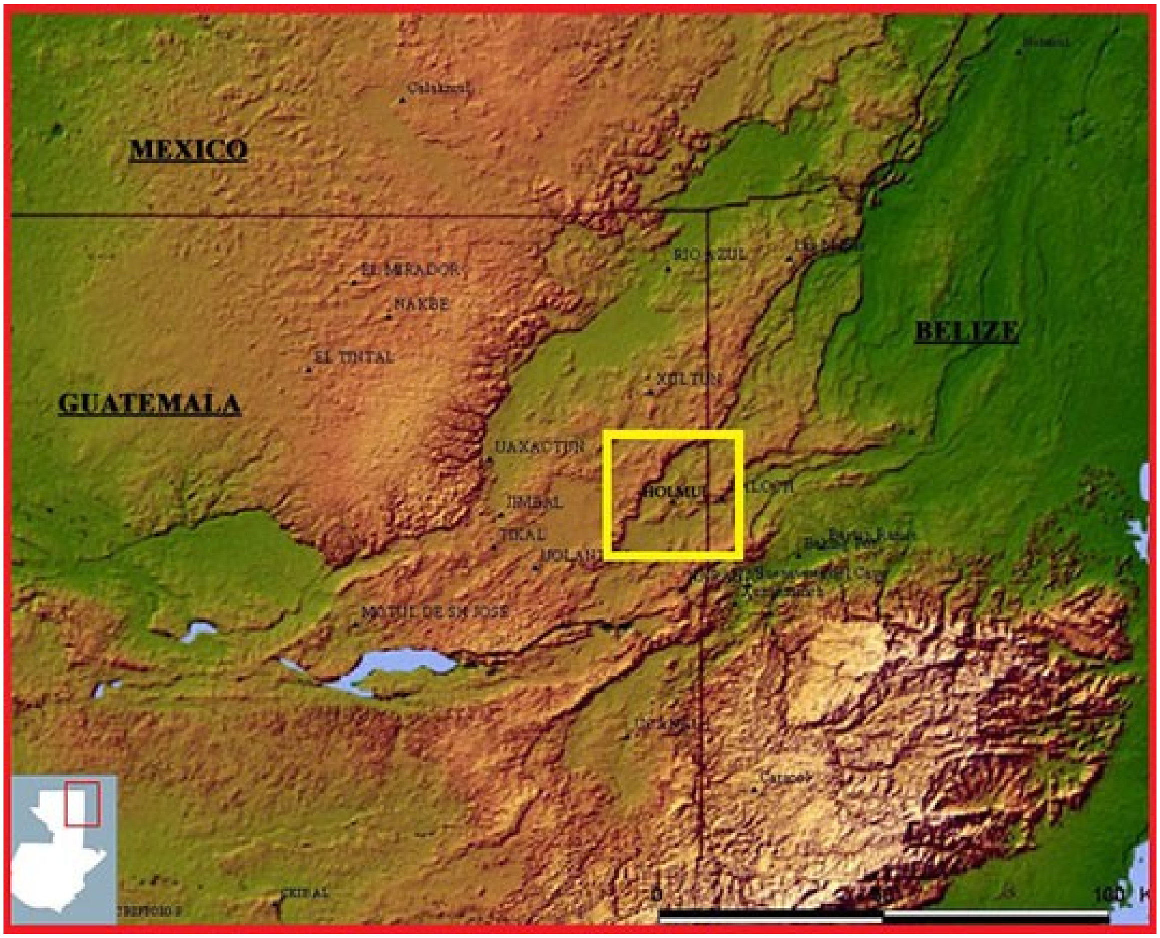

Figure 2.2 Map of the northeast Petén. The Holmul region is in yellow (adapted from Estrada-Belli 2010).

Holmul

The ancient Maya city of Holmul (Figure 2.5) has attracted scholars' attention since the explorations of the early 20th century due to the presence of Late Preclassic and Classic period burial and ceramic assemblages (Merwin and Vaillant 1932; Bullard Jr. 1960; Hammond 1984; Brady et al. 1998; Reents 1985). In 1909, the Peabody Museum of Archaeology and Ethnology at Harvard University sponsored the first archaeological excavations of a Maya site, an expedition led by Raymond E. Merwin to the site of

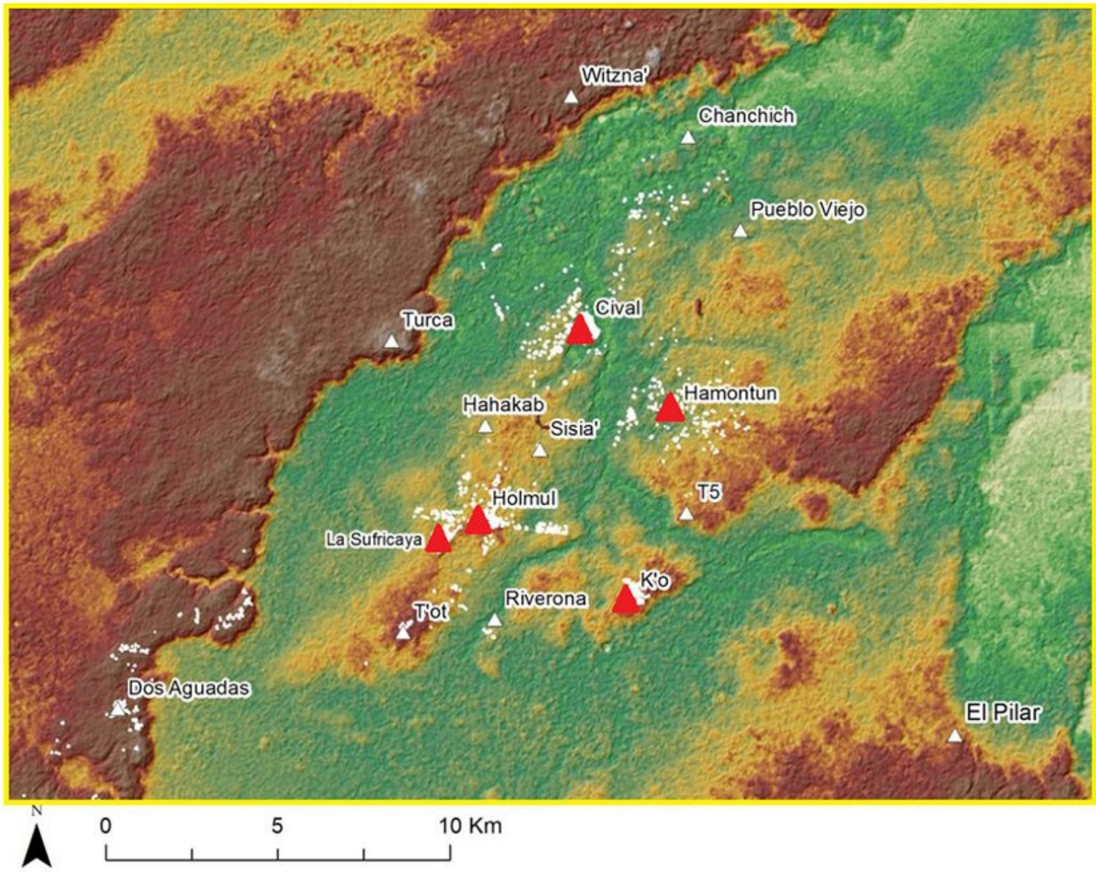

Figure 2.3 The Holmul region. The sites of this study are marked with red triangles (adapted from Estrada-Belli 2015:2).

Holmul. Merwin would go on to work at sites throughout the Maya region, most notably Tikal, extending the earlier work of Alfred Maudslay and Teobert Maler. Merwin's excavations at Holmul from 1909 to 1914 (Merwin and Vaillant 1932) produced the first stratified chronology for the region through ceramic typology and architectural excavation, as well as the numerous systematically excavated elite burials for future bioarchaeological analysis. The burial goods and human remains were transferred to the Peabody at Harvard and are currently stored in their collections and archives, along with Merwin's original field notebooks.

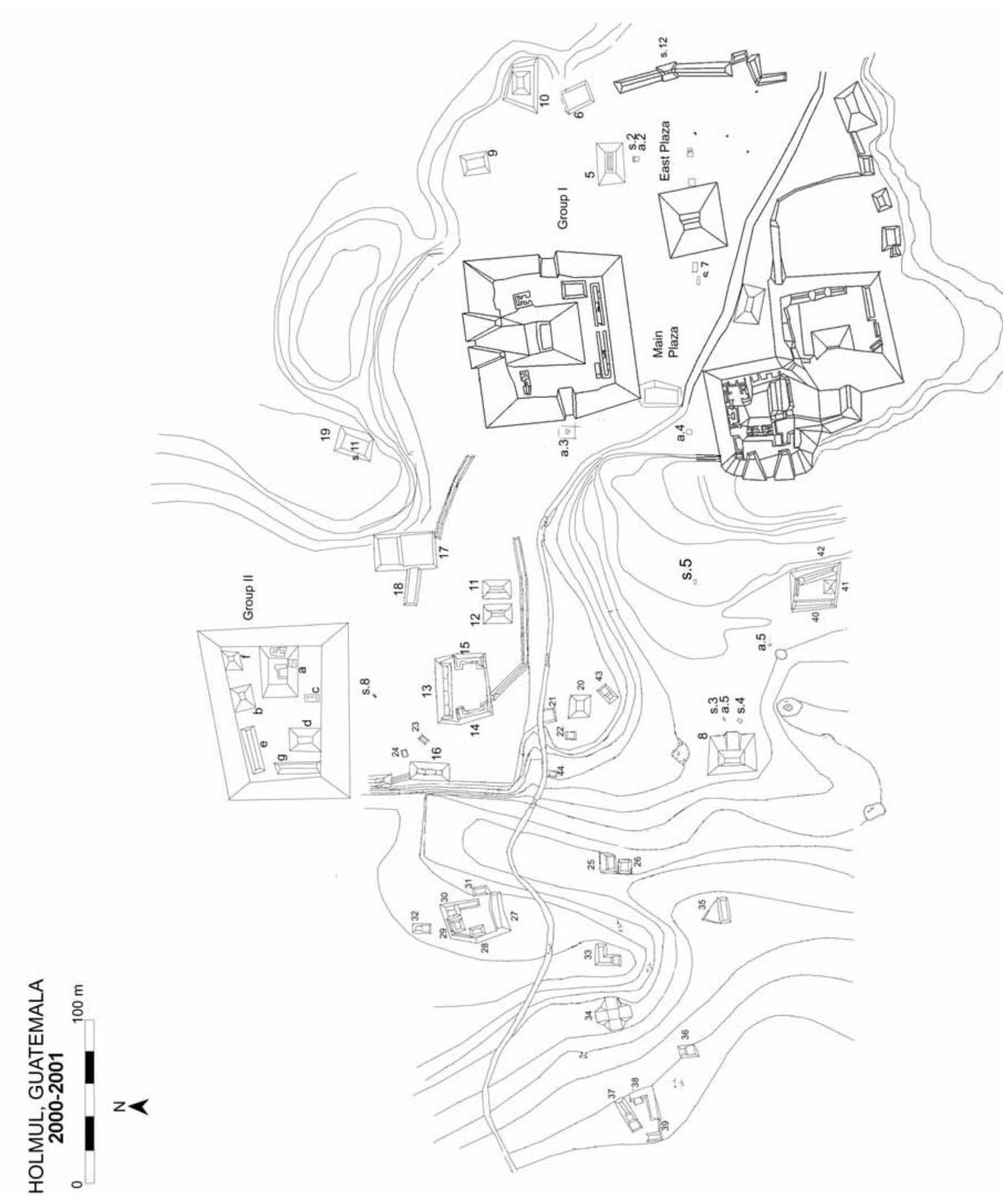

Figure 2.4 Map of Holmul (Estrada-Belli 2001:19).

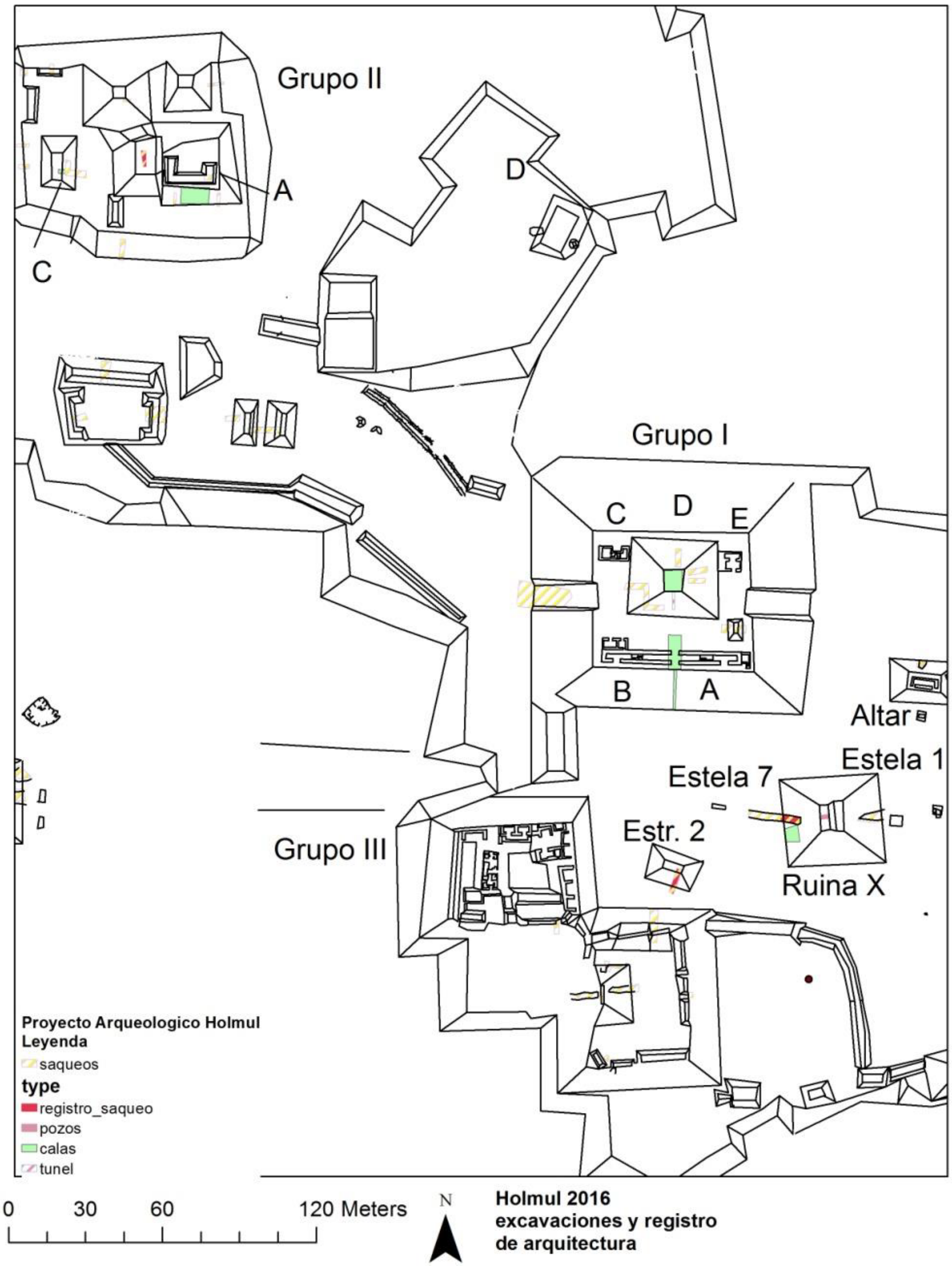

Figure 2.5 Holmul site core (Estrada-Belli 2016:3).

At Holmul, Merwin identified and excavated two large plazas (Groups I and II), Building X near Group I, and a group of buildings designated as Group III (Merwin and Vaillant 1932). He paid particular attention to Building B of Group II, where he painstakingly excavated and illustrated extensive elite tombs and funerary shrines. He revealed the sequence of occupation from the Late Preclassic to the Late Classic through examination of the elaborate polychrome ceramics and grand public architecture.

In 2000, Francisco Estrada-Belli and the Holmul Archaeological Project (HAP) continued Merwin's excavations at Holmul. They elaborated upon Merwin's initial mapping of the Holmul's site center and began to survey nearby residential areas (Estrada-Belli 2000, 2001, 2002). Since 2000, the HAP has excavated at Holmul, revealing tombs, fantastical facades, and grand mask sculptures (Estrada-Belli 2011). In subsequent field seasons and continuing today, Estrada-Belli and his team explored the surrounding area, (re)locating the sites of Cival, Hahakab, Hamontun, K'o, Riverona, T'ot, and Dos Aguadas (Estrada-Belli 2006, 2011).

The HAP demonstrated that the Holmul region had an uninterrupted sequence of human occupation spanning nearly two millennia, from the Early Middle Preclassic (1000 BC) to the Terminal Classic (AD 900) (Estrada-Belli 2006). In particular, both the sites of Holmul and Cival experienced major Late Preclassic (350 BC-AD 250) florescence, with Holmul becoming the center of a large polity surrounded by the aforementioned smaller centers during the Classic period (Estrada-Belli 2006). Building B of Group II, the most elaborate temple at Holmul in the Late Preclassic, was in use as a site of royal ritual and burial of elites through the Early Classic and into the Classic period (Estrada-Belli 2004a). In the fifth century, Building B was expanded with the burial of 22 individuals (Merwin and Vaillant 1932), reflecting the strength of Holmul as the center of power in the region. During the sixth century, construction of major elite architecture was focused on Group III, indicating the period of prosperity and power that lasted until the ninth century (Estrada-Belli 2004a). After ca. AD 800, the authority of the elites at Holmul began to collapse with settlement patterns indicated minor occupation until final abandonment of the Group III palace area in ca. AD 900, as well as the rest of the city (Estrada-Belli 2004a).

The Burials of Holmul. In the early 20th century, Merwin was particularly focused on excavating the elite burials in the city center of Holmul and transporting them back to the Peabody Museum at Harvard. Merwin excavated human remains primarily from Building B of Group II, but also from Building F of Group I, Building F of Group II, Building A of Group III, and Building X. Merwin numbered the individuals corresponding to the building from which they were excavated. For example, there is a "Skeleton 1" from Group I Building F, but also skeletons numbered "1" from Group II Building B, Group II Building F, Group III Building A, and Building X. The Peabody Museum at Harvard assigned accession numbers to the individuals from Holmul (site number 11-6-20) excavated by Merwin (Table 2.1). At times, the records list more than one accession number per skeleton number, and in some cases a skeleton mentioned by Merwin in the site report does not correspond to an accession number. Further, there are a few cases where the Peabody record does not offer an associated skeleton number or additional contextual information. In addition, many of the accession numbers contain more than one individual, although are labeled with only one skeleton number. It is possible that the skeletons excavated and numbered by Merwin, but lacking accession numbers, are comingled with others.

Harvard Burial ID	Merwin ID	Merwin Context Description
11-6-20/58614.0	Skeleton 1	Group I Building F
11-6-20/58596.0	**Skeleton 1**	**Group II Building B Room 1**
11-6-20/58597.0	Skeleton 2	Group II Building B Room 1
-	Skeleton 3	Group II Building B Room 1
-	Skeleton 4	Group II Building B Room 1
11-6-20/58599.0; 11-6-20/C5558.0	**Skeleton 6**	**Group II Building B Room 1**
11-6-20/58609.0; 11-6-20/C5566.0; 11-6-20/C5567.0	Skeleton 9	Group II Building B Room 2
11-6-20/C5561.0; 11-6-20/C5562.0; 11-6-20/C5563.0	Skeleton 10	Group II Building B Room 2
11-6-20/58605.0	**Skeleton "12 or 5"**	**Group II Building B Room 2**
11-6-20/58605.0	Skeleton 13	Group II Building B Room 2
11-6-20/58607.0	**Skeleton 14**	**Group II Building B Room 2**
11-6-20/58600.0	**Skeleton 15**	**Group II Building B Room 4**
11-6-20/58611.0	Skeleton 16	Group II Building B Room 7
11-6-20/58601.0	**Skeleton 17**	**Group II Building B Room 8**
11-6-20/58602.0	Skeleton 18	Group II Building B Room 8
-	Skeleton 19	Group II Building B Room 8
11-6-20/58617.0	Skeleton 20	Group II Building B Room 8
11-6-20/58604.0	Skeleton 21	Group II Building B Room 9
11-6-20/58612.0	Skeleton 22	Group II Building B Room 10
11-6-20/58615.0	Skeleton 1	Group II Building F
11-6-20/58624.0	-	Group II
11-6-20/58616.0	Skeleton 2	Group II Building F
11-6-20/58618.0	Skeleton 1	Group III Building A
-	Skeleton 1	Building X
11-6-20/58622.0	**Skeleton 2**	**Building X**
11-6-20/58623.0	Skeleton 3	Building X
11-6-20/58620.0; Burial 3	**-**	**-**

Table 2.1 Merwin Holmul burial list. Data compiled from Merwin and Valliant 1932 and the Peabody Museum collections (individuals in **bold** are those selected for this study).

Since 2001, the Holmul Archaeological Project (HAP) has excavated human remains during field seasons at the sites of Holmul, La Sufricaya, Cival, K'o, Hamontun, and Dos Aguadas. From 2001 to 2007 the burials excavated by the project were numbered based on the order excavated from any site. For example, Burials 1 and 2 were excavated from Holmul, but Burial 3 was excavated from La Sufricaya. At times, however, this system was not followed. For example, there are two burials numbered 2, the previously mentioned Burial 2 from Holmul (context HOL.T.28.04.09.01) and Burial 2 from La Sufricaya (context SUF.T.03). The duplicate numbers were corrected and the Burials 2 and 3 from La Sufricaya were renumbered in the HAP Burial List as Burials 28 and 29, respectively. The three burials excavated from Hamontun were also labeled numbers 1, 2, and 3, which were altered to be HAM 1, HAM 2, and HAM 3.

Beginning in 2008, the burials were referred to by their context numbers only. All previous excavations are also labeled by their context numbers, which renders the burial numbers used prior to 2008 irrelevant. For the HAP, the context numbers are composed as follows in Figure 2.6:

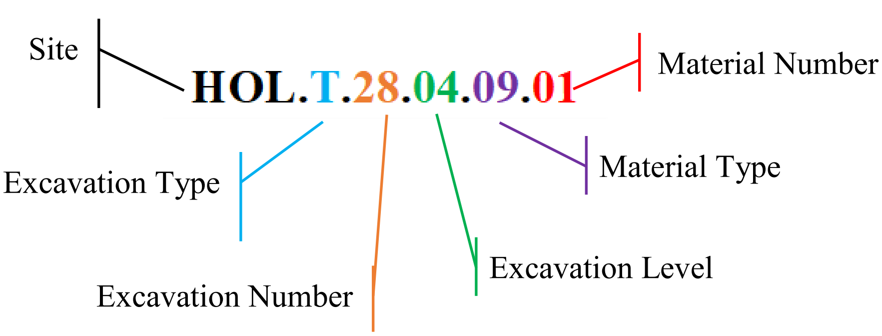

Figure 2.6 Diagram explaining the HAP context numbering system.

The context number begins with an abbreviation for the archaeological site (e.g., HOL: Holmul; CIV: Cival; KOL: K'o; SUF: La Sufricaya; HAM: Hamontun; DAG: Dos Aguadas), followed by the type of excavation, usually T for an archaeological excavation trench and L for looter's trench or tunnel. The number for the excavation unit follows with the corresponding level number. For example, the first level (usually composed of humus) of archaeological excavation number 3 at Holmul would be referred to as HOL.T.3.01. The last two positions designate an artifact type found within this level and its assigned number. For example, the fourth piece of jade found in level 3 of the aforementioned unit would be assigned the context number of HOL.T.3.03.06.04. Some common artifact type designations include 02 for ceramics, 05 for obsidian, 06 for jade, 08 for animal bone, and 09 for human skeletal remains. For human remains, the material number designation indicates an individual. If two individuals were found in context HOL.T.3.03, they would be designated HOL.T.3.03.09.01 and HOL.T.3.03.09.02. If an element of the remains of an individual was separated from the skeleton, such as for laboratory testing, an additional number would be added. For example, if the left first molar of HOL.T.3.03.09.02 was exported for stable isotope analysis and it was the first element separated from the remains, it would be labeled HOL.T.3.03.09.02.01. If the left third molar was selected next, from the same individual, it would be labeled HOL.T.3.03.09.02.02.

It is important to note that there were some cases when human remains were found in a looter's tunnel or not in a type of grave construction, that they were not labeled with a 09 designation or entered on the Burial List. In 2013, I catalogued the human skeletal remains housed in the HAP laboratory in Guatemala, integrating any isolated skeletal elements into the Burial List. For example, skeletal remains (a few cranial fragments and seven teeth) were found when excavating a tunnel CIV.T.1.04, but not within a grave construction. These remains were just labeled CIV.T.1.04 and were not entered on the Burial List nor treated as a burial. Bioarchaeologists define a burial as all contexts that contain human remains (Welsh 1988), which allows for a more nuanced analysis of mortuary behavior. I have included CIV.T.1.04 in the HAP Burial List, extending its context number to be CIV.T.1.04.09.01. There some labels of select contexts, which I have chosen not to change as to preserve the connection between the reports, field notes, and containers holding the remains (e.g., SUF.LT.1.W.01 and HOL.T.47.05.09-04).

An abbreviated list of the HAP Holmul burials follows in Table 2.2:

HAP Burial ID	Context Number	Context Description
1	**HOL.T.06.09.01**	**Holmul, Group III, Court B, Structure 43, South Room**
2	**HOL.T.28.04.09.01**	**Holmul, South Group I, Structure 1, Room 1**
9	**HOL.T.30.20.09.01**	**Holmul, South Group I, Structure 1, Room 2**
10	HOL.T.41.06.09.01	Holmul, Group II, Building B
12	**HOL.T.37.09.01**	**Holmul, South Group I, Trench 31 North Extension**
14	**HOL.T.30.33.09.01**	**Holmul, South Group I, Structure 1, Room 2**
15	HOL.T.31.02.09.01	Holmul, South Group I
16	**HOL.T.47.05.09-04**	**Holmul, South Group I, Structure 103, Trench 47**
17	**HOL.T.28.33.09.01**	**Holmul, South Group I, Structure 101, Room 1**
20	HOL.T.28.38.09.01	Holmul, South Group I, Structure 101
22	HOL.T.58.16.09.01	Holmul, Group III, Court B, Structure 59, Merwin Rm 23
23	**HOL.T.50.27.09.01**	**Holmul, Group III, Court B, Structure 59, Merwin Rm 1**
	HOL.L.20.21.09.01	**Holmul, Group II, Building A, Tomb**
	HOL.L.20.15.09.01	**Holmul, Group II, Building A, under stairs**
	HOL.T.84.14.09.01	**Holmul, Group I, Structure 1, Building D**

HOL.T.78.42.09.01	**Holmul, Group II, Building A**
HOL.T.24.23.07.01	**Holmul, Group 13**
HOL.T.93.27.09.01	**Holmul, Group I, Structure 1, Building D**
HOL.T.100.03.09.01	**Holmul, Ruin X**
HOL.T.98.04.09.01	**Holmul, Group II, Building A**
HOL.T.41.08	
HOL.T.24.10	
HOL.T.70.04	
HOL.T.71.26	
HOL.T.71.02	
HOL.T.71.28.09.01	
HOL.T.71.24	
HOL.T.71.28	
HOL.T.35.03.08.03	
HOL.T.62.00.02	
HOL.T.49.6	
HOL.T.49.16	
HOL.T.24.23.07.01	
HOL.T.24.29.09.01	
HOL.T.24.29.08.1-5	
HOL.T.24.08.09.01	
HOL.T.24.09.09.02	
HOL.T.24.09.09.01	
HOL.L.63.20	
HOL.T.41.14	

Table 2.2 The HAP Holmul burial list.
Individuals in *italics* were isolated fragments of human remains not originally considered burials; those in **bold** were selected for this study.

Cival

In 2001, the HAP began mapping outlying minor centers within a 7-km radius of Holmul. Cival (Figure 2.7), originally mapped by Ian Graham in 1984, was (re)located 6.5 km north of Holmul (Estrada-Belli 2001). In seasons since, the HAP found that this large ceremonial center was oriented east-west and had over 50 massive structures,

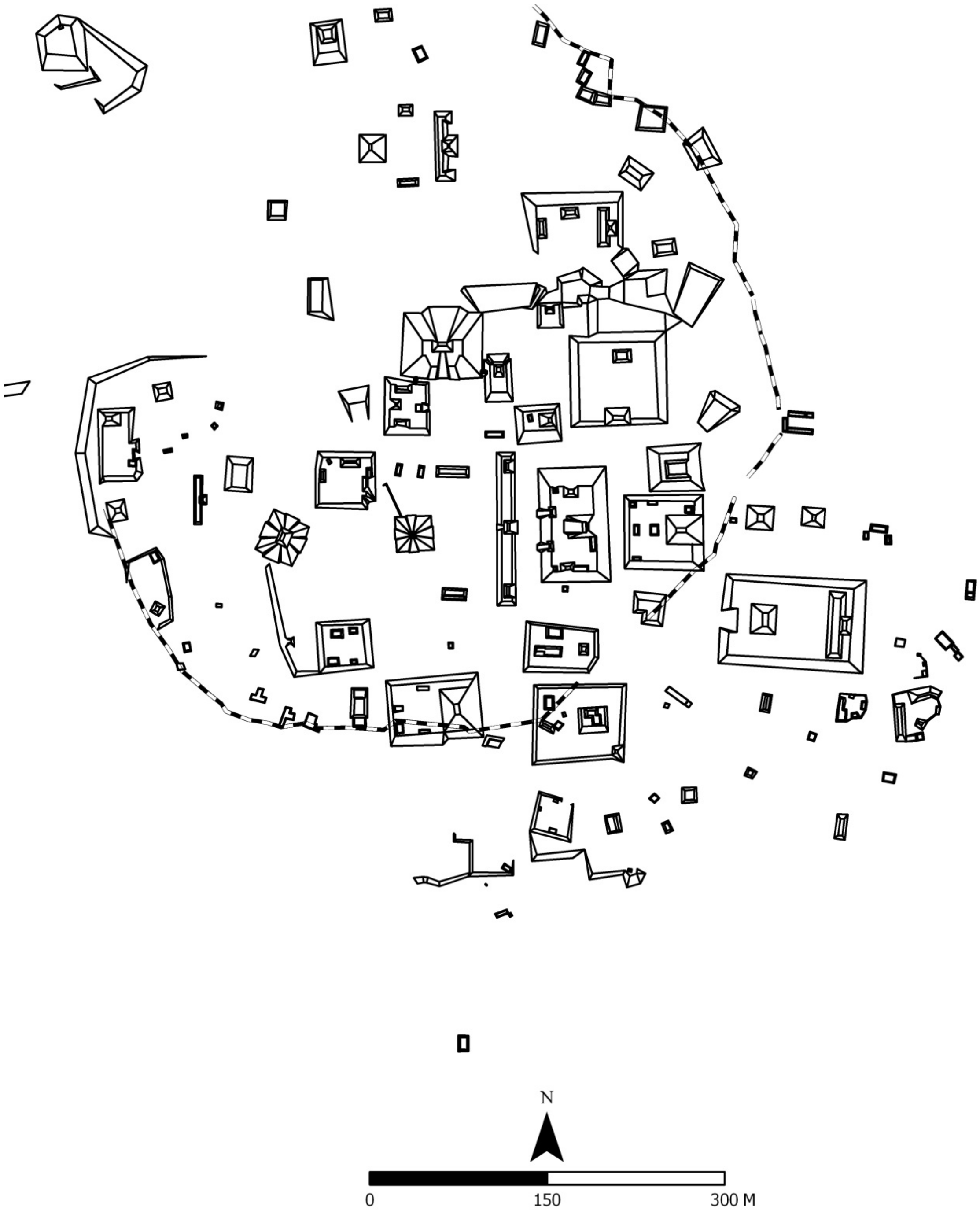

Figure 2.7 Map of the civic/ceremonial center of Cival (Estrada-Belli 2014:28).

pyramids, platforms, and range structures, with a 27 m high triadic temple platform dominating Group I (Estrada-Belli 2001; Estrada-Belli et al. 2003). Significant finds included patterned architecture (an E-group), monumental sculpture, iconography, caches, and burials that suggest an early development of Maya ideology and institutional structure (Estrada-Belli 2006).

Evidence of the first ritual activity at Cival dates to around 600 BC when, “five water jars, five upright celts, and 114 jade pebbles were placed in a four-level cruciform cut into the soft limestone bedrock” (Estrada-Belli 2006:59). This cache is similar to one of six upright jade celts and five jars found at Seibal, also dating to the Middle Preclassic (Estrada-Belli 2006, 2011). The placement of the vessels and celts may have been used to evoke the supernatural powers of water, rain, and maize deities in their arrangement that reflects the cross partition of the cosmos (Estrada-Belli 2006).

A Late Preclassic structure decorated with large, anthropomorphic, modeled and painted masks was revealed at Cival (Estrada-Belli 2006, 2011). These masks are almost identical to those at Cerros, which date to about 50 BC (Freidel et al. 2002; Estrada-Belli 2006). The Cival masks may represent an entity that is both a celestial place and a being, and is related to the themes of water, birth of the maize god, and the raising of a cross-shaped world tree (Estrada-Belli 2006). The jade cache was deposited circa 600 BC, while the masks were created sometime between 200 and 160 BC, indicating a continuation of iconographic tradition and of ritual and cosmological ideology practiced by Cival’s rulers throughout the Preclassic (Estrada-Belli 2006).

According to the historical reconstruction, following its Late Preclassic florescence, Cival was abandoned and power shifted to Holmul for the Classic period. It has been suggested that this shift represented a change in regional power or capital (Estrada-Belli 2003a) or indicated intra-regional competition and fractionalization, perhaps connected to the decline of the large Late Preclassic site of El Mirador (Estrada-Belli 2004a). In either case, a hastily built wall was found surrounding the site center dating to the Terminal Preclassic and just before activity in the site core ceased (Estrada-Belli 2004a).

The Burials of Cival. Human remains were excavated in Cival beginning in 2003, following the HAP burial numbering system. An abbreviated list follows in Table 2.3:

HAP Burial ID	Context Number	Context Description
25	**CIV.T.22.13.09.01**	**Cival, Northern Sector midden**
33	**CIV.T.28.11**	**Cival, North Pyramid chultun**
34	**CIV.T.28.11.09.01**	**Cival, Far West Group Str 33**
	CIV.T.45.11.09.01	**Cival, Far West Group Str 33**
	CIV.T.55.03.09.01	**Cival, Unit 55**
	CIV.T.63.03.09.01	**Cival, Residential Hill Group 37**
	CIV.T.61.04.09.01	**Cival, Residential Hill Group 38**
	CIV.T.01.09.01	**Cival, Group I, Structure 1, tunnel to mask**
	CIV.T.01.04.09.01	**Cival, Group I, Structure 1, tunnel to mask**
	CIV.T.45.14.09	Cival, Far West Group Str 33
	CIV.T.55.09.09.01	
	CIV.CL03.01.09.01.09	
	CIV.CL4.01.08/09	
	CIV.T.12.02	

Table 2.3 The HAP Cival burial list.
Individuals in *italics* were isolated fragments of human remains not originally considered burials; those in **bold** were selected for this study.

La Sufricaya

Ian Graham also explored La Sufricaya during the 1980s, noting the presence of a stela and an acropolis platform (Estrada-Belli et al. 2009). In 2001, the HAP (re)located this minor center or ritual group 1.2 km west of Holmul (Estrada-Belli 2001). The HAP systematically mapped (Figure 2.8) and excavated the main acropolis (Group I) and surrounding residential architecture, including an Early Classic ball court, Early Classic polychrome painted walls, and various inscribed stelae (Estrada-Belli 2002; Estrada-Belli et al. 2009).

During the Early Classic period, the ceremonial center at La Sufricaya was significantly remodeled with a palace on a platform, the ball court, and a funerary pyramid-shrine (Estrada-Belli 2011). It is possible that Holmul's centralization of power may have shifted to this nearby locale between AD 350 and AD 450 (Estrada-Belli et al. 2009). The inscribed stelae and mural paintings refer to specific dates and individuals and suggest complex proceedings that may have occurred at the site during this time (Foley 2005; Estrada-Belli et al. 2009; Estrada-Belli 2011). Stela 5 demonstrates a dynastic line of the Holmul region with the reference to the seat of a lord name *Aj-Wosal* and a Long Count date of August 6th, AD 422 (Grube 2003:703). Stela 6 also has a date (377 or 387 AD) and includes a reference to the lord *Siyaj K'ahk* (Smoking Frog), a figure associated with Teotihuacan and mentioned in inscriptions at Tikal, Uaxactun, and other sites in the Petén (Grube 2003).

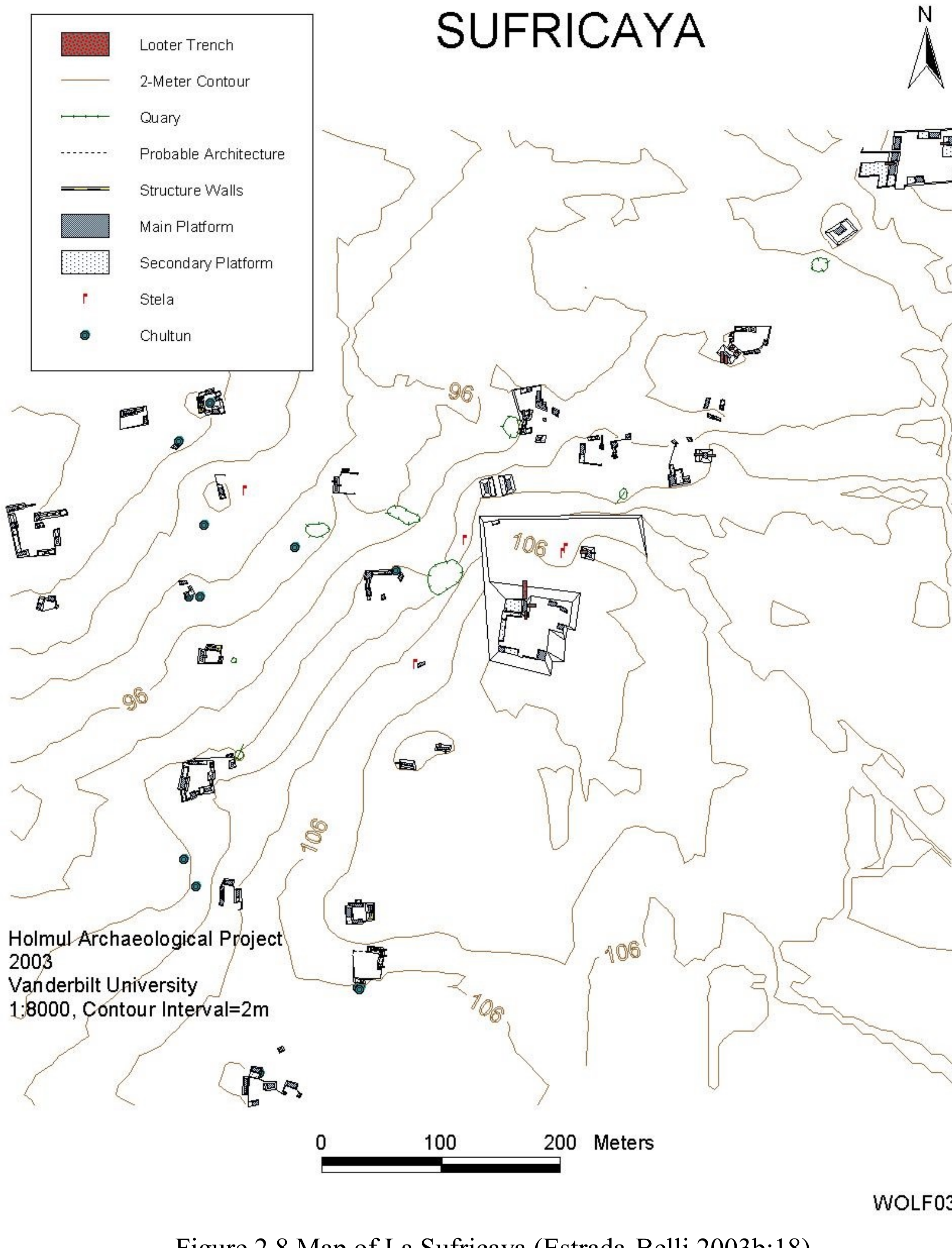

Figure 2.8 Map of La Sufricaya (Estrada-Belli 2003b:18).

The palace murals found during the 2005 HAP field season (Estrada-Belli 2005) may provide insight into the identity of the elites at La Sufricaya and their interactions with Teotihuacanos during the “entrada” or “arrival” (Coggins 1976; Stuart 2000). The murals that line the inside and outside of the palace depict events or rituals that probably occurred locally at this ritual center (Estrada-Belli 2011). These murals include imagery of warriors in costume typical of Teotihuacanos and holding weapons, such as the *atlatl* (spear-thrower) and trilobed-tipped darts, from the central Mexico (Estrada-Belli 2011). These warriors are depicted attending and perhaps escorting a visiting dignitary to some sort of ritual or feast. More attendants are shown dressed in Maya garb and others in a mix of Maya and Teotihuacan costume. Other rituals are depicted on the walls of the palace, such as human sacrifice for royal accession ceremonies (Estrada-Belli 2002).

Mural 7, located on an interior wall of the structure, contains inscriptions that may have particular historical significance. The Early Classic style hieroglyphs refer to the dedication of a “stone,” perhaps representing the palace structure itself (Estrada-Belli et al. 2009; Estrada-Belli 2011). The inscription continues with a reference to various earlier events, including one 364 days before when *K’awiil* arrived at Mutal (Tikal) on January 16th, AD 378. The text ends with a return to the current dedicatory ceremony with the protagonist named as *Siyaj K’ahk* (also referred to as *K’awiil)* (Estrada-Belli et al. 2009).

One possible interpretation of the inscription is that this ceremony, on the year anniversary of the arrival of *Siyaj K’ahk*, was attended by the man himself or his representative (Foley 2005; Estrada-Belli et al. 2009). Another or additional explanation, supported further by the imagery of the Teotihuacan warriors, is that the elite of La

Sufricaya and Holmul were using Teotihuacano iconography to demonstrate their allegiance to and relationship with Tikal (Foley 2005; Estrada-Belli et al. 2009). In either case, the inscriptions of the murals and stelae at La Sufricaya suggest some sort of connection between the center of power in the Holmul region and that of Tikal.

Following Tikal's defeat by Calakmul in AD 562, the Tikal-La Sufricaya/Holmul region relationship was terminated, leading to the destruction of monuments and complete burial of the palace at La Sufricaya (Estrada-Belli et al. 2009). The centralization of power likely returned to the Holmul ceremonial core with a new relationship formed with Naranjo and Calakmul, demonstrated by later inscriptions at Holmul and the lack of inscriptions referring to Central Mexico (Estrada-Belli 2005). The archaeological and epigraphic studies of the La Sufricaya evidence allows for this exploration of complex inter-polity alliances of the Maya and intraregional dynamics, especially regarding the role of smaller sites.

The Burials of La Sufricaya. Human remains were excavated at La Sufricaya beginning in 2001 and followed the HAP burial numbering system. An abbreviated list follows in Table 2.4:

HAP Burial ID	Context Number	Context Description
3	SUF.ST.10	La Sufricaya, Group I, Str 1?
5	**SUF.T.11.06.09.01**	**La Sufricaya, Group VI, Str 110**
6	**SUF.ST.09.02**	**La Sufricaya, Group I, Str 1**
11	**SUF.ST.20.27.09**	**La Sufricaya, Group I, Str 1**
13	SUF.ST.17.21.09	La Sufricaya, Group I, Str 1
18	SUF.T.23.56	La Sufricaya, Group I, Str 146
19	**SUF.T.23.54**	**La Sufricaya, Group I, Str 146**
21	**SUF.T.23.66**	**La Sufricaya, Group I, Str 146**
27	SUF.T?	La Sufricaya, in fill across from Mural #2
28	**SUF.T.03**	

29	SUF.ST.10 (SUF.T.03.02)	La Sufricaya, Group I, Str 1?
	SUF.LT.1.W.01	
	SUF.L8.01.09.01	**La Sufricaya, Group XVI, Str 3**
	SUF.T.23.21	
	SUF.T.22	
	SUF.ST08.80.09	
	SUF.L8.01.09.02	
	SUF(?).ST1.LT.2	

Table 2.4 The HAP La Sufricaya burial list.
Individuals in *italics* were isolated fragments of human remains not originally considered burials; those in **bold** were selected for this study.

K'o

In 2000, the existence of the site of K'o (formerly Lechugal) was mentioned to Estrada-Belli by an official from Guatemala's *Instituto de Antropologia e Historia* (Estrada-Belli 2000). Following initial reconnaissance in 2001, excavations began during the 2002 season and continued through 2008 (Tomasic 2009). K'o (Figure 2.9), located 4.6 km southeast of Holmul, consists of a site core with several large pyramid structures, various plazas, a ball court, and a Late Classic defensive wall enclosure (Tomasic 2009). In 2008, a high-status burial dating to the Late Preclassic was excavated from within a chultun in a residential area, accompanied by numerous vessels and an effigy bowl depicting the maize god (Estrada-Belli 2008, 2011).

K'o was originally thought to have been a newly settled center in the Terminal Preclassic aiming to recover the power lost by the decline of Cival (Tomasic 2009). With this hypothesis, K'o would have been subsumed by Holmul and become a part of its regional hierarchy by the Late Classic (Estrada-Belli 2003a). Instead, archaeological evidence points to the founding of K'o during the Late Middle Preclassic (600-350 BC)

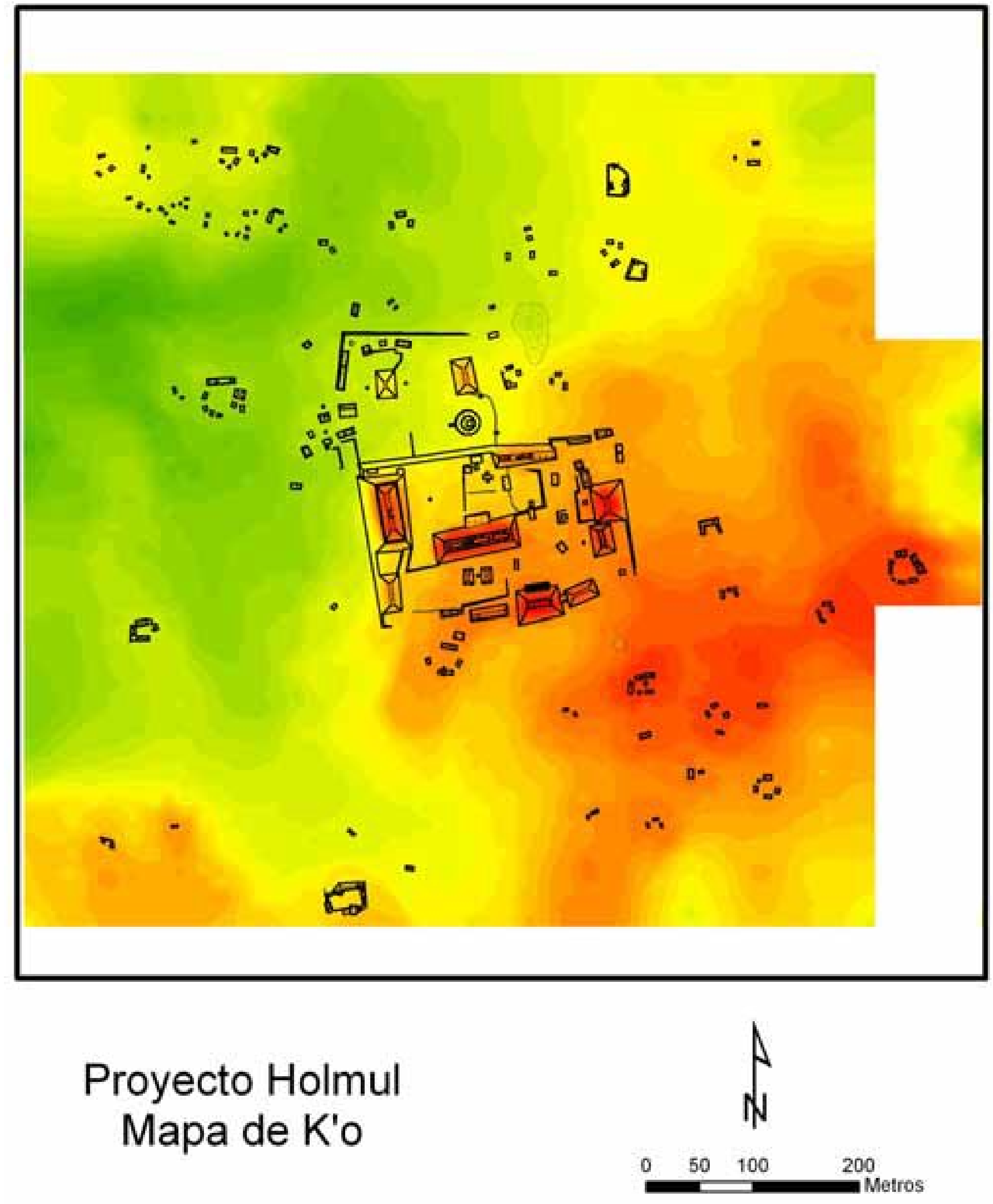

Figure 2.9 Map of K’o (Estrada-Belli 2008:69).

with settlement patterns similar to Holmul during this time, suggesting a close political relationship, perhaps in opposition to Cival (Tomasic 2009). K'o was inhabited throughout the Classic period and into the Terminal Classic when the aforementioned defensive wall was constructed from dismantled structures near the wall (Paling 2016).

The Burials of K'o. Human remains were excavated at K'o beginning in 2005 and followed the HAP burial numbering system. An abbreviated list follows in Table 2.5:

HAP Burial ID	Context Number	Context Description
24	**KOL.L.02.00.09.01**	**K'o, Group XXXIX, Structure 3, Looter's Trench 2**
30	KOL.T.15.05.01	K'o, Group IV, Structure 60
31	KOL.T.22.12	K'o, Group XXXVII, Structure 166
32	**KOL.T.17.01.09.01**	**K'o, Group XII, Structure 107**
	KOL.T.26.03.09.01	**K'o, Group IV, Structure 60**
	KOL.T.32.06.09.01	**K'o, Group XXXVIII, Structure 45**
	KOL.T.32.10.09.01	**K'o, Group XXXVIII, Structure 45**
	KOL.L.07.01.09.01	**K'o, Group XXXVIII, Structure 45, Looter's Trench 12**
	KOL.T.29.05.09	K'o, Group XV, Structure 140
	KOL.T.29.06.09	K'o, Group XV, Structure 140
	KOL.T.34.15	K'o, Group XV
	KOL.L.05.00.09	K'o, Group XV, Structure 140
	KOL.T.15.08.01	*K'o, Group IV, Structure 60*
	KOL.T.18.02	*K'o, Group XVIII, Structure 34*
	KOL.T.15.13	*K'o, Group IV, Structure 60*
	KOL.T.18.07	*K'o, Group XVIII, Structure 34*
	KOL.T.22.16	*K'o, Structure 166*

Table 2.5 The HAP K'o burial list.
Individuals in *italics* were isolated fragments of human remains not originally considered burials; those in **bold** were selected for this study.

Hamontun

In 2002, the ceremonial center of Hamontun was (re)discovered 4 km northeast of Holmul, with mapping and excavations beginning in 2009 (Figure 2.10). The HAP found that the settlement of Hamontun extended in a radius of 2 to 3 km, with much of the residential settlement dating to the Preclassic (Estrada-Belli 2009). The site center of Hamontun has four Preclassic plazas with palace structures, pyramidal structures, and a ballcourt (Estrada-Belli 2009).

The abundance of painted orange ceramics recovered at Hamontun in Early Classic contexts, and the decline of Cival, led Callaghan (2008) to propose its shifting loyalty of the Hamontun elite to Holmul during the Early Classic. The site center and the surrounding settlement expanded throughout the Classic period until being abandoned in the Terminal Classic, with no evidence to suggest a violent or chaotic end as at Cival and K'o (Paling 2016).

The Burials of Hamontun Human remains were excavated at Hamontun in 2009 and followed the HAP burial numbering system. An abbreviated list follows in Table 2.6:

HAP Burial ID	Context Number	Context Description
HAM 1	**HAM.T.07.08.09.01**	**Hamontun, Group XX?**
HAM 2	**HAM.T.05.08.09.01**	**Hamontun, Plaza IV**
HAM 3	HAM.T.29.13.09	
	HAM.LT.30.01.09.01	**Hamontun, Group XXXIV**
	HAM.T.28.02.14.01	**Hamontun, Group XXXV**

Table 2.6 The HAP Hamontun burial list.
Individuals in **bold** were selected for this study.

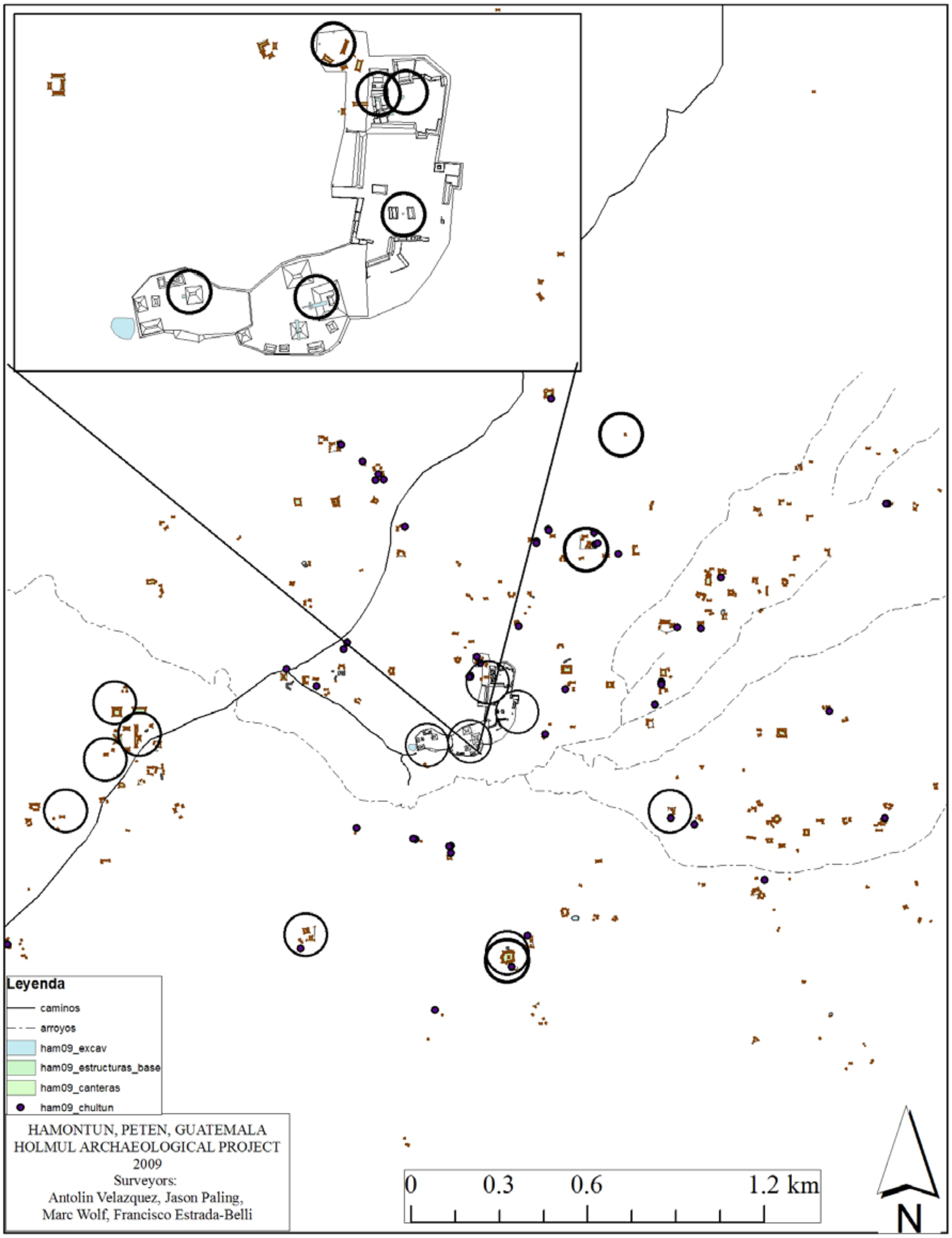

Figure 2.10 Map of Hamontun and areas of 2009 excavations (Estrada-Belli 2009:18).

Previous Bioarchaeological Investigations of the Holmul Region

Excluding the burial excavations by Merwin and the HAP in the Holmul region, few scholars have undertaken bioarchaeological analyses of the human remains recovered. In 1988, Welsh included the Holmul burials excavated by Merwin in his establishment of a standardized mortuary typology for the ancient Maya. John Gerry (1993, 1997) used stable carbon and nitrogen isotope analysis of human bone to discuss dietary patterns of individuals from the site of Holmul, as well as the Maya sites of Uaxactun, Baking Pot, Barton Ramie, Seibal, Altar de Sacrificios, and Copan. Volney Friedrich (2013) sampled dental enamel for stable strontium, oxygen, and carbon isotope analyses from six individuals from La Sufricaya and two from Holmul in order to understand Maya regional and interregional interactions. Friedrich (2013) also sampled and analyzed a molar from a stratigraphically excavated deer at Holmul to establish a local stable isotope baseline for the site of Holmul and the surrounding sites.

Chapter Summary

The archaeological and osteological materials for this project were excavated at the sites of Holmul, Cival, La Sufricaya, K'o, and Hamontun, in the northeastern Petén district of Guatemala. This region provides an ideal location for a study of Maya identities, since centuries of occupation provide evidence of social complexity, of institutionalized social stratification, and of divine kingship as early as the Middle Preclassic period (ca. 1000-400 BC). The sample burial population of 52 individuals is drawn from the five archaeological sites. Previous bioarchaeological studies in the region have either focused on broad mortuary or dietary questions or have been limited in scope to isotopic tests of a select few individuals. This study will be the first to consider multiple lines of evidence to construct detailed osteobiographies of a large sample population of the region.

CHAPTER 3: RECENT TRENDS IN BIOARCHAEOLOGICAL METHOD & THEORY

There has been considerable growth in the fields of bioarchaeology and mortuary studies, especially concerning theoretical applications, methodological diversity, and their recent intersections in archaeological investigations. Bioarchaeologists are investigating a variety of broad topics that provide critical insight into questions of social, political, economic, and religious creation, growth, and collapse within ancient societies. The development of a close relationship between skeletal analysis and mortuary theory in bioarchaeology has allowed scholars to move beyond osteological reports and skeletal classifications and towards applying bioarchaeology as a theoretical tool for understanding cultural interactions and identities in the past. While initially referring to the archaeological study of faunal remains (Clark 1972), specifically in the U.S.[1], bioarchaeology is defined as the study of human remains with the intention of understanding past human life histories and sociopolitical organization (Buikstra 1977). Buikstra (1977:67) emphasized a multidisciplinary bioarchaeological approach, contextualizing human osteology with archaeological and mortuary evidence to address questions of behavior, social organization, activities, paleodemography, mobility, diet, and disease.

[1] In the United Kingdom, scholars prefer the term osteoarchaeology, as bioarchaeological studies there include faunal and floral remains, equating to environmental archaeology in the US.

Methodological Advances

The first wave of bioarchaeological theory was concerned with a population-focused perspective and emphasis on adaptive changes within the skeleton in relation to environmental changes (Cohen and Armelagos 1984). The second trend of bioarchaeological analysis involved the development of methodology and technology to investigate health and lifestyle in the past. For example, ancient DNA (aDNA) and stable isotope analysis are currently being championed as ground breaking methodologies in the field of bioarchaeology. As explored more in depth to follow, bone chemistry and stable isotope analysis provide insights regarding questions of diet and subsistence (e.g., Gerry 1997; Whittington and Reed 1997a; Gerry and Krueger 1997; Scherer et al. 2007), social status/complexity (e.g., Knudson et al. 2004; Turner et al. 2009; Tung and Knudson 2011), and origins and movement/migration (e.g., Price, Burton, et al. 2006; Sykes et al. 2006; Perry et al. 2008; Schroeder et al. 2009; Thornton 2011; Kenoyer et al. 2013; Hemer et al. 2013).

Scholars are enthusiastic to welcome aDNA analyses to the methodological toolkit of bioarchaeology, although poor preservation severely complicates successful extraction (Kemp et al. 2007). Ancient DNA has been applied to various questions within bioarchaeology, including sex determination (De La Cruz et al. 2008), population movement (Kemp et al. 2006; Kaestle 2010), biological relationships (Keyser-Tracqui et al. 2003), dietary reconstruction (Poinar et al. 1998), and disease (Baron et al. 1996; Drancourt et al. 1998; Mitchell 2003; Gilbert et al. 2004; Aufderheide et al. 2005; Bouwman and Brown 2005; Donoghue 2009). Ancient DNA can elucidate human behavior in the past; however, the problematic preservation and required high-level of expertise limit the productivity of the methodology and its application in older archaeological contexts.

As these analytical and methodological approaches advance, bioarchaeologists are examining critically the biases inherent in the biological data of the skeletal samples. The seminal paper by Wood and colleagues (1992), which is elaborated upon in a following section, demonstrated how the health of a skeletal sample may not accurately reflect the health of the living population. While a person may have died with skeletal lesions (indicating disease), they lived long enough for the lesions to develop (and sometimes heal), signifying that the individual may actually have been considered healthy in that particular context.

Theoretical Directions

The most recent theoretical developments in the field of bioarchaeology involve the enhanced focus on contextualizing archaeological skeletal remains. Bioarchaeologists are engaging with various scholarly fields, including archaeology, history, ethnology, chemistry, environmental studies, and critical disability studies, in order to facilitate a "new bioarchaeology" or "social bioarchaeology" (Agarwal and Glencross 2011) where skeletons can be examined to understand lived experiences and social processes in the past. With greater collaboration with these associated fields and colleagues around the globe, bioarchaeology continues to combine the biological and social sciences, allowing for a deeper understanding of social identities in the past.

For mortuary analysis, cross-cultural studies of funerary practices emerged in the early 1900s (Kroeber 1927); however, in the late-twentieth century, mortuary studies became a prominent focus of anthropology and archaeology. In the early 1970s, scholars focused on how mortuary practices related to the society's sociocultural organization, inspired by the dissertation work of Saxe (1970). For example, in 1971, Brown edited the volume *Approaches to the Social Dimensions of Mortuary Practices* in the 25th Memoir of the Society for American Archaeology, in which the chapters by Binford (1971) and Brown (1971a, 1971b) continue to be widely cited as support for the relationship between the mortuary behavior (treatments, grave goods, etc.) and the social status of the deceased (e.g., Hohmann 2001). This processual perspective, "the Saxe-Binford Approach," was influential in the publication of *The Archaeology of Death* (Chapman et al. 1981), where Brown (1981) emphasized that the burial is just a part of the entire ritual process and Buikstra (1981) and Cook (1981) demonstrate how the skeletal remains should be incorporated in the analysis of the mortuary context.

Criticism of the Saxe-Binford Approach emerged shortly on both sides of the Atlantic, as scholars demonstrated that any ranking of mortuary behavior was subjective (Braun 1981) and that there is great difficulty in quantifying certain aspects of mortuary behavior, such as spatial variation (McHugh 1999). The postprocessual theoretical approach (Hodder 1982, 1985) advocated that mortuary ritual was practiced by the living, and thus reflected the assertions, agency, and social identity of the living, not only that of the dead (Parker Pearson 1993). Postprocessual scholars argued that the processual view masked any variation in mortuary practice, while relying on overly generalized cross-cultural analysis (Cannon 1989). Instead, the postprocessual framework demonstrates how mortuary practices reflect the fluctuations of status and social identity, illustrating and implementing cultural changes.

In the 1990s, some scholars (Carr 1995; Beck 1995; Kamp 1998) returned to the Saxe-Binford Approach, defending the nuances of cross-cultural comparisons and generalizations and emphasizing a geographic focus beyond intra-site analysis. Others (e.g., Parker Pearson 1995; Chesson 2001; Silverman and Small 2002) continued to criticize the generalizations, embarking on case studies (e.g., McGuire 1992; Curet and Oliver 1998; Hill 1998) that demonstrate how mortuary practice allows for the manipulation of sociopolitical identities. Many recent studies focus on the connection between the living and their ancestors (e.g., Parker Pearson and Ramilisonina 1998; Ashmore and Knapp 1999a, 1999b; Silverman and Small 2002; McAnany 2014; Velasco 2014; Hill 2016; Źralka et al. 2017), either in the funerary contexts of the dead or in the lives of the living.

Encouraged by bioarchaeology, mortuary scholars have begun to integrate the analysis of skeletal remains into the mortuary contexts from which they are excavated. In the volumes *Interacting with the Dead: Perspectives on Mortuary Archaeology for the New Millennium* (Rakita et al. 2005) and *Social Archaeology of Funerary Remains* (Gowland and Knüsel 2006), scholars analyze human skeletal remains in the framework of social archaeology, emphasizing how social context is vital to the interpretation of information from the skeleton. These mortuary scholars are connecting the biological analyzes of the skeleton to the mortuary context of their burial and merging, not dichotomizing, science and social theory. The field of mortuary studies is aligning with bioarchaeology, towards a holistic and multi-disciplinary approach to the research of lives (and deaths) in the past.

Within this chapter, I present the reviews of three major current discussions in bioarchaeology that inform my research: 1) the bioarchaeology of identity; 2) the bioarchaeology of health, diet, disease, and stress; and 3) the bioarchaeology of migration and mobility. Within each, I evaluate the evolution of bioarchaeological and mortuary theory, and discuss the associated methodological advances as they pertain to my dissertation. These discussions provide the framework for the bioarchaeological assessment and interpretation of the 52 individuals from the Holmul region.

The Bioarchaeology of Identity

The archaeology of identity is a current popular focus within the field, with scholars examining the relationship between identities and the social and cultural behavior of past populations. The practice of bioarchaeology can move archaeology beyond the study of material culture into an in-depth examination of human remains as active populations and as social beings with incredibly complex identities. For my research, I consider the bioarchaeology of identity to understand who the people of the Holmul region thought they were, how they advertised this identity to others, and the identity their peers may have instilled upon their funerary content.

Bioarchaeologists can explore the complexities and the variability of identity formation and manipulation by interacting with multiple fields and utilizing various lines of evidence, including social theory, bioarchaeology, archaeology, mortuary analysis, ethnohistory, and ethnographic data. These many approaches (and combinations therein) allow for the examination of the diversity of identity manifestations, formations, and manipulations in the past. Further, the archaeology and bioarchaeology of identities aims to understand the construction of identity at a variety of levels, including public, private, group (nationality, ethnicity, etc.), community, household, family, and individual (age, gender, disability, etc.). Typically, these dimensions of identity are considered separately, although Meskell (2001:188) has called for scholars to "break the boundaries of identity categories themselves, blurring the crucial domains of identity formation…". This consideration has led to the use of life course theory and osteobiographies to understand the socially constructed and fluid narratives of identity, not merely the components therein. In this project, I consider identity formation and manipulation within the osteobiographies of the 52 individuals from the Holmul region.

Gender, Age, and Disability

Because "determining" biological sex and age is the traditional first step in a bioarchaeological analysis, initial studies of age and gender identities were undermined and individual experiences obscured (Agarwal 2012). To combat the implications of this categorization, bioarchaeologists have engaged with social theory to understand the social identities of the past (Knudson and Stojanowski 2008; Sofaer 2006). Contemporary bioarchaeologists are explicitly distinguishing between biological sex and gender, with the former referring to the biological identity of the individual, and the latter, the social identity (Walker and Cook 1998). Early research focused on gender roles and associated patterning in the past (for a review see Hollimon 2011), while more recently, bioarchaeologists (White 2005; Robb et al. 2001; Torres-Rouff 2002) are considering the intersectionality of gender identity with the normative categories of sex, age, status, ethnicity, and occupation.

With many bioarchaeological collections and current excavations dealing with poor preservation and fragmentary remains, there is an ever-increasing need for updated age estimation techniques that do not rely on complete long bones. While some scholars continue to explore validating existing methods for estimating age from the os pubis (Hoppa 2000; Schmitt et al. 2002; Konigsberg et al. 2008; Kimmerle et al. 2008), auricular surface (Buckberry and Chamberlain 2002; Igarashi et al. 2005; Mulhern and Jones 2005; Falys et al. 2006), and sternal rib ends (Kunos et al. 1999; Schmitt and Murail 2004; Kurki 2005; Ríos and Cardoso 2009), bioarchaeologists and dental histologists are uniting to explore the potential of cementum annulations (TCA) in estimating age-at-death (Wittwer-Backofen et al. 2004; Wedel 2007; Aggarwal et al. 2008; Wittwer-Backofen 2012; Gocha and Schutkowski 2013; Naji et al. 2014; Colard et al. 2015). While a destructive analysis, there is strong evidence that there is a high correlation between subjects known age-at-death and the TCA estimation from the acellular cementum banding (Jankauskas et al. 2001; Wittwer-Backofen et al. 2004; Maat et al. 2006).

As the bioarchaeology of childhood and the bioarchaeology of disability become increasingly popular subjects in archaeology and anthropology, it becomes essential that scholars acknowledge the complexity of age identities, recognizing the lives and agency of the young and old (Lucy 2005; Sofaer 2006). Similarly to the acknowledgement of the difference between biological sex and the social construct of gender, scholars are now differentiating between chronological age (time since birth), physiological or developmental age (biological stage), or social age (socially constructed appropriate behavior for cultural age category) (Halcrow and Tayles 2008; Knudson and Stojanowski 2008). It is the intersection of these various age categories, as well as other identity constructs that informs the age identities.

The two fundamental biological age categories for bioarchaeologists are adult and subadult (or non-adult or juvenile). Biologically, an individual is an adult when they are no longer growing in height, as the epiphyseal fusion of their long bone ends their longitudinal growth, typically around 18 for females and 19 or 20 for males (Martin et al. 2013:154). Bioarchaeologists can identify an individual as within the biological stage of adulthood (physiological age) and perhaps can estimate a chronological age, but they must consider any possible constructed social age when investigating biocultural identity.

The biological age category of subadult is complicated, not just by the intricacies of growth and development, but also in the use of terminology. Subadult, non-adult, juvenile, and child are all terms used by scholars for the biological age before that of adulthood. Not only is the use of multiple terms interchangeably in the literature confusing, but the connotations of the terminology are controversial. Subadult conveys the western notion that the normal, and thus right, identity is adult, with those not yet adults ranked inferiorly (Sofaer 2006; Halcrow and Tayles 2008; Martin et al. 2013). Non-adult may remove the hierarchical connotations, but retains the implications of deviancy and identifies the individual by what they are not (Halcrow and Tayles 2008; Martin et al. 2013). Similarly, child maintains the dichotomized relationship of western culture, implying a passivity and lack of agency compared the adult. Juvenile remains problematic due to its use in some literature as various stages within the category of subadult (Halcrow and Tayles 2008:196). When constructing the age identity for an individual who did not reach the biological stage of adulthood, it is best to acknowledge the complications of the biological terminology chosen and emphasize the consideration of the chronological age estimated from the skeletal remains in conjunction with any information referring to the particular construction of social age.

Numerous bioarchaeological investigations have begun to consider the cultural role that children play in society in conjunction with their estimated physiological age (for a review see Halcrow and Tayles 2008). *The Bioarchaeology of Children: Perspectives from Biological and Forensic Anthropology* (Lewis 2007), *The Social Experience of Childhood in Ancient Mesoamerica* (Ardren and Hutson 2006) and the scholarly journal *Childhood in the Past* (first published in 2009) indicate this growing interest. Globally, of note are the investigations in the Byzantine Near East (Perry 2005), the Irish Neolithic (Finlay 2000), and the pre-Hispanic Maya (Tiesler 2011; Ardren 2011).

Recently, bioarchaeologists are also considering disability and impairment in order to understand further the social construction of identities. Previously, most bioarchaeologists had focused on the clinical description of paleopathological conditions and differential diagnoses of diseases with an intention of understanding population health. Some of the first mentions of disability in bioarchaeology occurred in the 1970s and 1980s, when Solecki (1971) described the Neanderthal "Shanidar I" as "crippled" (192), with "paralysis" (404) and "probably blindness" (409); Frayer and colleagues (1987, 1988) reported the skeletal analysis of an Upper Paleolithic individual with dwarfism, who was "deformed" (1987:60) with a "serious handicap" (1987:61); and Dickel and Doran (1989) presented a "severely handicapped individual" (325) with spina bifida from Early Archaic Florida. These studies (Solecki 1971; Frayer et al. 1987, 1988; Dickel and Doran 1989) not only present the analysis of individuals with potential disabilities, but refer to the care, compassion, and moral decency of others in the societies who allowed the individuals to survive.

Dettwyler (1991) harshly criticized the idea that scholars could infer disability and care in the bioarchaeological record, resulting in the dearth of studies until more recently. She emphasized the limitations of skeletal analysis to deduce productivity and the limiting biases of the researchers. Dettwyler (1991) was increasingly worried that the western assumptions of the bioarchaeologists blinded them from considering the associated archaeological and ethnographic evidence. She elaborated, presenting 5 of these assumptions: (1) that most members of the past society are inherently productive and self-sufficient; (2) that individuals lacking skeletal or physical differences (the abled-bodied) were not considered disabled or impaired; (3) that an individual with skeletal or physical differences was unproductive or unable to contribute to the society; (4) that if a disabled individual survived, it showed "compassion"; and (5) that providing for or caring for disabled individuals was considered the "compassionate thing to do"

(Dettwyler 1991:379–382). Her criticism was valid, and bioarchaeologists renewed focus, for the most part, on medical impairment, shying away from any inference that might allude to the social experience of disability.

In 1999, Finlay attempted to reinvigorate the discussion with a special issue on disability in the *Archaeological Review from Cambridge*, which suggested using sociological models from disability studies to develop an archaeology of disability (Finlay 1999). Unfortunately, even with the publication of this issue and the involvement of disability scholars and bioarchaeologists (Roberts 1999; Shakespeare 1999), it wasn't until 2013 that bioarchaeologists began to actively engage with disability studies, anthropological views, and historical perspectives (Southwell-Wright 2013). Most recently, following a symposium at the 2015 Annual Meeting of the American Association of Physical Anthropologists, the volume *Bioarchaeology of Impairment and Disability: Theoretical, Ethnohistorical, and Methodological Perspectives* demonstrates the new prominent trend in bioarchaeology for holistic analyses, with multi-disciplinary perspectives, considerations of social and cultural contexts, and acceptance of limitations (and assumptions) of purely skeletal analysis (Byrnes and Muller 2017). Further, the bioarchaeology of care also has been reinvigorated with the methodology of the Index of Care (Tilley and Cameron 2014) and two contextualized volumes in the Springer series *Bioarchaeology and Social Theory* (Tilley 2015; Tilley and Schrenk 2016).

The Embodied Person

As bioarchaeology focuses on an individual's skeletal remains first and foremost, it becomes imperative to understand the theoretical language used in bioarchaeological and archaeological studies of identity and the body, such as agency, embodiment, and personhood. In the late 20^{th} century, scholars (Anawalt 1981; Kuttruff 1993; Peregrine 1991) considered the body to be a surface upon which ornaments and costumes were instilled to display and communicate an individual's identity, such as gender and social status. This view relied on the work by Earle (1987) where he linked prestige materials in costumes to social status. The body was merely the legible surface where an individual's previously-determined social identity was instilled. Other scholars (e.g., White 1992), while agreeing that the body served as a surface for demarcating identity, believed that this identity was emerging from within the body, not placed upon it. This view essentially moved the concept of the body from being a two-dimensional surface to a three-dimensional person with lived experiences. In 2002, Boyd called for archaeologists to consider more than just the inscribed surface of an individual and engage with "the social body and embodied agency" (2002:137). Identity was not merely being expressed on the body; instead it was being actively constructed through the body. Further, he states that the mortuary treatment should be viewed as a "*practice* relating to perceptions of the body… by the living on the bodies of the dead" (Boyd 2002:142 emphasis in original).

Agency, or "agentive practice" (Ortner 1984), is a concept widely recognized by scholars (processualist and postprocessualist alike) as a valid concept, but few can agree on the definition. Dobres and Robb (2000:8) outline four principles largely agreed upon: "(1) the material conditions of social life; (2) the simultaneously constraining and enabling influence of social, symbolic and material structures and institutions, habituation, and beliefs; (3) the importance of the motivations and actions of agents; and

(4) the dialectic of structure and agency." Further, agency is not synonymous with action; agency is a quality of action (Dobres and Robb 2000). As archaeologists began to emphasize performance and practice, they acknowledged the agency of the individual and how body practices are performances that correspond to social transitions and fluctuating identities (Joyce 2000).

To engage with agency within the body, some scholars have drawn from Foucault's (1980) discussions of power relations and the body. However, Foucault objectifies the body, stripping the body of agency, and emphasizes the power over the body (Meskell 2000a). In contrast, feminist archaeologists have emphasized early 20th century French philosopher Merleau-Ponty's (2014) idea that bodies are created from lived experience, or embodied. Most famously, Butler (1990) situated gender not within the physical aspects of the body, but instead in the performance of bodies in socially constructed activities. The embodiment of identity involves more than just discussions of gender; identities intersect and overlap in the lived experience (Fisher and Loren 2003). Meskell (1998:159) argues that an "embodied body represents, and is, a lived experience where the interplay of irreducible natural, social, cultural, and psychical phenomena are brought to fruition through each individual's resolution of external structures, embodied experience, and choice."

In bioarchaeology, embodiment has been connected to materiality by Sofaer (2006:66), where the "effects of materiality of specific bodies lead to particular embodied experiences of individuals." She prefers to consider bodies as material culture, uniting archaeologists and bioarchaeologists. Buikstra and Scott (2009) caution that this approach can overemphasize the connection between the dead and the mortuary context, effectively erasing the actions of the living in mortuary behavior. Further, its emphasis on plasticity obfuscates other aspects of identity, such as heritage (Buikstra and Scott 2009).

The body as material also limits the engagement that bioarchaeologists can have with the archaeological theory of personhood. The terms individual, self, and person are frequently interchanged in bioarchaeological literature. Harris (1989) emphasizes that the individual is a biological entity, the self as psychologistic or the location of experience, and the person as the one in possession of agency. In *The Archaeology of Personhood*, Fowler (2004:7) emphasizes that a person can be anything that is personified, including spirits and souls lacking physical bodies, and can experience an ongoing "attainment of personhood" or the creation, maintenance, and transformation of personhood.

In order to engage with all types of identities and how they continue to change through time and space, as well as engage with both the individual and the person, bioarchaeologists are using an archaeology of embodied personhood. Joyce (2007:92) argues that an embodied personhood will allow scholars to understand how "human beings in the past may have experienced their world through the body, and experienced their bodies through their specific cultural positions." The embodied personhood encourages bioarchaeologists to step beyond the dichotomy of skeleton and grave, and employ multi-disciplinary, theoretically-rich approaches to understanding the intersectionality of identities in the past.

Religion, Ethnicity, and Social Status

Studies of religious identity, ethnicity, and social status differences have considerable history within the fields of anthropology, archaeology, and mortuary studies. While these three dimensions of identity could be analyzed separately, a comprehensive study allows for an understanding of identity and ideology at the group level, informing a member's complex social identity. As most often the material correlate of these many dimensions of identity is ritual, it becomes imperative for bioarchaeologists to examine ritual behavior as an indicator of complex social identities, not simply as the material trace of religion.

While religion has been a focus of anthropology since the late 1800s, archaeologists have been uncertain as to how to approach it. Processual archaeologists preferred to not "study religion" and allow other social science fields to pursue the subject (Edwards 2005). With the influx of postprocessual thought, mortuary studies and archaeology have turned to mortuary contexts and the preparation of deceased individuals for interpretations of religious identity and ritual behavior. In this way, archaeologists are more interested in the ritual practice that can be identified in the archaeological record than in identifying religion. Thus, archaeologists have to grapple with the theoretical terminology of religion, ritual, and ideology in order to discuss complex social identities.

From a structuralist point of view (see Geertz 1973), religion is a stable sociocultural system of symbols and beliefs, while rituals enact or perform the meanings behind the symbols (Fogelin 2007). Some archaeologists agree that ritual is the mechanism that reinforces and perpetuates religion (Jones 2007), while anthropologists with a practice perspective view ritual as actively constructing, creating, or modifying religious beliefs, leaving material traces in the archaeological record (Bell 1992, 2009). Bruck (2007) emphasizes that ritual extends beyond the dichotomies of ritual/secular and sacred/profane, as it can create and maintain other types of identities, such as national identities.

Ideology is frequently used in reference to religion by archaeologists, as rituals also can reinforce and disseminate ideology. Ideology, however, engages with power relations and social inequalities. Ideology is a "system of values and ideas that promotes social behavior benefiting some classes of interest groups more than others" (Brumfiel 2007:265). Thus, ritual, including mortuary ritual, can convey more than just religious identity, but also class identity and social status.

While anthropologists have exhaustively studied class, castes, and other types of social statuses, archaeologists tend to use the terms interchangeably (for a review of castes vs. class see Coningham and Young 2007) or simply examine social status differences. When studying mortuary ritual, archaeologists discuss social status differences and the associated identities from differential mortuary treatment, body modification, and, most recently, diet from bone chemistry. Early studies assumed a direct relationship between complexity, wealth, and class and used a processual approach to understand social differences at the population level. This approach was criticized for ignoring the active individual and their presentation of social status (Miller and Tilley 1984). Archaeologists (e.g., Andrews and Fenton 2007) are now aiming to expose the complex meanings and manifestations of class identity, as well as how it can be constructed and maintained by the living.

Similarly to the assumed connections between material culture variations and social status differences, archaeologists have long been using differences in material culture to identity various ethnic groups (a culture historical approach). In the 1970s, scholars (Hodder 1978; Shennan 1978) began to question this notion, emphasizing that material culture is not a passive product that presents ethnicity, but an active material that creates and maintains ethnic distinctions. Further, it was also during this time that scholars began to consider ethnic groups and the social actors involved, and not tribes or races. Jones defines ethnic groups as “fluid self-defining systems which are embedded in economic and political relations” (2007:48) and ethnic identity as “that aspect of a person’s self-conceptualization which results from identification with a broader group in opposition to others on the basis of perceived cultural differentiation and/or common descent” (1997:xiii). Due to the fluidity of ethnicity and the interplay of ethnic identity with other social identities, bioarchaeologists and archaeologists find it difficult to define ethnic groups in the past. Instead, they tend to emphasize inherited skeletal and dental features within in-depth multi-disciplinary contextualization to inform discussions of ethnicity and other social identities (Knudson and Stojanowski 2009).

One closely associated identity, migrant identity, must enter the conversation as bioarchaeologists develop methods to study population migration and mobility. When anthropologists have studied migrant identity, they tend to conflate it with ethnic identity, referring instead to migrant ethnic identity (Nesdale et al. 1997). As Neuzil (2008:7–8) emphasizes, there are social consequences of modern migration to the indigenous and the migrant, including the “renegotiation of identity and sense of place… for both groups”. The identities of both groups may be altered, may persist, or may be subsumed within each other (Anthony 1997). Further, migrants may have a distinct identity for a short while, quickly renegotiating in order to integrate into their new social environment. At the same time, they tend to retain some elements of their premigration culture, causing ties to multiple identities in some cases (Levy and Holl 2002). Thus, as demonstrated with the fluidity of modern migrant identity, bioarchaeologists cannot only study one type of identity from the mortuary ritual and the skeletal remains. They must consider all facets of social identity (and its formation) to the best of their ability, with a multi-disciplinary approach and utilizing multiple lines of evidence.

Life Course Theory, Life Histories, and Osteobiographies

Stimulated by sociology’s life course theory and evolutionary anthropology’s lifecycles, bioarchaeologists have begun to approach the analysis of an individual’s life and death, often veiled and imperceptible in the archaeological record, through osteobiographies, with a culturally contextualized understanding of life (and death) events. Similarly (and perhaps identically), the bioarchaeology of individual life histories aims to decode the “biological condition and cultural circumstances of individuals or small groups” (Zvelebil and Weber 2013:275), through holistic means, combining stable isotope analysis, aDNA, bone histology, mortuary analysis, art and iconographic studies, paleoethnobotany, paleopathology, and/or paleodemography. Through a consideration of life course theory and the osteobiographical approach, scholars can reach beyond major biocultural trends to understand the individuals of the past- their lives, deaths, and contextual social identities.

Since the 1970s, the study of life courses has spread across the social sciences, beginning in sociology and leading to interdisciplinary research of anthropologists, demographers, economists, and psychologists. Life course sociology (Bengston and Allen 1993; Elder Jr 1994, 1998; Elder Jr et al. 2003; Mayer 2009; Diewald and Mayer 2009) focuses on the changes in human lives from various perspectives and contexts: an individual's lifetime, a cohort or community's lifetime, across life domains (e.g., work and family domains), and development within a cultural framework. The fastest growing topic within life course research concerns the intersection between health and aging- understanding health over the lifespan, morbidity and mortality, and health varying by socioeconomic class (Lynch 2008; Mayer 2009; Glencross 2011).

As bioarchaeologists have begun to focus on health and disease in past individuals, a consideration of the sociological life course theory becomes increasingly informational. However, when bioarchaeologists focus only on the human remains of a single individual to reconstruct their life history, they are conforming to the western notions of the bounded and discrete life course (Niewöhner 2011). Gowland emphasizes that life courses resemble "Russian dolls", as they are "nested and entangled both socially and biologically across several generations" (2015:537). When considering the life of a particular individual, bioarchaeologists should consider the construction of those lives within these multi-generational social and biological contexts.

Evolutionary biology and anthropology have focused on lifespans and lifecycles of various species to understand emerging social complexity, such as social cooperation during the *Australopithecus-Homo* transition (Key 2000) and the physical and social experiences of Neanderthals (Pettitt 2000). Lifecycle studies emphasize the continuity or continuum of the human experience, while life course studies highlight particular phases or stages within the human's life that are culturally segmented (Gilchrist 2000). Further, lifecycles may correlate with other cyclical aspects of life, whether daily, seasonal, or annual repetitions, and of death. The important distinction here is that lifecycles emphasize the biological (and sometimes cross-cultural) elements of life, while the term life course refers to a more contextually-rich study, with rituals that mark the transition over symbolic or physical thresholds (Gilchrist 2000). To fully understand social identity and life in the past, bioarchaeologists may benefit from a life course approach that considers and integrates lifecycles and the continuum of human experiences (e.g., Meskell 2000b).

In 1961, Frank Saul proposed the analytical approach of osteobiography as a means to engage with past life histories and as an alternative to merely documenting uninterpreted skeletal measurements (Saul and Saul 1989). Osteobiography was posited to elucidate details through skeletal osteology to answer the questions, "who was there", "where did they come from", "what happened to them", and "what can be said about their way of life", in order to understand population composition, organization, activities, and health (Saul and Saul 1989). Saul and Saul (1989) cautioned using solely the skeletal remains to interpret the heath or lifeways of an individual, as they found in their forensic work that osteobiographies can contradict provided historical information.

Armed with this caution and encouragement, scholars (e.g., Hawkey 1998; Renschler 2007; Mayes and Barber 2008; Boutin 2008; Knüsel et al. 2010; Tourigny et al. 2016) have advanced osteobiographical methods with the combination of biogeochemistry, archaeological sciences, and human osteology to reconstruct past identity profiles on an individual or community level around the globe. As presented in a special issue (32.3) of the Journal of Anthropological Archaeology edited by Zvelebil and Weber (2013), these methodological advances allow scholars to "(1) …reconstruct long segments of individual life histories from birth to death; (2) to assess variation in prehistoric human behavior; and (3) to place this behavior in the context of dynamic interactions with the natural environment" (2013:275). While in this special issue, scholars present life histories of individuals and groups primarily from the Neolithic period (Le Bras-Goude et al. 2013; Eriksson and Lidén 2013; Bentley 2013; Zvelebil and Pettitt 2013), the life history approach also has been used in younger contexts, such as in Medieval Italy (Reitsema and Vercellotti 2012) and Late Formative (AD1-500) northern Chile (Knudson et al. 2012). As demonstrated by these studies, advancements in methodology have allowed for the construction of individual life histories to further understand the identities of specific individuals and groups.

Robb (2002) expanded the methodological focus of osteobiography (and life histories) to consider the theoretical and cultural aspects of a life. He refers to osteobiography as "the study through human skeletons of the biography as a cultural narrative" (Robb 2002:160). In other words, while Saul's osteobiography is purely a methodological means to obtain details of an individual's life, Robb's osteobiography incorporates theory as he fuses these methods with a "cultural understanding of life events and… the history of human remains after death" (2002:160). Robb aims to understand the meaning of life and death within a particular social context, which aligns with the intentions of White and colleagues (2009:155) to "promote the movement from traditional osteobiography to social biography for the purpose of better understanding social identity."

These scholars, perhaps unintentionally, have inspired the use of sociological life course theory in archaeology and bioarchaeology to create more nuanced and contextualized biographical narratives of individuals and to understand the development and transformation of identities in the past. While the study of individual life history is more prevalent in bioarchaeology, some scholars are incorporating life course theory to understand the fluidity of lived experiences. The increased consideration of cultural age and gender identities (e.g. Halcrow and Tayles 2008; Kamp 2001; Perry 2005) opened the door and created the foundation for the life course framework in bioarchaeology to investigate social lives. Other scholars (Glencross 2011; Prowse 2011; Gowland 2015) have focused on diet, health, and injury with the life course perspective to situate events and experiences within larger historical and cultural contexts. Whether considering diet, health, injury, mobility, age, or gender, life course theory has begun to be incorporated into osteobiography to present social biographies and study social identity within the past.

The Bioarchaeology of Health, Disease, Diet, and Stress

New advancements in the analysis of human skeletal remains have provided bioarchaeologists and paleopathologists increasing insight into the health and disease of past populations. From evaluating the contributions of dietary patterns, the presence of widespread infectious disease, the impoverished environmental conditions, and the occurrence of parasitic infestations, scientists can enhance the understanding of the lifestyle and well-being of past groups or societies. Traditionally, paleopathology, the "investigation and reconstruction of past human health and disease" (Buzon 2011:58), has not been grounded in archaeological research, instead drawing from skeletal biology and various medical fields. By taking a bioarchaeological approach to paleopathology, scholars holistically can reconstruct the lives of past populations, while integrating social theory and skeletal analysis.

Paleodemography and The Osteological Paradox

There is an increasing quantity of questions concerning the paleodemography of past populations, specifically the part played by estimations of age-at-death within the demographic profile. These demographic profiles and their associated health and lifestyle assessments have been challenged by questions surrounding the ability to discern frailty, mortality, and childhood morbidity in past populations amongst the addition of sampling and preservation problems (Spence and White 2009). Wood and colleagues (1992) highlight these difficulties in understanding health profiles of skeletal populations with their introduction of the Osteological Paradox. They propose that increases in skeletal lesions may not be a simple measure of declining population health; instead, individuals with lesions may actually be biologically advantaged, living long enough to fight the infection and for its trace to be left on the bone tissue. Wood and colleagues (1992) generated a debate about the methods used and inferences drawn from bioarchaeological research, demanding reevaluations of population health data and insisting on the use of multiple indications or skeletal characteristics in the creation and evaluation of demographic or health profiles of a past population. Wood and colleagues (1992) introduction of the paradox has sparked intense debate among scholars, challenging them to rethink the assumptions within their research and understand the multitude of interpretations for the patterns they find within their sets of human skeletal remains.

Many different methodological advances could allow scholars to evaluate hidden heterogeneity in frailty and selective mortality with their skeletal samples. The use of multiple different analytical methods can further the understanding of the reasons behind lesion abundance and the frailty of a population. For example, the increasing inclusion of ancient DNA research can make it possible to identify specific pathogen DNA in skeletal remains that may not have lesions present (Wright and Yoder 2003). This research is essential in determining if the specific individual was never infected or if they were so frail that they passed away immediately following infection. The further combination of stable isotope analysis and paleopathological evaluation can only strengthen the understandings of population heterogeneity and health status.

Unfortunately, most bioarchaeological investigations have not even attempted to understand the paradoxical complications of Wood and colleagues (1992). DeWitte and

Stojanowki (2015) found that while over 550 publications have cited Wood and colleagues (1992), very few directly address the paradox and its implications. Most studies only reference the paradox as an important theoretical consideration, a limitation, or an excuse for contradictory results (DeWitte and Stojanowski 2015). DeWitte and Stojanowki (2015) suggest incorporating the paradox into research design, as well as considering new advances in genomics, phenomics, and epigenetics in paleopathological studies. Further, they call for additional focus on the paradox as a topic of study itself, not just as an assumption or limitation (DeWitte and Stojanowski 2015).

Bioarchaeologists must move beyond recognition of the paradox's existence and complications in order to actively consider its implications in their bioarchaeological analyses and test its validity within their samples through new and diverse methodologies. DeWitte's study of a Black Death cemetery serves as an example of middle-range research and how to examine patterns of mortality within a situation of tight temporal control (DeWitte and Wood 2008; DeWitte 2009; DeWitte and Hughes-Morey 2012). Further integration of the paradox into bioarchaeological and paleopathological research will provide a more nuanced interpretation of health status in past populations and the effects of cultural change and environmental strain upon these ancient societies.

Stable Isotope Analysis and Paleodiet

Bioarchaeologists have used carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope analyses of human bone for dietary and lifestyle reconstruction. Because the amino acids consumed through eating contribute to the protein building sites in the body, the $\delta^{13}C$ of the individual's bony tissue should reflect that of their diet (Van Der Merwe and Vogel 1978; Krueger and Sullivan 1984). Bone collagen reflects primarily the protein component of the diet, while the bone and enamel apatite may give a broader picture of the whole diet (Tykot 2006).

The $\delta^{13}C$ of the diet is a result of the metabolism of carbon from atmospheric carbon through the reaction of photosynthesis (Larsen 2002; Tykot 2006). As there are three different types of photosynthetic pathways (C_3/Calvin, C_4/Hatch-Slack, and Crassulacean Acid Metabolism/CAM), different plants fixate carbon to a specific degree depending on the pathway used. Researchers have determined that individuals who primarily consumed C_3 plants (e.g., wheat, barley, and quinoa) have the most negative values (avg. -21.5‰ for collagen, -14.5‰ for apatite), while C_4 plants (e.g., maize, sorghum, millet, and sugarcane) give less negative values (avg. -7.5‰ for collagen, -0.5‰ for apatite) (Tykot 2006). Individuals who consume CAM plants (e.g., agave and aloe) and those who consume a variety of C_3 and C_4 plants yield intermediate values (Tykot 2006; Bethard 2012).

Maize is an example of a tropical grass that fixes carbon by a different photosynthetic pathway (the Hatch-Slack or C_4 pathway) than most plants found in temperate zones (Katzenberg 2008). Because of the prominent social and economic connections between maize and cultures of the New World, the $\delta^{13}C$ individuals' diet may reveal interesting variations of consumption. These studies can provide a precise timing of the adoption of domesticates like maize (Carpenter et al. 2002; Coltrain et al. 2007), as well as any variations in importance or access from trade, war, or climatic events (Larsen 2002). In addition to these temporal differences, variations in identity or social status may be elucidated through a study of the isotopic values in conjunction with bioarchaeological and mortuary behavior (White, Longstaffe, et al. 2006; Linderholm et al. 2008). While scholars acknowledge that maize was a significant component of the New World diet, isotopic studies can reveal nuances in regional diversity of maize consumption (Gerry 1993; Wright and White 1996; Gerry and Krueger 1997; White 1997).

Nitrogen isotopes ($\delta^{15}N$) have been used to reveal trophic level positions within the food chain, the consumption of marine sources, and the timing of weaning practices. Non-leguminous plants have $\delta^{15}N$ values higher than legumes and the standard of atmospheric nitrogen (Katzenberg 2008). Concordantly, herbivores consuming non-leguminous plants will have higher $\delta^{15}N$ values than those eating legumes (Katzenberg 2008). These values will be typically 2-3‰ higher than the plants, which is the typical rise in tropic level, even as a carnivore consumes an herbivore (Tykot 2006). Nitrogen isotope values from freshwater resources also register a trophic level effect, allowing scientists to estimate population reliance on fish among groups with an abundant availability of fish (Katzenberg 2008). In general, the $\delta^{15}N$ values for freshwater fish and marine mammals/fish are much higher than terrestrial plants and animals (Tykot 2006), allowing scholars to estimate whether the individuals were relying on marine or terrestrial food sources (e.g., Richards et al. 2005).

Stable isotope analysis can provide more precise information concerning the timing and rate of weaning behavior, in comparison to enamel defect analysis. Changes in $\delta^{15}N$ values during early childhood can highlight the practice of breast feeding of infants (Fuller et al. 2006; Tsutaya and Yoneda 2015). An infant still receiving breast milk will have higher $\delta^{15}N$ values in comparison to their mother, and to weaned infants (Larsen 1997; Tsutaya and Yoneda 2015). Hypotheses concerning the timing of weaning in agricultural societies versus non-sedentary groups may be tested by the study of $\delta^{15}N$ from nursing mothers and their infants (Katzenberg and Harrison 1997; Katzenberg 2008). Katzenberg (2008) explains that trophic level increases in $\delta^{15}N$ beginning shortly after birth and decreases when the child's diet was supplemented with other foods. $\delta^{15}N$ values can be compared from pre-agricultural and agricultural sites to understand differences in weaning practices, potentially influencing the health of the populations (Katzenberg 2008).

The Bioarchaeology of Migration and Mobility

Theorizing Migration and Mobility within Archaeology

Traditionally, migration has been used as an explanatory device to comprehend the movement and history of culture. Due to the grandiose nature of these academic narratives, few scholars have attempted to understand the varied processes of migration itself, and the individuals involved. Instead, scholars have focused on the theoretical underpinnings of migration, considering how ideas and material culture moved across the landscape. Any methodological advances were developed under the umbrella of the theoretical notions of the time, supporting theory instead of offering alternative understandings.

This theoretical focus began with the proponents of cultural evolution and cultural diffusionism. Beginning in the mid-19th century, scholars followed the biblical notion that technology and civilization began in the Near East and spread east until reaching Europe. Thomsen (1836; Heizer 1962), of the Three Age System, believed that the successive migrations east of population groups displaced local groups and brought about stages of technological change. Montelius (1899, 1903), a Swedish scholar, expanded upon this notion of *ex oriente lux* and developed the theory of diffusionism, where innovations and technological change were brought upon by the gradual movement of ideas, not necessarily from the displacement of populations. In the late 19th and early 20th centuries, the concept of culture was introduced to the field of archaeology, as scholars such as Childe (1925) adapted the diffusionist theories to understand not just technological change, but cultural change, all the while concurrently attempting to understand how migrations might be detected within the archaeological record.

With Childe's (1950) foray into the field of archaeological culture, the culture-historical notions of migration began to take hold, suggesting that a defined ethnic group may migrate in relatively short time frames causing grand population displacement and significant cultural impact on the receiving landscape. Situated within a nationalist framework, the culture-history approach developed alongside historical linguistics and race anthropology; these disciplines all aimed at explaining cultural changes in prehistory, while upholding ethic integrity and deep history of national origin.

In the 1960s, archaeologists began their "retreat from migrationism" (Adams et al. 1978) turning instead to New Archaeology and the application of archaeological science to understand social change in the archaeological record. The application of radiocarbon dating expanded the time depth of prehistory and slowed the rates of change, causing great doubt in the previous notions of short-term, long-distance movements causing cultural change. Adams and colleagues called for a greater emphasis to be placed on the actual mechanics of movement, criticizing the culture-historians for their "refusal… to consider the social, technological, and logistic mechanics of human movement" (1978:523). These processual archaeologists aimed to engage with the actual processes and effects of human movement by returning to the grand narratives and large-scale population dispersal theories.

In the late 20th century, post-processual archaeologists criticized this grandiose perspective, "where complex migration processes are reduced to little more than arrows on maps" (Hakenbeck 2008:16). These scholars attempted to focus instead on the individual agency of the persons involved and the internal mechanisms that drove culture change. This point of view led to the criticism that these scholars were being "immobilist," or focusing too much on the indigenous or "in place" development of social change and material culture (Chapman and Hamerow 1997; Snow 1995).

To compensate and to counter deterministic ideas of the archaeogenetics scholars, Anthony (1990, 1992, 1997) and Burmeister (2000) turned back to grandiose theoretical frameworks, this time of other social science disciplines. They suggest a more dynamic theoretical model, which considers the social processes of modern and historical migrations, integrating universal principles of migration into pre-historic situations before considering the "development of a method for establishing archaeological proof of migration" (Burmeister 2000:540). Hakenbeck (2008:18) criticizes the separation between and prioritization of modern theoretical models above the methodological advancements, which limits the investigations of "the actual processes and potential variability of migrations in the past."

Hakenbeck (2008:19) instead calls for the understanding these modern models are not always applicable to pre-historical situations, and that we cannot "assume that migration in the past was limited to the movement of ethnic groups or demographic expansion." She cautions that this emphasis restricts scholars' understanding to the statistics of the overall populations. Further, she calls for the use of the more encompassing term "mobility", which could include many different, specialized forms of migration, allowing for a deeper consideration of the variety of social, historical, and environmental pre-historic contexts.

Hakenbeck (2008) lauds the methodological advancements of stable isotope analysis in consideration of the questions of pre-historic, human mobility, citing the seminal studies regarding the Bell Beaker period of Central Europe by Price and colleagues (1994, 1998, 2004). Price and other scholars have used stable isotope analysis to understand prehistoric mobility from around the world (e.g., Grupe et al. 1997; Balasse et al. 2002; Schweissing and Grupe 2003; Turner et al. 2009; Britton et al. 2011; Theden-Ringl et al. 2011; Kenoyer et al. 2013), including the Maya region of Mesoamerica (e.g., Wright 2005a; Price, Burton, et al. 2006; Price et al. 2010; Wright 2012; Price et al. 2015; Scherer and Wright 2015). Hakenbeck (2008:19) praises studies such as these that provide evidence for specific patterns of mobility using "a bottom-up evidence-driven approach… [that] bridges the gap between large-scale patterns of mobility and the small-scale effects of mobility on individuals and their burial contexts."

Migration in Urban Contexts

The process of urbanization, the emergence of urbanism, and the definitions of *urban* and *the city* have captivated sociologists, political scientists, geographers, historians, economists, anthropologists, and archaeologists since the early-twentieth century. Until the late 1970s and 1980s, these scholars relied heavily on the standard sociological definition of the city, which focused on large population size, but also included dense population concentration and high internal diversity (Wirth 1938; Childe 1950; Weber 1958; Fischer 1975). The population size and density definition of the city derived from Western examples of urbanization, not considering the diversity of pre-historic and pre-industrial cities around the globe and throughout history. Following Fox's *Urban Anthropology* (1977), there has been a movement beyond the universal definitions of cities and urbanism towards the recognition of a broad variety of urban traditions in the past and present (Sanders and Webster 1988; Low 1996; Smith 2001; Brenner 2003, 2004; Cowgill 2004; Çaglar 2007; Nijman 2007; Kloosterman and Lambregts 2007; Joyce 2009). Archaeologists in particular, over the past 20 years, have developed more flexible definitions of cities and urbanism that may be less precise, but allow for greater cross-cultural and temporal comparison and consideration (Smith 2001, 2011; Cowgill 2004; Ur et al. 2007; Butzer 2008; Bard 2008; Jones 2008; Joyce 2009; Yoffee 2009; Isendahl and Smith 2013; Fisher 2014; Kelly and Brown 2014; Razeto 2014; Carballo and Fortenberry 2015).

As mentioned above, internal population diversity or significant heterogeneity, which includes individuals of different ethnic and geographic backgrounds, is an important component of an urban center. Diverse individuals or migrants are difficult to consider within the archaeological record, especially in discussions of urban centers and cities, where the material excavated is more easily interpreted using a top-down approach. Many discussions of modern cities, urbanism, and globalization have the capability to consider and directly interact with the diverse participants of the urban centers, exploring the role of immigrant incorporation in the creation and continuation of cities (Vertovec 2007; Brettrel 2011; Salih and Riccio 2011; Goode 2011). Similar to the archaeological perspectives, urban studies tend to view immigrants or the diverse, non-elite, urban population as the labor force manipulated by the elites, as members of ethnic communities, or the locus for social problems of the city (Glick Schiller and Çağlar 2009; Glick Schiller and Simsek-Caglar 2011). Further, in Mesoamerican archaeology, the ethnic identity of migrants and their role in ancient Mesoamerican centers has focused on analyses of the *barrios* of Teotihuacan (White et al. 2004) and settlement clusters of the Classic Maya (Smith 2011; Isendahl and Smith 2013). Joyce calls for Mesoamerica archaeologists to consider further how urbanism involves complex interactions of individuals with various “identities, viewpoints, and access to resources and power” (2009:195). Migrants are significant agents within an urban landscape.

Bioarchaeological Methods for Understanding Mobility and Migration

Bioarchaeological methods of analysis, including those of biodistance, aDNA, and stable isotope ratios, provide researchers with the opportunity to use the actual biological and physical remains of the populations in question in order to test these hypotheses of mobility and migration. Traditionally in archaeological studies, evidence of population movement and individual mobility was found in the excavated material culture, monumental architecture, or historical texts. For example, in studies of Paleolithic archaeology, mobility patterns have been inferred from lithic materials and their manufacture (Brantingham 2003, 2006; Nejman 2013). Other scholars examine non-local or luxury grave goods in mortuary contexts or from long-distance trade to infer population mobility (Johannesson and Machicek 2013). Further, documents from ancient Greece and Rome mention mobile workers or traders in their census documents (Cohen 2003). These studies are inferring mobility or migration from movement of goods or textual information, not from the individuals who were moving. Bioarchaeology can directly approach these complex archaeological questions and hypotheses from biological remains of the population, not just from the material culture that they produced.

Biological distance ("biodistance") analyses estimate genetic similarity or morphological variation within or between populations (see Stojanowski and Schillaci 2006 for general review; and Scherer 2007 for a Maya example). Biodistance analysis, and its extensive data collection and statistical interpretation, is being supplemented, transformed, and replaced by the fields of ancient DNA ("aDNA") analysis and bone chemistry. Because stable isotope analysis can identify possible geographic origins of individuals within a population, larger questions of social, political, and economic dynamics can be addressed beyond the conclusions of diversity from the absence or presence of gene flow clustering.

Biological Distance Analyses for Population Mobility

Before (and after) the availability of stable isotope chemistry, scholars used biodistance analyses to estimate genetic similarity or morphological variation within or between populations (Buikstra et al. 1990; Stojanowski and Schillaci 2006). Biodistance researchers study phenotypic inheritance as demonstrated from cranial or dental metric and non-metric attributes present in the skeletal remains of the population in question (Konigsberg 2006). Biodistance is applied to cemetery contexts, where questions arise concerning variability in: kinship and cemetery structure, post-marital residence, the aggregate population, temporal residence, and demographic organization (Stojanowski and Schillaci 2006). Biodistance can be used on a larger scale to examine population diversity among regional or continental populations in order to understand geographic origins, long distance mobility, and/or microevolutionary processes (Buikstra et al. 1990; Stojanowski and Schillaci 2006).

Biodistance measures for genotypic data through the proxy of metric and non-metric skeletal traits. These polygenic traits can reveal both biological and environmental differences within sample population (Buikstra et al. 1990). The "calculation" of biodistance is derived from the observation, recording, and statistical analysis of cranial metrics, dental metrics, and non-metric traits. Metric analyses, whether cranial, dental, or post-cranial, involve the quantification of skeletal elements using standard points of reference or landmarks. The inter-landmark measurements are recorded using the metric system, unless it is the recording of the appearance of an attribute, in which case it would be indicated as "present or absent" (White et al. 2012). Traditionally, researchers have recorded measurements manually, using a variety of instruments designed specifically for osteological measurements. More recently, advances in computerized tomographic (CT) and laser scanning technologies have enabled researchers to gather metric data digitally (White et al. 2012).

Cranial metrics are the most commonly used, primarily due to early scholarship's fascination with race and brain size, which lead to the selective collection of crania and the resulting metric data. Similarly, dental metrics are quantified for metric analysis, although the landmarks for measurement are less universal, as different sets of metric landmarks are proposed (e.g., Buikstra and Ubelaker 1994; Hillson 1996). While post-cranial metric data acquisition is common, it is not used for biodistance analysis due to the functional, weight-bearing purpose of the post-cranial bones and lack of inter-individual variability (Stojanowski and Schillaci 2006). Non-metric traits, also known as discrete traits, have subtle variation in expression, which is due to their underlying familial inheritance (Buikstra and Ubelaker 1994; Stojanowski and Schillaci 2006). The non-metric traits are those commonly recorded based on presence or absence. Non-metric cranial traits usually fall into one of four categories: ossicles within cranial sutures, abnormal proliferation ossifications, ossification failure leading to defects, or variation in foramen number or location (Buikstra and Ubelaker 1994). Because of the heritability of the non-metric traits, scholars frequently document them in biodistance studies.

In most current scholarship, the metric and non-metric data collected is analyzed statistically using the Relethford and Blangero's (1990) approach to R matrix analysis for quantitative traits. This method expresses that populations will deviate from the model when they experience greater-than-average or less-than-average long-distance gene flow than expected relative to the other populations in the region (Buikstra and Beck 2006; Konigsberg 2006; Scherer 2007). Biodistance studies use these statistical methods to assess the important biological data and express population genetic diversity.

Stable Isotope Analysis and Paleomobility

As mentioned previously, while bone chemistry of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) has been widely used for dietary and lifestyle reconstruction, recently, scholars have used stable isotope analysis to identify instances of mobility or migration and address questions concerning the early instances of agriculture and pastoralism. Researchers are stepping beyond archaeobotanical and archaeozoological investigations to use stable isotope analysis in investigations of the specifics of pre-historic husbandry practices and the mobility of agropastoral economies (e.g., Stevens et al. 2013; Towers et al. 2011; Giblin et al. 2013; Vaiglova et al. 2014). Further, Hammond and O'Connor (2013) emphasize the importance of isotopic testing of both faunal and human remains from the same contexts to fully understand the diversity of animal management strategies in the past.

Researchers typically have used the analysis of stable isotope ratios to study: 1) the aforementioned mobility patterns of humans and fauna in relation to the early advent of agropastoralism (e.g., Towers et al. 2011; Hammond and O'Connor 2013; Stevens et al. 2013; Giblin et al. 2013); 2) specific migratory or diasporic events (e.g., Evans et al. 2006; Price, Tiesler, et al. 2006; Perry et al. 2008; Schroeder et al. 2009); 3) migration and models of exchange (e.g., Sykes et al. 2006; Thornton 2011; Kenoyer et al. 2013;

Hemer et al. 2013); and 3) immigration, diversity, and social complexity (e.g., Ezzo et al. 1997; Knudson et al. 2004; Turner et al. 2009; Tung and Knudson 2011). These studies demonstrate the productivity of stable isotope analysis for answering broader questions about migration and society.

Both oxygen ($\delta^{18}O$) and strontium ($^{87}Sr/^{86}Sr$) values have been used to reconstruct residence, individual migration, and regional mobility in prehistoric populations throughout the world (e.g., Grupe et al. 1997; Larsen 1997; Balasse et al. 2002; Schweissing and Grupe 2003; Hodell et al. 2004; Larsen 2006; Price, Tiesler, et al. 2006; Turner et al. 2009; Price et al. 2010; Britton et al. 2011; Theden-Ringl et al. 2011; Kenoyer et al. 2013). An individual's oxygen isotope composition ($\delta^{18}O$) is related to the particular water source that they imbibe and can be affected by various local geographic variables (e.g., climate, temperature, and humidity), creating a potential signature for a region (Tykot 2006; Spence and White 2009). But because of the annual variability of rainfall, possible reservoir effects, and cultural practices, such as cooking, storage, diet, and breastfeeding, the use of oxygen isotopes for pinpointing geographic origin is considered highly experimental (Price et al. 2010). However, oxygen isotope results can be used to demonstrate variability within a sample, to identify some immigrant individuals from outlying values (beyond the 2‰ variability), and to supplement the more concrete strontium results.

Strontium does not fractionate by biological or geological processes and thus can be considered to directly reflect the local geochemistry of the region where an individual may be located during their growth and life (Larsen 1997, 2006; Tykot 2006). When an individual consumes water and food, the strontium from these resources replaces some calcium in the hydroxyapatite of their bones and teeth mirroring the geographic isotopic values. As previously mentioned, the strontium ratios in the teeth reflect the geographic area of residence during dental development and the ratios in the bone produce values that mirror the location of the individual during their most recent instances of bone remodeling. Comparing the strontium values of the individual's enamel to their bone values, or the local bedrock values (place of burial), can allow for an understanding of their personal migratory history.

Strontium and oxygen isotope analysis help explore population interaction and movement in past societies. But in order to understand individual mobility, it becomes increasingly necessary to establish better regional geologic baselines and develop the use of more isotopic markers. The integration of many types of isotopic analyses can only bolster the discussion and interpretations. These less frequently used elements include barium for the identification of marine and non-marine diets (Burton and Price 1990; Gilbert et al. 1994; Burton et al. 2003); sulfur for understanding the consumption of marine, freshwater, and terrestrial resources (Richards et al. 2001, 2003; Cheung et al. 2017); calcium for the elucidation of past dairy and marine resource consumption (Gilbert et al. 1994; Sillen et al. 1995); and lead for mobility and migration (Valentine et al. 2015; Sharpe et al. 2016; Shaw et al. 2016). Like strontium, lead substitutes for calcium in teeth, allowing scholars to compare isotope ratios to established geological baselines for information regarding trade and migration. Even more, further inclusion and comparison of different bone tissues, including apatite and dental enamel, will allow continued understanding of regional diversity in terms of subsistence and residential mobility.

Chapter Summary

This chapter presented broad reviews of three major current discussions in bioarchaeology that frame for the bioarchaeological assessment and interpretation of my sample population: 1) the bioarchaeology of identity; 2) the bioarchaeology of health, diet, disease, and stress; and 3) the bioarchaeology of migration and mobility. Of most relevance to this project, the bioarchaeology of identity allows for the understanding of the complexities and the variability of identity formation and manipulation by past populations. Through interactions with multiple fields and utilizing various lines of evidence (e.g., social theory, bioarchaeology, archaeology, mortuary analysis, ethnohistory, and ethnographic data), bioarchaeologists can examine the diversity of identity manifestation, construction, and management in the past. In particular, bioarchaeologists are employing osteobiographical analysis to approach an individual's life and death, often veiled and imperceptible in the archaeological record with a culturally contextualized understanding of life (and death) events. The bioarchaeology of health, diet, disease, and stress contribute to the osteobiographical compilations as these inquires can further the understanding of the lifestyle and well-being of past groups or societies.

Finally, a brief discussion of the bioarchaeology of migration and mobility provides theoretical context for frequently employed bioarchaeological methods of analysis, including those of biodistance, aDNA, and stable isotope ratios. This project uses stable isotope analysis to identify the geographic origin of the individuals and how it may impact their migrant or local identity. While not engaging with hypotheses of broad mobility and migration, the framework is necessary to understand the methodology used and how individual mobility may impact the complex identities of the people of the Holmul region.

CHAPTER 4: CURRENT DIRECTIONS IN MAYA BIOARCHAEOLOGY

Bioarchaeological studies of the ancient Maya began with early explorers' curiosity and early physical anthropologists' obsession with identifying race from the human cranium. Nineteenth century explorer John Lloyd Stephens conferred with physical anthropologist Samuel Morton to understand the people who built the prehistoric cities of the Americas and their descendants (Buikstra 1997). In the early 20th century, as systematic archaeological techniques were introduced, the limited descriptions of the human remains were typically relegated to the appendices of excavation reports (e.g., Ricketson 1925; Smith and Kidder 1951), followed by accession of the crania and long bones to American institutions' osteological collections. In 1972, Saul published *The Human Skeletal Remains of Altar de Sacrificios: An Osteobiographic Analysis*, where he lamented how prior scholars ignored "the people who made the pottery and built the structures" (1972:3). Instead of merely documenting the apparent age, sex, and body modifications, Saul (1972) paid attention to the pathology on the skeletal remains, asking larger demographic questions concerning heath and nutritional stress and their relation to collapse. Saul's seminal work is indicative of the trends to come, as published physical anthropology/bioarchaeology journal articles regarding heath and the body increased between 1970 and 1994 from 35% to 65% percent (Buikstra 1997).

In the latter half of the 20th century and continuing today, Maya scholars have expanded beyond the simple, demographic inventories; bioarchaeologists have become more commonplace on archaeological excavations, offering detailed bioarchaeological reports and publishing comparative, contextualized analyses of human and cultural behavior. Further, following the publication of Buikstra and Ubelaker's *Standards for Data Collection from Human Skeletal Remains* (1994), the field of bioarchaeology gained a standardized classification system that emphasized the subjectivity of the observer and how the data collected could be applied to the larger questions in the field of archaeology. This handbook (essential for novices and experts in the field alike), coupled with ever-advancing technology and methodology, have allowed Maya bioarchaeologists to address large, cultural questions with broader implications. Particular recent focus has been on questions of status differences, nutrition and disease, demographics at various scales (regional, city, group, household, etc.), diet, and implications of skeletal trauma, as well as the examinations of any patterning or chronological variation of the aforementioned (Webster 1997).

In this chapter, I present the more traditional and popular avenues of exploration in Maya bioarchaeology, such as trauma, sacrifice, cannibalism, and the collapse. These sections will demonstrate the new directions scholars are taking, as they consider new theoretical frameworks and methodological advances. I evaluate the bioarchaeological inquiries of identity, health/diet, and mobility/migration in the Maya region and elsewhere in Mesoamerica. I consider the osteological paradox in Maya bioarchaeology and how new advances, such as stable isotope analysis, have contributed to our understanding of Maya paleodiet and paleomobility. I present recent studies of Maya identities, focusing on multi-disciplinary approaches that combine skeletal analysis, mortuary analysis, bone chemistry, material culture, inscriptions, and monumental architecture, in order to understand the Maya life course.

Mesoamerican Trauma, Violence, and Sacrifice

While warfare, human sacrifice, and cannibalism are highly popularized subjects within Mesoamerican prehistory, current bioarchaeological research has journeyed beyond the reporting of trauma data and conclusions of violence to interpreting the social relationships beneath the violent acts and addressing questions about ritual behavior. With the use of comparative methodologies, Mesoamerican bioarchaeologists have been able to study the patterning of perimortem and posthumous body processing to elucidate the social, political, and religious practices encompassing violence and death within ancient Maya populations (Tiesler et al. 2007:21). Unfortunately, the study of the bioarchaeology of violence of the Maya has fallen victim to poor preservation, limiting the material available to evaluate for these perimortem marks of sacrificial and postsacrifical practices. The recent introduction of *osteotaphonomy*, or the analysis of depositional taphonomic context of human remains (Tiesler et al. 2007), may allow for greater interpretations and reconstructions of the ritual behavior accompanying the evidence of trauma.

Ritualized Violence and Human Sacrifice

Ritualized violence and the offering of human sacrifice in Mesoamerica have been extensively studied, with its popularity launched from vivid images from codices and historical accounts of conquistadors. As Spence and White (2009:238) explained, “the word ‘sacrifice’ is derived from the Latin *sacer facere*, which means to make sacred and normally implies a surrender to the supernatural of something precious.” While sacrifice can include offerings of various bodily tissues, including blood, in these situations, perimortem trauma of the skeletal tissue is specific evidence of a sacrifice resulting in death.

Bioarchaeologists evaluate osteological indicators of trauma, demographic patterning, and depositional composition to explore symbolic behavior of the ritual. Massey and Steele (1997) examined the crania remains from a "Maya skull pit" at Colha, Belize, finding no indication of widespread disease or nutritional deficiencies, a variation of cultural modifications of the skeletons, and evidence of decapitation and then flaying of the crania. The ceremonial flaying and specific layering of the skulls suggest a pattern of deference and respect. Further, nearly equal numbers of adult males, adult females, and children suggest a symbolic meaning to the demographic composition of the ritual (Massey and Steele 1997). Alternately, the cut marks, evidence of burning, and associated end of Classic occupation at Colha suggest political upheaval and the use of the skulls as war trophies (Massey and Steele 1997).

Continued evaluation of the skeletal remains found in the Cenote of Sacrifice at Chichén Itzá also has contributed to the further understanding of Maya ritual activities that involve human sacrifice and posthumous body processing. In conjunction with an earlier analysis (Beck and Sievert 2005), Guillermo de Anda Alanis (2007) found that a majority of the sacrificed were juveniles or subadults, which, when viewed in conjunction with ethnographic sources, may indicate the presence of cenote-related sacrificial rituals for the rain gods. The infants and subadults experienced "dismemberment, defleshing, flaying, perimortem violence, and heat exposure" (de Anda Alanis 2007:201), while the few adults were deposited articulated without dismemberment. The bioarchaeological analysis of the remains from this cenote, with consideration of associated ethnographic and epigraphic evidence, provides Mesoamerican archaeologists with the ability to evaluate the complex sacrificial ritual activities.

Similarly to the Cenote of Sacrifice at Chichén Itzá, investigations of the Midnight Terror Cave in Belize revealed that 43% of the MNI (of over 10,000 bones recovered) were subadults (Prout and Brady 2017). The mortality curve reported demonstrates a peak between five and ten years of age, which is quite different than a normal mortality curve and suggests the act of sacrifice, not natural death. Further, this study highlights that subadults held a significant role in Maya sacrifice rituals and practices (Prout and Brady 2017).

Tiesler and Cucina (2006) documented the "cultural marks" found on individuals that seem to have been "companions" of Janaab' Pakal and the "Red Queen." They supplemented their interpretations with contextual archaeological and taphonomic data to provide a more complete view of ritual violence and companion sacrifice at Palenque (Tiesler and Cucina 2006). The authors use this evaluation to explore the role of ritual killing as a religious expression within companion sacrifice. They conclude that "the motivations for attendant sacrifice and the placement of the victims most likely responded to the specific demands during each phase of the funerary preparation and ancestor commemoration" (Tiesler and Cucina 2006:104). The skeletal remains of the Red Queen's "attendants" display conclusive evidence of perimortem violence, including many multidirectional vertebral cut marks. Those cut marks found on the cervical vertebra may indicate instances of decapitation, while those marks found on the lower vertebral bodies may support the procedure of heart extraction (Tiesler and Cucina 2006).

Tiesler and Cucina (2006) expand upon the procedure of heart extraction with their evaluation of anthropogenic marks on Classic Maya skeletons found at Calakmul, Palenque, and Becán. They support their interpretation of the trauma as perimortem and not post-mortem, and thus sacrificial in nature, with experimental replication of heart extraction in modern corpses (Tiesler and Cucina 2006). The trauma described in their article can serve as referential evidence for renewed and future examinations of heart extraction among the ancient Maya and in greater Mesoamerica. The authors call for precise taphonomic recording to support any evidence that may be found of per-mortem heart extraction and warn that preservation may make it very difficult to examine the remains for marks of heart extraction (Tiesler and Cucina 2006).Even more, they highlight that heart extraction may result in few perimortem marks and warn that "absence of evidence does not mean evidence of absence" (Tiesler and Cucina 2006:505). The study of the anthropogenic marks of heart extraction is an intriguing and complicated facet of the bioarchaeology of violence in Mesoamerica.

With the development of sophisticated techniques, specifically stable isotope analysis, for determining geographic origins and migration, the bioarchaeological analyses of sacrificial victims can be augmented with the possible origins of the individuals and can lead to more in-depth conclusions concerning the social and political factors behind sacrificial violence. Using stable isotope analysis, White and colleagues (2002) elucidate the geographic identities of the sacrificed individuals at Teotihuacan, Mexico, to understand the political and military implications of their identities of sacrificial victims. Price and colleagues (2007) also evaluated the isotopic data of sacrificial victims at the Maya sites of Kaminaljuyu, Tikal, Palenque, and Copan to identify local versus foreign individuals in these sacrificial contexts. While they find great variation in the selection of sacrificial victims, the use of multiple bioarchaeological methods is greatly beneficial in the evaluation of traumatic contexts and violent practices in ancient populations.

Duncan (2011) exemplifies the implementation of many methodological techniques to understand the social and political context of violent, sacrificial deposits at Ixlú, Guatemala. In addition to the perimortem trauma evidence, this study evaluates demographic data, taphonomic data, evidence of cultural modification, and biological distance along with ethnohistoric and archaeological contexts to obtain a complete picture of the sacrificial ritual within the bioarchaeology of violence (Duncan 2011). Duncan (2011) determined that the presence of the articulated vertebrae with the crania and cut marks at long-bone joints suggest dismemberment and decapitation of the individuals. These remains did not have evidence of other markers of posthumous processing, such as defleshing, polishing, or burning, or more complex processing acts such as cannibalism (Duncan 2011). The author attempts to understand any relationship between the deposit and the religious world view of the population, emphasizing the cyclical relationship of birth and death and the public performance that would have led to the sacrificial deposit. He also suggests that future studies could continue to focus on biodistance in sacrificial practices in order to understand the biological relationship between the victims of violence (Duncan 2011).

Human sacrifice is thought of as a common act of the Classic Maya populations, but little has been determined concerning the practice during the Postclassic period until the time of Spanish contact. Serafin and Peraza Lope (2007) apply "osteotaphonomic analysis" to the complex human sacrificial deposits from the Maya site of Mayapan in the Yucatan peninsula of Mexico. The human remains show some evidence of cut marks on the mandibles, possibly a reflection of the removal of the mandible for a war trophy from the sacrificed individual, as depicted in colonial accounts. While the specific identities of the victims are not known, this evidence of the trauma patterns might indicate that these were sacrificed war captives (Serafin and Lope 2007). The authors support the comparative use of ethnohistoric and archaeological data with their osteotaphonomic approach in order to reconstruct more fully the practice of human sacrifice during this Postclassic period before the arrival of the Spanish.

Perimortem violence and posthumous body manipulations usually denote sacrificial practices, but also may be connected to ancestor veneration rituals. This complication is explored by Nelson and colleagues (1992) when they incorporate archaeological, osteological, and ethnohistorical evidence to evaluate whether the posthumous body processing at La Quemada, Mexico indicated rituals pertaining to slain enemies, sacrificial victims, or honored community members or ancestors. While they conclude that the context appears to express the practice of ancestor veneration, this is a worthy example of the complexities and possible alternate conclusions (other than violence) in studying perimortem trauma and posthumous body processing (Nelson et al. 1992).

Cannibalism

A particularly flashy subject of bioarchaeology of violence throughout the world is that of cannibalism among ancient populations. In the past, any indication of posthumous body manipulation, specifically defleshing, boiling, or burning the remains, would be used as evidence for the practice of cannibalism. Scholars now suggest that these posthumous manipulations of the human remains are indicative of ritual actions or tool manufacture and not cannibalism. Medina Martin and Sanchez Vargas (2007) present pieces of human bone from the site of Calakmul that displayed evidence of reuse and may have been used for polishing soft materials. Even more, Spence and White (2009) determine that the practice of cannibalism was not as prominent among ancient Maya populations, as the Spanish chroniclers suggested. Some argue that cannibalism can only truly be concluded from remains of human coprolites that contain traces of human remains, none of which have been found in the Maya region (for a debate on the subject see Bullock 1991; Turner and Turner 1992a; Dongoske et al. 2000; Billman et al. 2000; Leonard et al. 2000). Other secondary sources of evidence include tooth marks on human bone and traces of human remains on cooking and serving vessels (Turner and Turner 1992b, 1995). In any case, the sensationalized subject of posthumous practices as indications of cannibalism mostly has been passed over by the academic community in favor of understanding the processing practices during various sacrificial rituals or customs of ancestor veneration.

Interpersonal Violence

Interpersonal violence is most commonly represented by archaeological evidence of fortifications or burned residences and pictorial representations of warfare and captive sacrifices. Most Mesoamerican trauma analyses are focused on ritual violence of sacrifice and rarely emphasize interpersonal conflicts or trauma as a result of warfare. Tiesler and Cucina (2012) propose the use of bioarchaeological evidence to answer questions concerning the goals of organized violence, the use of specific weapons, and the tactics used in these instances of conflict. The authors emphasize how "skeletal evidence of specific healed and unhealed trauma patterns provide information about the types of interpersonal violence used in Maya society and the weaponry that was used to accomplish that violence, thus complementing conventional interpretations derived from the material record or from Maya imagery" (Tiesler and Cucina 2012:162–163). Their examination of frontal bones suggests that Maya elites engaged in battlefield conflict, not hidden from battle, but actively in the combat. Many of the frontal bone traumas were caused by long-range arrows or other projectiles, such as spears or stones (Tiesler and Cucina 2012). The patterns of frontal bone trauma geographically and temporally, finding that even coastal populations engaged in violent practices, perhaps from economic arguments, and that there was an increase in social violence during the volatile period of the Terminal Classic (Tiesler and Cucina 2012). The bioarchaeological patterns of skeletal trauma may be able to contribute to studies of the Classic collapse of the Maya where archaeological contexts demonstrate warfare activities. This evaluation of frontal bone trauma acts as an example for future researchers to follow in their reconstructions of violence within ancient Maya populations.

Bioarchaeology and "The Classic Maya Collapse"

Bioarchaeologists have approached the "Classic Maya Collapse" with fresh eyes, refuting the original sensationalized conclusions. Scherer and colleagues (2007) present isotopic data from Piedras Negras that does not support the decline of maize cultivation during the Late Classic period; instead, they suggest that the region remained economically and ecologically viable into the ninth century. Instead, the subsistence changes may relate to broader eighth century sociopolitical transformations and increased warfare at the margins of the polity (Scherer 2007). This study is one example of the application of bioarchaeological methodology to assess ecological explanations for the collapse at the end of the Classic period.

Wright and White (1996) also tackle the ecological explanations for collapse, as they find little isotopic support for generalized ecological models and argue instead that the Maya lowlands show considerable diversity in dietary and health indicators. They combine dietary and paleopathological methods of analysis, which fail to show a consistent change in isotopic composition of diets in the Terminal Classic and a correlation among diet and nutritional disease, growth disruption, and infectious disease. With a comparison to other preindustrial cultures, they find that the health burden experienced by the Classic Maya showed few differences and in fact, the most dramatic change in human biology and health may have occurred during and following the

Postclassic due to the Spanish Conquest (Wright and White 1996). They conclude that any dietary and health changes that may have occurred in the Terminal Classic may have been due to local environmental and political factors.

Wright (2006) evaluates the mortuary, paleopathological, and bone chemical data from recovered burials in order to study both biological and social changes and to evaluate the environmental explanation for the collapse of Classic civilization in the Pasión region. She determines that nutritional stress and disease were not significant factors in the collapse of the Pasión sites, since the paleopathological indicators were present equally throughout all periods of occupation. Further, instead of a diet limited to maize due to environmental pressure, the stable isotope signatures are considerably heterogeneous, indicating a varied diet and possible population movement (Wright 2006). These scholars' research demonstrate how bioarchaeology can tackle one of the most popular subjects in Maya archaeology and contribute extensively to the discussion, even providing the groundbreaking, contrary evidence that causes reconsideration of a popular collapse model.

Ancient Maya Health, Nutritional Stress, and Disease

Most of the paleopathological research within the Mesoamerican world pertains to trauma and nutritional stress. While some paleopathological studies were interested in identifying syphilis and treponemal infection (Mansilla Lory et al. 2000; Pineda et al. 2009), identifying lesions consistent with nutritional stress or vitamin deficiency became more popular. Detecting and classifying these lesions and skeletal pathology in general is increasingly difficult due to poor preservation of skeletal material from the Maya region. Some Maya scholars (Saul 1977; Whittington and Reed 1997b; Wright and Chew 1998) have identified porotic hyperostosis and cribia orbitalia, pitting and diploë expansion of the ectocranial surface and eye orbits, respectively (Angel 1966), which may be linked to the deficiency in iron, either related to anemia or parasitism. Lesions consistent with scurvy, resulting from a vitamin C deficiency, have been identified only at Maya sites in Belize (White, Maxwell, et al. 2006; Wrobel 2014); however, as the Maya had access to dietary vitamin C, it is more likely that the lesions once again are a result of anemia or parasitism (White, Maxwell, et al. 2006).

The most common measure of juvenile stress is enamel defects, which can illustrate particular times of vulnerability during childhood and related sociopolitical events. For example, Danforth (1997) considers patterns of formation of various dental enamel defects in Late Classic samples from three Petén sites (Tikal, Seibal, and Barton Ramie) that differ markedly in size and political importance. Danforth's (1997) linear enamel hypoplasia results suggest that residents at larger sites had incurred more health disruptions during childhood compared to more rural sites. Similarly, hypoplasia and Wilson band frequencies were also significantly higher than during later periods. The results of the microdefect analysis more strongly confirm a long-held assumption that the health of the Late Classic Maya was worse than that of their predecessors.

Consideration of the Osteological Paradox in Maya Bioarchaeology

Many Maya bioarchaeologists actively consider the Osteological Paradox's implications in their bioarchaeological analyses of health and nutrition. Storey (1997) is an example of a Mesoamerican scholar actively considering the implications of Wood and colleagues' (1992) paradox in her discussion of individual frailty, elite children, and stress in Late Classic Copan. She suggested that "one way to study the possible effects of individual frailty and the effects of morbidity upon mortality is to follow individuals through childhood, comparing defects of the deciduous and permanent dentitions and the age-at-death" (Storey 1997:119). Storey (1997) concluded that at Copan there were multiple stress episodes suffered by the majority of the population, indicating possible deficiencies in providing the basic necessities of life and that the community may have lost many of its individuals during their childhood. This study demonstrates the integration of bioarchaeological analysis and the consideration of the paradoxical questions of morbidity and mortality to further the ability of archaeologists to understand the past.

The consideration of lesion development is an essential component of paradoxical interpretations, because the presence of lesions is used as primary evidence of health issues within past populations. Because of frequency and extensive documentation, lesions of porotic hyperostosis are a perfect avenue to explore the paradox within paleopathological series. With the warning that there might be parasitic influence in the formation of anemic lesions, scholars (e.g., Wright and Chew 1998) have begun to approach the study of infections as a contribution to, not a primary cause of, dietary iron deficiency anemia. The presence of these lesions on adult remains may indicate low frailty and the survival of childhood anemia (Wright and Yoder 2003).

Wright and Chew (1998) approached their study of porotic hyperostosis and paleoepidemiology with an understanding and acceptance of Wood and colleagues' (1992) paradoxical complications. The authors reconsidered lesion abundance and its implications within samples of ancient Maya skeletons, modern living Maya populations, and forensic skeletal material from this modern population. They explored "the use of ethnographic analogy as a tool to evaluate the broader implications of poor health on an archaeological culture" (Wright and Chew 1998:924). The authors determined that 65% of prehispanic children who survived past their childhood had suffered from anemia, which is dramatically higher than the 30% of rural, modern Maya children and 12% of the forensic remains of the modern Maya population (Wright and Chew 1998:931). Wright and Chew (1998) evaluated three different factors: (1) diet, (2) infection, and (3) mortality, or a combination therein—to understand these differences among the groups and they determined that the differences were not from greater malnutrition or parasitism among the ancient Maya populations. Instead, the authors determined that the greater presence of healed lesions is instead a reflection of lower mortality when compared to the evidence from the modern Maya populations, living and forensic (Wright and Chew 1998). In other words, this study confirms the validity of the osteological paradox as presented by Wood and colleagues (1992). The frail, ancient Maya children survived in a "healthier" environment with the ability to survive through anemia, which resulted in the frequency of healed skeletal lesions in the adult skeletons (Wright and Chew 1998).

Other Maya scholars also have approached their research with the active inclusion of the paradox and its implications. Cohen and colleagues (1997) highlighted low rates of pathological conditions on a skeletal series from the Tipu cemetery, in modern-day Belize. The apparent "healthiness" of the skeletal remains might instead reflect the deaths of individuals before their bodies had time to register pathologies in the skeleton (Cohen et al. 1997). The authors considered the possibility of the paradox at work within this sample but conclude that, in this situation, the skeletons should have reflected "the pre-epidemic burden of malnutrition and chronic infection," and instead show few signs of stresses (Cohen et al. 1997:86). Furthermore, they determined that "the treatment of the dead does not suggest mass or hurried burial and the population does not display the high frequency of severe growth disruption which should be expected in survivors of epidemics" (Cohen et al. 1997:86). While the authors' conclusions may not have indicated the paradox within this sample, Cohen and colleagues (1997) were able to consider its implications within their evaluation and thus deepen their understanding of this past population.

Stable Isotope Analysis and Maya Paleodiet

Stable isotope analysis can provide greater perspective on the relationship between food consumption, sociopolitical complexity, and population settlement within the Maya region. Scherer and colleagues (2007) examine bioarchaeological evidence (porotic hyperostosis, dental caries, and carbon and nitrogen stable isotope ratios) to explore the diachronic changes in diet and to determine if the trends align with the sociopolitical transformations at the Maya site of Piedras Negras at the end of the Classic period (c. AD 750 to 900). They find chronological changes in the stable isotope data that indicate that the Early Classic period (c. AD 250 to AD 600) was full of dietary variability, especially in terms of maize consumption (Scherer et al. 2007). The Late Classic diets became less varied, as maize was not as variably consumed and some relied on diets primarily of meat or fish. The authors do not believe these changes reflect the decline of maize cultivation or ecological downturn, but instead that the dietary changes relate to broader sociopolitical transformations, as well as increased discord and warfare at the edges of the polity that may have restricted the trade of food stuffs (Scherer et al. 2007).

As previously mentioned, Wright and White (1996) used the combination of paleopathological evidence and stable isotope analysis to assess the plausibility of the ecological models of the Classic Maya collapse. They find little isotopic support for generalized ecological models and argue instead that the Maya lowlands show considerable diversity in dietary and health indicators. The authors combine dietary and paleopathological methods of analysis, which fail to show "a consistent change in isotopic composition of diets into the Terminal Classic period… [and] a correlation among diet and nutritional disease, growth disruption, and infectious disease" (Wright and White 1996:185). They extend a comparison to other preindustrial cultures and find that the health burden experienced by the Classic Maya showed little differences and in fact, the most dramatic change in human biology and health may have occurred during and following the Postclassic due to the Spanish Conquest (Wright and White 1996). They conclude that any dietary and health changes that may have occurred in the Terminal Classic may have been due to local environmental and political factors.

In a separate study, as an extension of her dissertation, Wright (1997) also evaluates the mortuary, paleopathological, and bone chemical data from recovered burials, in order to study both biological and social changes and to evaluate the environmental explanation for the collapse of Classic civilization in the Pasión region. She determines that health stress was not a significant factor in the collapse of the Pasión sites, since it did not hinder the development of large Late Classic populations (Wright 1997). These authors (Wright and White 1996; Wright 1997) demonstrate the application of stable isotopic data in subsistence studies, as a complementary methodology, to larger sociopolitical questions of past populations.

Stable carbon and nitrogen isotope ratio analysis can also provide insight into the relationship between patterns in subsistence and distinctions in social status. It is possible for $\delta^{13}C$ values from individuals of different social statuses to suggest differences in maize consumption along these social lines. Gerry's (1997) stable carbon isotope analysis demonstrates that the Maya sample population follows the predictions for maize agriculturists. The nitrogen isotopic ratio analysis indicates that the Maya augmented their primarily vegetarian regime with the consumption of animal protein. He finds slight, perhaps insignificant, differences in consumption between status groups, and finds more significant differences pertaining to geographic location (Gerry 1997). Furthermore, Gerry (1997) explores the possibility that any dietary variation between social classes was not quantitative but instead qualitative. His study demonstrates how new analytical techniques can illuminate possible alternative interpretations of elite privilege among the Classic Maya. Whittington and Reed (1997b) also find that both the carbon and nitrogen isotopes measurements of the elite and commoners were equal. But they determine that the range of carbon isotope values for the elites is greater than that for the commoners, concluding that the diet for the elites may have been more varied than the commoners' diet. Scherer and colleagues (2007) take the complex interaction between diet and status a step further with the application of a comparative temporal frame to the analysis. When viewing chronological differences in conjunction with status differences, the authors determine that only the lower status individuals demonstrate a change in diet during the Late Classic period, while high status individuals maintained the same diet (Scherer et al. 2007). They suggest that a shift occurred where some parts of the population became less dependent on maize products and either ate more meat or supplemented their diet with more fish (Scherer et al. 2007).

Wright and Schwarcz "investigate the utility of stable carbon and oxygen isotopes in human dental enamel to reveal patterns of breastfeeding and weaning in prehistoric Mesoamerica" (1998:1). The authors examine the dental enamel of adult skeletons from Kaminaljuyú and elucidate their childhood diets and track the changes during their growth. Because the stable isotopes of oxygen reflect the origin of the water consumed and breast-fed infants could have higher oxygen ratios, Wright and Schwarcz (1998) believe that the $\delta^{18}O$ values could indicate breast feeding in a skeletal series. The authors select tooth enamel as their medium because it is less likely to be altered by biological processes than bone mineral. Wright and Schwarcz (1998) use carbon and oxygen isotope analysis to examine the enamel carbonate of specific teeth within the same skeleton and highlight changes in dietary practice through the life of an individual.

They conclude that this shift from breast feeding to solid foods was a long process and that the individuals began to consume solid food products at a young age while continuing to imbibe breast milk (Wright and Schwarcz 1998).

The Bioarchaeology of Maya Mobility and Migration

Prior to bioarchaeological investigations, researchers were limited to understanding Classic Maya inter-population mobility and diversity from hieroglyphic elite inscriptions (e.g., Culbert 1991a; Schele 1991; Schele and Matthews 1991; Martin and Grube 2000) and patterns of material culture distribution, particularly ceramics (e.g., Bishop 1994; Foias and Bishop 1997; Andrews and Mock 2002). While most of the material culture trends may suggest regional isolation, the material evidence of long distance exchange and the textual evidence of elite interregional marriages and regional conflict support the hypothesis of population mobility and migration of the Classic Maya. While aDNA (see Kaestle 2010 for review) is rarely used to explore Maya mobility due to preservation difficulties (Scherer 2007; Merriwether et al. 1997), biodistance studies and advances in bone chemistry, specifically stable isotope analysis, can provide a more direct and productive avenue for understanding population diversity and variability.

Before the use of stable isotope chemistry, archaeological evidence for migration into an urban environment relied on non-local monumental architecture characteristics, non-local material goods within burial contexts, and hieroglyphic texts or inscriptions. Some studies have suggested the presences of migrants from Teotihuacan in the Maya region (Smyth and Rogart 2004; Estrada-Belli 2011), multi-ethnic populations in Maya urban centers (Canuto and Fash 2004), and northern Yucatecan influence in the southern lowlands and Belize (Demarest 2006; McAnany et al. 2004). Textual references to elite mobility due to trade, tribute, or diplomacy abound at the centers of Dos Pilas (Inomata and Houston 2001; Martin and Grube 2000), La Corona (Inomata and Houston 2001; Martin 2001), and Piedras Negras (Martin 2001). There are further textual references of elite travel for ritual purposes and instances of warfare (Inomata and Houston 2001; Culbert 1991b; Schele and Matthews 1991; Webster 2000; Martin and Grube 2000; Demarest et al. 1997; Inomata 2004). These references focus on specific, important, elite individuals, limiting our knowledge about the mobility of non-specific elites and non-elites, which can be illuminated with stable isotope chemistry.

Biological Distance Analyses of Maya Mobility

In studies of Maya biodistance, dental measurements are the most commonly used. Cranial metric data are more difficult to amass, due to poor preservation of Maya crania (and skeletal material in general) and the ancient Maya practice of cranial modification, which would decrease the reliability of the cranial measurements and non-metric traits (Scherer 2007). Dental metrics and non-metrics are studied in cases of Maya biodistance due to the better preservation and the minimal occlusal wear of the dentition (Glassman and Garber 1999; Scherer 2007).

Austin (1978) used dental measurements to show biological discontinuity at the site of Seibal in the Late and Terminal Classic periods, which may have been due to an influx of immigration. Pompa and Padilla (1990) and Cucina and Tiesler (2004) also used dental metric data and did not find distinct regional clustering in their analyses of northern and southern lowland samples. In contrast, Wrobel (2003) found separate clustering in the data from Belizean sites and Pasión region sites.

Scherer has presented the most recent and most comprehensive study of Maya biodistance in his 2004 dissertation and the resulting 2007 article in the *American Journal of Physical Anthropology*. Scherer (2007) studied 827 dentitions from 12 Classic Maya sites distributed widely in the Maya region, in order to present comparative biological data from the entire region and to fully evaluate the extent of gene flow. Scherer (2007) disproved his hypothesis of "isolation by distance," which if proved would indicate that biological distance increases with geographic distance, suggesting relatively non-mobile populations and restricted gene flow. Instead, he found extensive gene flow between neighboring areas and also greater, long-distance gene flow in the Maya region during the Classic period (Scherer 2007).

As demonstrated by the studies of these Maya bioarchaeologists, biodistance analysis is a productive method for documenting phenotypic data and expressing genetic diversity among regional or inter-regional populations. However, because stable isotope analysis can identify possible geographic origins of individuals within a population, larger questions of social, political, and economic dynamics can be addressed beyond the conclusions of diversity from the absence or presence of gene flow clustering.

Stable Isotope Analysis and Maya Paleomobility

Mesoamerican bioarchaeologists have analyzed dental enamel for strontium and oxygen isotope ratio values to elucidate the geographic origins of specific individuals and test hypotheses of military, political, and economic relationships. These scholars have used this method to: (1) understand the implications of diverse geographic identity within Teotihuacan; (2) realize the influence of Teotihuacan throughout Mesoamerica; and (3) create biographical histories of individuals found in prominent, elite Maya tombs. Only most recently have Maya scholars begun utilizing stable isotope analyses on groups of individuals to relate biographical profiles and mortuary contexts to small-scale and large-scale mobility patterns in the Maya region and beyond.

Due to the elusive social structure of Teotihuacan and its mysterious connections and influences throughout Mesoamerica, scholars have produced many isotopic studies aimed to understand Teotihuacanos within the city and outside its limits. Isotopic examinations of osteological material from within Teotihuacan were employed to understand the immigrant status and social positioning of the individuals from the residential compound of Tlajinga 33 (White et al. 2004). White and colleagues (2004) found that 29% of the residents were immigrants and their phosphate $\delta^{18}O$ values indicate that they came from at least two different regions. They determined, through the comparison of burial location and food consumption, that the immigrants were able to attain high status over time and that they may have given up any former ethnic identification manifested through food and assimilated (White et al. 2004).

Another study of oxygen isotope ratios from within Teotihuacan attempted to understand the geographic identities of the sacrificial victims associated with the Feathered Serpent Pyramid and to interpret the political and military implications from their presence in this particular context (White et al. 2002). White and colleagues (2002:217) analyzed oxygen stable isotope ratios “as markers of geographic identity” and compared bone and enamel values to elucidate the different environments of their childhood and adult life. Furthermore, the patterns of residential movements detected in the isotopic analysis can lead to conclusions concerning military structure and behavior, the sociopolitical role of women, and the political nature of the state of Teotihuacan. The "soldiers" within the Feathered Serpent Pyramid may have been recruited from other regions and the female individuals included those born locally and foreign (White et al. 2002) The individuals from the center of the pyramid were not native to Teotihuacan and had not lived in the city long enough to register local oxygen signatures in their bones. They had moved from one foreign local to another or from Teotihuacan to foreign locales, indicating a merchant or priestly role in society (White et al. 2002). The isotopic analyses allow the authors to test many different hypotheses regarding the geographic identities of the individuals within the Feathered Serpent Pyramid and patterns of migration that might elucidate military and political structure and the sociopolitical role of women at Teotihuacan.

The nature of the political and social influence of the Mesoamerican state of Teotihuacan in other regions has been explored through the oxygen isotopic analysis of possible foreign individuals who were in positions of power in ancient Maya cities, such as Kaminaljuyú (White et al. 2000), Copan (Price et al. 2010), and Tikal (Martin 2003). White and colleagues (2000) evaluated oxygen isotope values of enamel phosphate from molars of individuals buried in prominent tombs, compared to a Kaminaljuyú baseline value that is isotopically distinct from the Valley of Mexico (Teotihuacan), the Valley of Oaxaca (Monte Alban), and the Petén. They found that foreigners were not restricted to these primary tombs and furthermore, the $\delta^{18}O$ values expose a second group of foreigners of an unknown geographic origin (White et al. 2000). These “foreigners” may have been buried in primary tombs, but do not have isotopic signatures from the Valley of Mexico and thus are unlikely to be Teotihuacan personnel (White et al. 2000). These studies, while focused on renowned individuals, do demonstrate the utility of bioarchaeology and stable isotope analysis in clarifying and correcting social, political, and economic conclusions based on architectural, epigraphic, and artifactual evidence.

Following the elucidations concerning connections with Teotihuacan, many of the most well-known studies from Maya archaeological samples use strontium isotope ratio analysis in hopes of expanding the biographies of those in prominent, elite tombs, such as the Acropolis burials from Copan (Price et al. 2010), the royal burials from Tikal (Wright 2005a, 2012; Scherer and Wright 2015), and the ruler Pakal and the Red Queen from Palenque (Price, Burton, et al. 2006; Price et al. 2015).

Price and colleagues (2010) present the stable isotopic analysis from Early Classic Copan as a tool to understanding ancient migrations and the geographic origins of the dynastic founder. They emphasize how the two isotope measurements (strontium and oxygen) should be used in combination to explore questions of mobility and residential changes among those buried at Copan. For example, the oxygen isotope data confirm the non-local status of the Hunal skeleton (probably the dynastic founder of Copan, K’inich Yax K’uk’ Mo’) and the strontium isotope data may be able to point out possible locations of origins (Price et al. 2010). None of the values from the Hunal individual are close to the range for Teotihuacan and he does not appear to have spent his childhood or later years in Central Mexico. Instead, the strontium values correspond most closely with those from Tikal and the surrounding northern Petén (Price et al. 2010). The isotopic data, combining the results of the oxygen and strontium values, work together to provide convincing evidence for the non-local birth of a number of individuals at Copan, including the occupant of the Hunal burial (Price et al. 2010). This use of multiple isotope ratios in combination is an excellent example for future researchers to follow, which will allow for more concrete and complex conclusions about the bioarchaeological data.

Strontium stable isotope analysis was introduced as a method for testing the hypothesis that the Early Classic ruler, Yax Nuun Ayiin I, found in Burial 10 of Tikal may have had geographic origins at Teotihuacan, as suggested by epigraphic evidence (Wright 2005a; Martin and Grube 2000; Stuart 2000). The strontium stable isotope results from the tooth tested indicated geographic origins of Tikal or nearby, thus suggesting that Yax Nuun Ayiin I did not spend his childhood at Teotihuacan (Wright 2005a). This application demonstrates how stable isotope analysis can be used to confirm or revise interpretations of residential mobility surmised from epigraphic study.

Price, Burton, and colleagues (2006) compare strontium isotope ratios in enamel and bone samples to provide new evidence of Palenque's ruler's residential history and familial ties to the female dignitary ("Red Queen") buried near the temple shrine. They determine that, when compared to isotopic signatures for various parts of Mesoamerica, for Pakal and the Red Queen, the isotopic signature is for the general region around Palenque, but not necessarily for the actual site itself (Price, Burton, et al. 2006). The authors also emphasize the value of an accompanying epigraphic approach to the question of origin, providing crucial additional insight to local versus non-local birth (Price, Burton, et al. 2006).

As demonstrated above, within Mesoamerica and more specifically within the Maya cultural region, the application of bone chemistry has focused on elucidating specific residential histories of significant individuals and testing hypotheses of particular military, political, and economic relationships. Price and colleagues (2010) sampled a number of non-elite remains from Copan, but primarily use the cluster of oxygen results as a local signature to compare to the elite burials of the Acropolis. Researchers at Tikal analyzed 83 skeletons for stable strontium isotopic data, in order to determine the local individuals and compare these results to the local strontium ratio values previously determined from faunal material and from environmental data (Wright 2005b). Wright published further stable isotope analyses, emphasizing the results of several key, elite individuals from Tikal in order to understand the role of migration in the history of the state of Tikal (Wright 2012:349). As demonstrated from these aforementioned cases, scholars primarily have analyzed individuals from a broader population to gain insight into economic systems of the Maya, with conclusions emphasizing connections and interpretations external to the city centers.

More recent projects have gone beyond these major Maya archaeological sites to generate isotope ratios of more non-elite individuals from smaller Maya sites, especially in the Belize Valley (Freiwald et al. 2014; Freiwald 2011; Micklin 2015). This work, as well as further analysis on individuals from Copan (Miller 2015), supplements and amplifies the database of local, baseline isotopic data for the Maya region. Thornton (2011) has also contributed to the baseline data through her strontium isotopic analysis of faunal remains from throughout the Maya region.

The Bioarchaeology of Maya Identities

Traditionally, the ethnic, socio-economic, political, and gender identities of the ancient Maya were understood from the archaeological analyses of material culture and iconography, mortuary analyses, and ethnographic accounts. Bioarchaeologists can use multi-faceted approaches and methodologies, such as bone chemistry, biodistance, skeletal analysis, and paleodemography to deepen interpretations of the social identities from the archaeological, mortuary, and ethnographic record. For example, stable isotope analysis, in conjunction with mortuary analyses and ethnographic accounts, can allow bioarchaeologists to reach beyond the broad questions of Maya diet and mobility and understand the intersectionality of Maya identities.

Maya Identities from Mortuary Analysis

Maya archaeologists have elucidated Maya mortuary ritual behavior from a combination of hieroglyphic texts, pictorial representations, and elaborate temple burials, as well as residential religious architecture, residential burials, and artifact assemblages. The similar ritual practices across both types of contexts demonstrates consistent beliefs and worldview no matter the social strata- an ethnic Maya identity (Kunen et al. 2002). Burial practices can be examined as indicators of ethnic identity, as the knowledge about specific funeral rites and death symbolism is not easily accessible to non-group members

(Weiss-Krejci 2006a). As scholars reconstruct these ritual acts that focus on human bodies, expressions of both a greater Maya identity and more nuanced Maya identities can be explored through the examination of mortuary contexts, including the burial location, positioning and processing of the body, and/or the grave goods associated with the deceased.

In order to consider of the construction and maintenance of Maya identities from mortuary contexts, consistent terminology must be used. Traditionally, many Maya scholars differentiated the ritual deposits of burial and cache, as containing human remains or not, respectively. For example, Coe defines cache as “one or more objects found together, but apart from burials, whose grouping and situation point to intentional interment as an offering” (1959:77) and burials as having implicit attention in the deposit to the deceased as a human being. Welsh (1988) argues that any interred offerings containing human remains, including caches, should qualify as a burial, due to the fact that they allow scholars to infer methods of interment or disposal of the dead leading to a more nuanced analysis of mortuary behavior. By explicitly dividing these two categories, as Coe suggests, certain similarities are dismissed and ritual behavior can be obfuscated (Kunen et al. 2002). For example, as some burials may have been considered offerings and thus also could be called a cache, both burials and caches should be considered ritual deposits (Becker 1993). Instead of categorizing or classifying based on the contents of the ritual deposit, Kunen and colleagues suggest assessing the sacred status of the deposits from a behavioral perspective, emphasizing the series of ritual actions that “conjoined in the sacralization of the column of space” (2002:209).

Further, ritual practice and social identity cannot be reconstructed without understanding the taphonomic processes affecting the human remains and burial location. Archaeothanatology, inspired by the French *l'anthropologie du terrain*, studies the biological and social aspects of death from both a taphonomic examination in the field and bioarchaeological analyses in the lab (Duday et al. 2009). This new way of conceptualizing human burials deeply considers human anatomy, decomposition processes, and the natural influences (environmental, floral, or faunal) on the body. A combination of this detailed approach in the field and the bioarchaeological analysis in the lab allows for a deeper understanding of the life history and death history of the individual (Scherer 2017).

Maya Mortuary Space. While Maya mortuary customs were diverse, the majority of Maya burials consisted of complete or partial skeletons in or around residences, temple structures, plazas, and caves. Typically, the body was positioned in extended supine position and flexed (Weiss-Krejci 2006a). This uniformity in mortuary behavior suggests the presence of an ethnic Maya identity, while variations within, such as different body processing methods and body positioning, may suggest regional identities, differences in social status, or changes in ritual through time. For example, cremation was not a typical Maya mortuary practice in the Preclassic or Classic periods, due to Maya cosmology and beliefs of the soul and afterlife (Weiss-Krejci 2006a, 2006b). However, cremation has been found from the Late Classic and Postclassic periods in the northwestern reaches of the Maya region, spreading through the western lowlands and highlands, but not reaching the eastern coast. This regional divide in behavior might indicate ideological, sociocultural, or ethnic differences between the elites of the west and those in the east (Weiss-Krejci 2006a).

Similarly, most Maya individuals were not buried in extended prone position; however, some rare cases have been found primarily in the Belize River Valley from the Middle Preclassic to the Postclassic (Weiss-Krejci 2006a; Novotny 2015). Weiss-Krejci (2006a) suggests that this mortuary behavior may be indicative of a specific ethnic group in the region. When extended prone burials are found in the highlands and lowlands, the consistent mortuary characteristics suggest that a specific group of people with shared beliefs and ideology were present in both regions, but concentrated mostly in the Belize River Valley (Weiss-Krejci 2006a; Novotny 2015).

Maya archaeologists typically were concerned with documenting "'wealth' in the form of grave goods" (Rathje 1970:359) in order to understand sociopolitical organization and social status differences. Welsh (1988:102) evaluated and categorized grave goods based on their type, quantity, and positioning, in order to elucidate any function, whether physical, sociopolitical, or ritual. Bioarchaeologists currently are stepping beyond sociopolitical differences and considering the interplay between the body and the material goods to understand various social identities of the deceased and their descendants. Weiss-Krejci (2006a) emphasizes that while quantity and type of grave good varies for the Maya, the placement, especially in conjunction with other elements of the mortuary behavior, may be interpreted as markers of ethnic (or other) identities. For example, some Maya bodies were covered by vessels, either at the head or the pelvic region, which was a common characteristic for the unusual Preclassic extended prone burials. In this case, the positioning and type of grave good may be a “ethnic marker” of shared beliefs or identity (Weiss-Krejci 2006a:52).

Some Maya scholars believe that the location of tombs under temple-pyramids and residential structures suggested that the Maya lived in “necropolises, which the living were gathered to worship the honored dead” (Coe 1988:234). Others argue that Maya centers were not built as “places of the dead,” but had important, various sociopolitical and economic functions (Welsh 1988:186). Early works examined burial location (ceremonial center or residential area) as indicative of social role and rank- “At death, office holders were buried in the ceremonial center with which they had been associated…those who had not been initiated in ceremonial center activities were interred in their house platform” (Rathje 1970:368).

Maya burials are now referred to as being located in relation to the landscape or to descendants (Ashmore and Geller 2005). For example, some Maya burials are interred in geological caves in mountains, while others are within metaphorical caves buried deep below temples or in *chultuns* in residential areas. These caves represent a liminal boundary between the earthly and otherworldly realms, allowing burial sites to act as locations that transform the deceased and their identities (Ashmore and Geller 2005). Many scholars are reaching back to Coe’s (1988:235) idea that the Maya temples were “house-sepulchers writ large,” as they examine burials in residential areas as representative of “family mountains” (Ashmore and Geller 2005:85).

Novotny (2015) studied the Maya mortuary space of eastern structures in residential zones in the Belize Valley, as well as the act of veneration through tomb re-entry. She concluded that since there was little evidence for physical interaction with human remains via tomb re-entry, veneration was practiced without viewing the human bone as a ritual object (Novotny 2015). Instead, veneration was tied to the geographic location and the architectural structure, such as royal funerary temples or the residential eastern structures. Maya mortuary studies have reached beyond regarding burials as purely a conveyer of social status or a location of reverence; mortuary ritual is now considered "an opportunity for identity and social memory to be constructed, tested, and renegotiated" by the dead and the living (Fitzsimmons and Shimada 2011:2).

Maya Persons: from Body to Ancestor. The Maya believed that the body was constructed of bones, representing the patriline, and flesh or blood, contributed by the matriline (Gillespie 2001). In addition, each person had one or more souls (Gillespie 2002) that "connected them to the ancestors and to the local setting of their social group" (Gillespie 2001:91). Thus, the death of an ancient Maya person involved both a physical or biological death of the body and a social death of the soul or essence of the social person. Personhood of the ancient Maya could extend beyond biological death, with the social life of the individual prolonged through mortuary ritual and tomb re-entry. For example, at Caracol the physical bodies were processed in stages, with the tombs re-entered and the bones removed (Chase and Chase 1996). McAnany (1998) interprets *muknaal* as the ritual event marking of social death, as dates marking this event often fall far beyond the date of biological death of an individual. The volume by Fitzsimmons and Shimada (2011) suggests the continuity of the social body through objects, images, and interactions. Inanimate objects are constructed as animate, as they contain the identity of the deceased or a new imposed character and emphasize the never-ending social life of a person in Mesoamerica.

Even though the person may have physically died, the deceased functioned as indispensable social actors among the ancient Maya. They continued to define social space and had an active role in creating and renewing a multitude of social connections (Fitzsimmons 2011). For example, some royal Maya individuals would possess trophy human bones, not just as reward, but to make the deceased a part of the captor's identity. Further, the captive person would become more powerful by association with the royal person (Fitzsimmons 2011). Both persons are social actors in shaping their own and each other's social identities. At Tikal, deceased elite were politicized and used by the living as a means of reinforcing status (Weiss-Krejci 2011). Mortuary ritual affected the status of the deceased, created new connections between groups, rewrote history, and retrieved social memory. While the living manipulated the dead, the dead build the living.

Ancient mortuary rituals emphasized the liminal aspects of death, connected the living and the dead, and maintained intimate relationships between members of the community, both living and dead. As emphasized in a special issue of the *Archeological Papers of the American Anthropological Association* entitled "Residential Burial: A Multiregional Exploration," scholars around the globe are examining the relationship between prehistoric peoples and their ancestors, as well as the impact that burials had on social relations within residential contexts (Adams and King 2010). In residential areas, the living and dead both occupy the same space; the dead were interred under the floors as the living continued their daily activities. The co-occupation enhanced the sacrality of their living space and allowed descendants to practice rituals at the location of their ancestors' body (McAnany 1998). Further, as the deceased were incorporated into the physical structure of the residence with architectural renovation, the social identities of the both the ancestors and the descendants are renegotiated, altered, and/or confirmed.

Maya Age, Sex, and Gender

With methodological advances in skeletal analyses and theoretical developments in social theory, bioarchaeologists can explore how the constructs of gender and age relate to Maya social and individual identities in the past. Scholars are stepping beyond the traditional estimation of biological age and developmental age to understand ancient Maya bodies within their cultural contexts. In particular, Geller (2005, 2009, 2016) has endeavored to "queer" skeletal analysis and illuminate Maya conceptions of sex and gender. While skeletal analysis delineates the duality of biological sex, ethnographic and iconographic evidence suggests that Maya gender identities included those of a third gender and ritualized cross-dressing (Sigal 2000; Geller 2005). Bioarchaeologists should consider that Maya gender identities were not directly associated with biological sex and may have varied over time, depending on the particular ritual or social role being performed.

One of the more prevalent bioarchaeological avenues for evaluating identities in Maya society is the exploration of the intersectionality of diet, gender, and status. Isotopic studies revealed that elite Maya women consumed fewer ideologically-valued foods than elite males, while non-elite women and men consumed the same (White 2005). This study suggests the relationship between gender and ritual consumption of food associated with social status. Ethnohistorical studies reveal engendered food production, with women serving as cooks, gardeners, wranglers of small animals for meat, and the servers in public rituals (Landa 1998). Private, hand-held figurines, from both elite and non-elite contexts, depict women in similar food production roles (Gerry and Chesson 2002). Spence and White (2009) suggest a future focus on reconstructing Maya women's domestic activities from the physical skeleton, a possible technique to reach beyond mortuary treatment and paleodiet as the primary means of determining the socioeconomic status of women and their roles in food production.

Similarly, Mesoamerican bioarchaeologists have begun to pay particular attention to contextualized age categories (Ardren and Hutson 2006; Joyce 2000, 2006; Ardren 2006; Storey and McAnany 2006; Tiesler 2011; Ardren 2011), with transitions between stages related not just to chronological age, but also biological development or social circumstances. In particular, the Maya infants were attributed age identities based on their developmental abilities, spiritual energy, and personal needs and vulnerabilities (Tiesler 2011). Using rough correlations in *Nahuatl* (an Uto-Aztecan language), Lopez Austin (1989) identified infant age categories that align with the modern and ancient concepts of Maya subadult age identities. In particular, he highlighted the separation between infants who have not yet been weaned and those who had, as well as infants who were beginning to speak (López Austin 1989). Joyce (2000) emphasized how the Aztec perceived infants to not have an identity at birth, until key moments during their life. For older children, there was a shift in age identity around the age of six, when the individuals were expected to assume their gendered societal roles (Ardren 2006). Before this transition, the individuals were not designated based by gender (Tiesler 2011).

The transition to adulthood may have been shaped by social events or personal achievements, not depending only on developmental age. For example, at Teotihuacan, some of the male individuals buried as soldier sacrifices at the Feathered Serpent Pyramid were between 14 and 16 years of age, while some of the female sacrifices were younger, 13 to 15 years at death (Serrano et al. 1991). These sacrificed adult individuals demonstrate how age identities in Mesoamerica are formed at the intersection of social age, gender, and status, not merely by chronological or developmental age.

The Age of Pakal: A Case Study.Perhaps the most well-known study of Maya age identities is explored in Tiesler and Cucina's (2006) volume about the life and death of Palenque's iconic ruler, Janaab' Pakal. This volume shifts the debate over Pakal's age away from the traditional "epigraphy versus bioarchaeology" arguments and presents a more nuanced discussion drawing on multiple lines of evidence. As the goal of this volume was not to reach a consensus concerning his age-at-death, it takes different approaches to the various paleodemographic and paleopathological questions, drawing on decades of fieldwork, lab analysis, and epigraphic research, as well as new analytical methods. Buikstra and colleagues (2006) review the age-at-death controversy, presenting the epigraphic evidence at odds with the conclusions concerning the skeletal anatomy. The early archaeological conclusion (Dávalos Hurtado and Romano Pacheco 1954) concerning Pakal's age-at-death estimated it as between 40 and 50 years old, which was supported by Ruz Lhuillier's (1954, 1973) glyphic interpretation of 39 years and 9 months old. Other translations in the 1970s and subsequent studies by linguists and archaeologists did not support these assertions. Schele and Mathews (1999) argued that, from epigraphic evidence, Pakal died at the age of approximately 80 years old.

Many of the scholars in the Tiesler and Cucina (2006) volume revisit this age-at-death clash and contribute evidence to enhance (and continue) this discussion. Buikstra and colleagues (2006) present Transition Analysis as a viable method for age-at-death estimations. Transition Analysis (Boldsen et al. 2002; Milner and Boldsen 2012) combines observations on standard skeletal indicators such as the pubic symphysis and auricular surface with mathematical modeling of mortality profiles in an attempt to improve on current skeletal aging methods, particularly for older adults. Through using Transition Analysis, Buikstra and colleagues (2006) conclude that it is difficult to determine that Pakal died at age 80, although even their most conservative estimates indicate that he did not die during this fifth decade, but lived on well into his second half-century.

Stout and Streeter (2006) present evidence from a histological study of a rib sample from the remains of Pakal in an attempt to provide answers to the dispute of his age-at-death. This analysis finds consistency with the documented age of 80 years, or in any case, an age much older than the one originally proposed in the 1950s. Grube (2006) also makes a strong argument in support of the veracity of Pakal's life history as recorded epigraphically. He demonstrates that the long life of Pakal was not unique among Maya rulers or in other preindustrial societies such as ancient Egypt.

Márquez and colleagues (2006) take a comparative approach to Pakal's age, employing a detailed paleodemographic and paleopathological study of the known skeletal sample from Palenque. They find that the demographic profile of the mortuary sample at Palenque is that of a young population, with only a few adults living beyond 40 years. They conclude that the 40 to 50 year age estimate originally made by Dávalos and Romano (1954) was more likely than an age of 80.

Hernández and Márquez (2006) also take a comparative approach, examining biological age as estimated from skeletal analysis with ages recorded in monuments for Maya rulers at Yaxchilán. They find multiple cases where epigraphic evidence provides ages at death substantially higher than those estimated from skeletal analysis. The authors seem to accept Dávalos and Romano's (1954) original age estimate and argue that Maya dynastic histories inscribed on monuments should be read with caution. Future scholars might consider that the incongruity between the epigraphic and skeletal evidence supports the interpretation of a constructed social age of Maya in positions of power.

Body Modification: Identity or Behavior?

Cranial and dental modifications were among the earliest foci of Maya bioarchaeological curiosity, perhaps because these alterations are results of the cultural practices that left traces on the human skeleton following decomposition. Initially, scholars (Stewart 1973, 1950, 1941; Romero 1970) created skeletal classification systems of body modifications, simply observing permanent artificial body alterations of the bone and teeth. Now, Mesoamerican bioarchaeologists combine ethnographic and bioarchaeological data to understand further the relationships of social behavior and identity expressed in the practice of Maya body modification (Duncan 2009; Spence and White 2009; Tiesler 1999, 2011, 2012, 2014, 2015).

Temporary and permanent modifications of ancient Mesoamerican bodies may be linked to social behavior and ideological expressions. Temporary modifications, such as hairstyles and body paintings, expressed a range of traditions by constituents of various identities (families, communities, gender, age, status, etc.). More permanent scars, tattoos, and piercings conveyed the social identities (e.g., warrior or king) and behaviors (e.g., mourning or sacrifice) of Mesoamerican bodies (Tiesler 2014). Unfortunately, for bioarchaeologists, the permanent soft tissue alterations are lost to decomposition, leaving only the associated body ornaments, such as ear plugs and labrets, as evidence.

Typically, only the permanent cranial shaping and dental modifications are visible in the preserved skeletal material of Mesoamerica. Because cranial shaping had to occur before the fusion of cranial sutures (in infancy) and permanent dentition were filed and inlayed, both modifications can be tied to specific age identities. Most dental work, filing and inlaying of semiprecious stones, appear in permanent dentition and was widespread by the Classic period in Mesoamerica. Thus, dental modification was obtained by those of an adult age identity and exhibited various degrees of wear or abrasion (Romero 1970), dismissing the idea of a perimortem or postmortem mortuary behavior. Beyond the general tendency for more precious stone inlays to be found in higher status burials, widespread dental modification of the Classic Maya demonstrates individual preference and social behavior, not any type of exclusivity based on identity (Tiesler 2014).

In the New World, cranial modification or head-shaping was an expression of ideology and beliefs, transmitting a type of sociocultural or ethnic identity to the next generation. Scholars debate the intention and causality behind the practice of head shaping: is cranial modification an expression of identity or the result of a behavior? Bioarchaeologists studying the cultures of South America (Knudson and Blom 2009; Torres-Rouff 2009) link cranial modification directly to expressions of social and ethnic identities. Torres-Rouff (2009) argues that individuals in San Pedro de Atacama used cranial modification to affiliate with foreign powers, while others used head shaping to consolidate group identity in later periods of social and economic upheaval. Knudson and Blom (2009) use biogeochemistry to identify migrant identities at Chen Chen, contrasting the local ethnic identity demonstrated by their cranial modification and mortuary behavior.

In Mesoamerica, however, identities may have been expressed in the behavior, while the permanent bodily modification was merely a physical result. Some Mesoamerican scholars (Duncan 2009; Tiesler 2011, 2012, 2014) argue that the head shaping was a secondary and perhaps unintentional result of a performance or religious practice to protect the soul of a susceptible child. Duncan (2009) argues that these religious practices had no direct intention of modifying the appearance of the individual and that head binding may have been only one technique to protect the Maya children. This interpretation acts to explain the presence of unmodified crania at Maya sites, where children were being protected through a behavior that did not leave permanent skeletal alterations. While not purposefully altering the infants' appearance to emphasize a particular identity, this practice may be the result of specific ethnic beliefs passed on from one generation to another, and thus imbuing an ethnic identity unintentionally.

Ancient DNA and Maya Identity

Many scholars consider DNA analysis to be a welcome addition to the pool of methodology for understanding ancient identities (Merriwether et al. 1997; Spence and White 2009). Unfortunately, very few studies have successfully used DNA analysis within Maya bioarchaeological studies. Merriwether and colleagues (1997:210) compare mtDNA samples from the ancient Maya of Copan with a collection of RFLP (restriction fragment length polymorphism) data defining the "four founding lineage haplogroups in nearly 2000 individuals from 27 contemporary and 3 ancient New World populations". They find a discrepancy between the frequencies of ancient and contemporary Maya, which may be caused by admixture in the contemporary populations with non-Maya native groups. They emphasize the many limitations of DNA studies of ancient remains, but are very glad that many more ancient Maya populations are being surveyed for DNA analysis and they encourage future archaeologists to consider the use of ancient DNA as a tool for examining human prehistory.

De La Cruz and colleagues' (2008) analysis should act as an example to emulate in future Mesoamerican studies. They were able to extract ancient DNA the sacrificial victims at Temple R of Tlatelolco to reveal their biological sex and used the analysis to come to understand ancient ceremonies and traditions of the Aztecs. Most of the victims were males, which is consistent with the notion that the victims chosen for sacrifice were a living impersonation of the god to whom they were offered (De La Cruz et al. 2008).

Further, the children were selected to personify deities because they epitomized the purity to communicate propitiously with the gods and obtain their favor. While poor preservation definitely complicates the extraction of viable DNA from Mesoamerican samples, this analysis provides hope that soon DNA analysis will successfully be included in the long list of complementary methods used in bioarchaeological analysis.

Maya Osteobiographies and Life Histories

As previously mentioned, Saul (1972) published one of the first osteobiographies of Maya individuals in his bioarchaeological report from Altar de Sacrificios. Maya bioarchaeologists have continued this trend, integrating skeletal analysis, mortuary analysis, bone chemistry, material culture, inscriptions, and monumental architecture to gain a more complete life history of Maya individuals. Most scholars (e.g., Buikstra et al. 2004; Tiesler and Cucina 2006; Price, Burton, et al. 2006; Tiesler et al. 2007) constructing life histories have focused on those of specific elite Maya individuals or others in unusual burial contexts (e.g., sacrificial victims). As more individuals are analyzed, bioarchaeologists can move beyond the life histories of the kings and the sacrificed, towards an understanding of Maya life courses, whether in the temporal scale (e.g., genetic or generational) or the geographic scale (e.g., household, barrio, elite vs non-elite, city, etc.).

Buikstra and colleagues (2004) follow Saul's (Saul and Saul 1989) holistic life history approach to understand seven historically-known individuals excavated from within the Copan acropolis, including K'inich Yax K'uk' Mo', the founder of the Classic period dynasty at the site. Through a combination of physical (osteological) analysis and isotopic analysis, the scholars reconstruct Early Classic life and the personal history of significant individuals. K'inich Yax K'uk' Mo' did not originate from the west, as previous interpretations of material culture suggested, but instead spent his developing years in the north (Buikstra et al. 2004). His long life included instances of violence, either of conflict or ritual nature, and the modification of his dentition demonstrated his identity as an elite. Further, this approach allowed the authors to critique written dynastic records, as the Margarita individual (Burial 93-2) was estimated to be a female of advanced age. The life history approach allowed the authors to holistically gain a more complete osteobiographical picture of Early Copan's political, social, and economic history, as well as the "humanity of its residents" (Buikstra et al. 2004:212).

As mentioned previously, Tiesler and Cucina (2006)'s *Janaab' Pakal of Palenque* is a presentation of the life history of Pakal and other royals of Palenque such as The Red Queen. By drawing on multiple lines of evidence and using new analytical methods, the contributors to this volume evaluate the life and death of Pakal and offer innovative approaches to a biocultural and interdisciplinary reconstruction of Palenque's dynastic history. The myriad of approaches for estimating Pakal's age-at-death, as outlined above, represent the final component of Pakal's life history, his death, while others present inventive approaches to reconstruct the history of his life and that of the dynasty.

By presenting a pathological analysis of Pakal's skeleton and refuting claims that Pakal had congenital defects such as clubfoot and polydactyly, Romano (2006) emphasizes not only the life history of Pakal, but his life course, alluding to his family genetics and the lives of his ancestors. To understand Pakal's residential history during his lifetime, Price and colleagues (2006) measured the strontium isotope ratios from dental enamel (representing the geography of his late childhood) and bone (representing the geography during the last few years of life). The isotopic signatures confirm the iconographic presentation of Pakal as local to the region, suggesting he was in or around Palenque from his late childhood to his death. Further, dental enamel isotopic signatures indicate that "the Red Queen" was most likely born in the region around (and including) Palenque (Price, Burton, et al. 2006), allowing for understanding of the life history (and marriage) of a female noble or elite bride.

The life history approach demonstrates how Maya bioarchaeologists integrate skeletal analysis, material culture, inscriptions, and monumental architecture to gain an osteobiographical picture of individuals from the past. With these considerations of identity, Maya bioarchaeology has successfully moved beyond the study of human remains into an in-depth examination of these remains as active populations and as social beings with incredibly complex identities. Following the global sphere's trajectory of the bioarchaeology of the individual, some Maya scholars (e.g., White et al. 2009) further argue for the movement from traditional osteobiographies to that of social biographies or life-course studies of identity. By stepping beyond the reporting of an individual's osteological data, Maya bioarchaeologists can begin to understand the experiences of life and death within social and historical contexts.

Chapter Summary

In this chapter, I presented an in-depth review of how the theoretical frameworks of the bioarchaeology of identity, bioarchaeology of health, diet, disease, and stress, and the bioarchaeology of migration and mobility have been applied in Mesoamerican archaeology, especially within the Maya region. I began with the most popular topics in Maya archaeology, such as trauma, sacrifice, cannibalism, and the collapse, and how bioarchaeology has contributed to the understanding of these subjects. This review was followed by that of more recent multi-disciplinary studies of Maya identities, those that combine skeletal analysis, mortuary analysis, bone chemistry, material culture, inscriptions, and/or monumental architecture in order to understand the Maya life course. This dissertation project will move beyond the osteobiographies of significant elite individuals, and will provide an in-depth examination of Maya human remains as active populations and as social beings with incredibly complex identities.

CHAPTER 5: BIOARCHAEOLOGICAL METHODOLOGY

For each individual included in this study, a comprehensive bioarchaeological evaluation was undertaken, formulating their distinct biological profile in conjunction with their mortuary analysis. The osteological information was compiled following the guidelines established in Standards for Data Collection from Human Skeletal Remains by Buikstra and Ubelaker (1994), as well as those established by the Arizona State Museum and the University of Arizona. Following the comprehensive inventory and photo documentation, human remains of each individual were evaluated for estimated age-at-death, biological sex, antemortem or perimortem trauma, body modification, pathology, and dental health. While the preservation of skeletal remains is not always ideal, in most cases, it is possible to compile nearly a complete biological profile.

In order to elucidate the mortuary behavior from the burial context of each individual (i.e., the burial type, burial manner, burial location, grave construction, burial orientation/positioning, and associated burial goods), the associated documentation and artifacts were examined. This data was gathered through investigation of the Holmul Archaeological Project (HAP) archives in their Guatemalan laboratory, as well as in the archives of the Peabody Museum. Field notebooks, burial drawings, and photographs were studied to determine the mortuary behavior associated with each individual. This project follows the classification system and specific terminology solidified by Welsh (1988) as the foundation for the mortuary analysis of this project.

Inventory of Skeletal Remains

To inventory each individual, their skeletal remains were carefully examined to assess which bones or elements are present and their state of preservation. The results of this assessment were recorded in spreadsheets inspired by the recording forms of Arizona State Museum/University of Arizona and in the database program *Osteoware*. *Osteoware* was developed in 1998 in conjunction with the Repatriation Osteology Lab of the National Museum of Natural History, Smithsonian Institution.

The inventory is organized categorically, beginning with the cranium and working inferiorly. The categories of the inventory are as follows: "Cranial" including the skull, dentition, and hyoid; "Axial" including vertebrae, sacrum, sternum, and ribs; "Appendicular" including scapulae, clavicles, ossa coxae, patellae, and long bones; and "Extremities" including both hands and feet. Each category is organized into "left" and "right" columns for the documentation of the anatomical positioning of each documented bone or element. For long bones, each is evaluated by segment: proximal epiphysis ("epi-p"). proximal 1/3 of shaft ("prox"), middle 1/3 of shaft ("mid"), distal 1/3 of shaft ("dist"), and distal epiphysis ("epi-d").

The bone, element, or segment receives a score of "f", "p", "c", or "x". The score of "f" refers to a fragmentary preservation of 1-25%. The score of "p" indicates the partial preservation of 25-75%. A "c" represents a complete bone, element, or segment with 75-100% preservation. The score of "x" indicates that the bone, element, or segment was not present to be inventoried. Each score is accompanied by notes concerning the state of preservation and highlighting any visible paleopathology that would impact morphological or metric evaluations.

Estimation of Age-at-Death of Adults

Following the comprehensive inventory of the skeletal elements and determination of their preservation, age-at-death of each individual was estimated macroscopically. Macroscopic analysis is faster and less destructive than microscopic methods of scoring age (Ubelaker 1999). For adult individuals, pubic symphyses were observed (Todd 1921; Brooks and Suchey 1990), auricular region of the ilium analyzed (Lovejoy, Meindl, Mensforth, et al. 1985), and cranial suture closure evaluated (Meindl and Lovejoy 1985). These analyzes, in conjunction of a consideration of their accuracy and precision, as well as details of the source data and reference population, allow for an age-at-death estimation. These estimations are conveyed as a possible age range: a "young adult" was estimated to be 20 to 35 years at death, a "middle adult" 35 to 50 years at death, and an "old adult" 50 or more years at death (Buikstra and Ubelaker 1994).

Transition Analysis (Boldsen et al. 2002) aims to combine multiple skeletal indicators of age to most effectively describe any morphological variation due to age. Overall age estimates are calculated by combining the likelihood distributions of three features scored: the pubic symphysis, auricular surface, and cranial sutures (Milner and Boldsen 2012). Milner and Boldsen (2012) concluded that Transition Analysis confirms that the pubic symphysis is the most reliable age indicator and the sutures are the least (of the elements commonly scored). They found that Transition Analysis can narrow the confidence intervals for individuals older than 50 years of age. Unfortunately, due to the lack of access to the computer software (ADBOU) required, the fragmentary remains of this study, and few individuals possibly over 50 years old, Transition Analysis was not employed in the study, but will be considered in future iterations.

Estimation of Adult Age-at-Death from the Os Coxae

The pubic symphyses are the first elements of the adult skeleton analyzed. The symphyses are useful for estimating age-at-death since surfaces continue to change after full adult stature has been reached and the fusion of long bone epiphyses has completed (White et al. 2012). The pubic symphyses of each individual (when present and preserved) were scored using the method developed by T.W. Todd (1921) from a sample of 306 males of known age-at-death. Todd highlighted ten phases of symphysis age from examining the billowing, nodules, and texture of four areas of the feature: 1) the ventral border, 2) the dorsal border, 3) the superior extremity, and 4) the inferior extremity. He also emphasized that his phases were more reliable between 20 and 40 years than after 40 years (White, 2000). To assist in the scoring of each individual's pubic symphysis, detailed descriptions and drawings of examples (White et al. 2012; Buikstra and Ubelaker 1994) from each stage were consulted.

Todd's phase system became the foundation for the later methods developed by McKern and Stewart (1957), Brooks and Suchey (1990), and others. These later methods emphasized differences in the metamorphosis of the symphyseal surfaces between males and females, a distinction ignored by Todd (Ubelaker 1999). Further, Todd's method was found to have standards that overestimated the age of females (Ubelaker 1999). For female individuals within this study, this overestimation has been acknowledged and checked using other age assessment methods.

The Suchey-Brooks Method is an additional age-at-death assessment method that was employed in this study to supplement the estimations from Todd's system. This secondary method was developed and revised by Brooks and Suchey (1990) inspired by Todd's phase system. Brooks and Suchey (1990) determined six phases of the pubic symphyses where the descriptions can be applied to both males and females, but separate visual comparisons (drawings) were made for each sex. While this method is considered more accurate and precise (White et al. 2012), it also has fewer phases, causing a large amount of variation within each phase. For this project, age-at-death assessment employing the Suchey-Brooks Method was aided by the drawings and descriptions found in White and colleagues (2012) and Buikstra and Ubelaker (1994). Plaster casts of the different phases of pubic symphysis development were also consulted.

The auricular region of the ilium can also reflect age-related change, but they are more complex and difficult to score than the pubic symphysis, which increases the intra- and inter-observer error for scoring methods (White et al. 2012). The auricular scoring method used in this study was developed by Lovejoy and colleagues (1985) from a sample of the Todd Collection. The method observes and scores various changes to the auricular region, including those on the apex, the superior demiface, the inferior demiface, and the retroarticular area. These changes include the granularity of the surface, density of the bone, and its degree of porosity. The Lovejoy Method employs eight phases to classify these various changes to the auricular surface and retroarticular area.

There are numerous benefits to assessing the auricular region for age-at-death estimation. Because of the inferior positioning of auricular surfaces within the human body, they tend to have better preservation in archaeological and forensic contexts (Buikstra and Ubelaker 1994; White et al. 2012). Further, the changes to the auricular surface continue past the age of 50 years, which allows for the refinement of Todd's final "50+" category. In addition, Lovejoy's method appears not to be affected by ancestry or sex (Buikstra, personal communication, 2014). While there are numerous benefits for employing Lovejoy's method, the possibility of estimation errors enforces its use in this study in conjunction with the multiple additional scoring methods mentioned.

Estimation of Age-at-Death from the Cranium

Cranial suture closure has been employed as an age-at-death estimation tool since the 1500s, until the assessment methods of the ox coxae were proved to be more accurate in the mid- 1900s (White et al. 2012). Meindl and Lovejoy (1985) developed an in-depth method for scoring cranial suture closures, using 17 points on the ectocranium and endocranium. They scored the sutures as follows: 0 (open), 1 (minimal closure), 2 (significant closure), and 3 (complete obliteration). The scores are added together in two groups, vault and lateral-anterior, to calculate "composite scores" that have associated age ranges and mean age values (Meindl and Lovejoy 1985).

Meindl and Lovejoy (1985) concluded that the lateral-anterior sutures were more reliable than the sutures of the vault and that the ectocranial sutures are superior to the endocranial sutures. Further, they found that the age estimates are independent of race and sex for this method. But they caution that suture closures should be used in conjunction with other skeletal age indicators. Cranial suture closures are considered the least accurate of the aging techniques, although sometimes the only method able to be used when the rest of the body is poorly preserved or not recovered (Buikstra, personal communication, 2014). Boldsen and colleagues even go as far as to say, “We include sutures in our analyses because isolated crania are often found in forensic and archaeological work, and we must do something with them” (2002:74). In this study, they are included but only relied on when the os coxae is not available for a specific individual.

Estimation of Age-at-Death of Juveniles

Estimating age-at-death of a juvenile individual is more complicated as it involves creating minute age ranges or age classes to further divide the period of human growth (White et al. 2012). This study follows the terminology used by skeletal biologists in continental Europe, with “Infans I” covering the period of birth to four years, “Infans II” referring to ages five to 14, and “Juvenile” as 15 to 22, around when the spheno-occipital synchondrosis closes (Martin and Saller 1957). It is always best to present the age-at-death estimation in addition to the age class. To estimate the age-at-death of an infans or juvenile individual, the dental development was considered (Ubelaker 1999; Logan and Kronfeld 1933; Moorrees et al. 1963; Smith 1991), ossification and epiphyseal union evaluated (Scheuer and Black 2000; Ubelaker 1999), and long bone diaphyseal lengths measured (Fazekas and Kósa 1978; Ubelaker 1999). In order to estimate age-at-death as accurately as possible, a comprehensive approach was employed, considering all possible evaluation criteria and paying particular attention to the differences in reliability between methods. Further, it is important to consider that the various methods are estimating the developmental and not chronological age-at-death of the individual (Hillson 1996).

Estimating Age-at-Death from Dental Development

The age-at-death of infans and juvenile individuals in this study are first estimated considering the methods that regard dental development. Primarily, two aspects of dental development have been used as indicators of estimated age-at-death: mineralization of the crowns and roots and eruption of the teeth (Scheuer and Black 2000; Ubelaker 1999). Mineralization and formation may be less affected by "intrinsic and extrinsic conditions" than dental eruption, which could be more influenced by nutrition or environmental conditions (Scheuer and Black 2000).

A terminological problem arises concerning the "eruption" of dentition. Eruption involves the movement of the tooth from alveolar bone to the occlusal level (Scheuer and Black 2000). Occlusal interaction of teeth, and thus eruption, may be interpreted from wear on the occlusal surface of the teeth in contact. Clinically, eruption is defined as the point when the tooth pierces the gum or rising above the surface of alveolar bone (Scheuer and Black 2000). When using reference material to estimate age-at-death of sample individuals, attention must be paid to the definition of eruption used by the reference author(s). Evaluating mineralization is less complicated, as mineralization can be observed throughout the life-time of the tooth, while eruption is a single event of unknown exact time and conflicting definition (Scheuer and Black 2000). Mineralization can be more difficult to observe from dry bone unless the alveolar region is fractured, allowing the researcher to determine the extent of crown formation and root development. Radiographic methods can be used to avoid this problem.

Dental age estimation has several advantages over the evaluation of skeletal age-at-death (Scheuer and Black 2000), especially for individuals between birth and 10 years of age (Ubelaker 1999). The dentition tends to preserve well in various inhumation contexts and is more readily available in skeletal assemblages where crania were the only skeletal element preferred and recovered. Dental age is considered more accurate and reliable than skeletal age and more widely used, as the dentition is under tighter genetic control (White et al. 2012). Most deciduous dentition mineralize and develop during the prenatal period and may be less altered by environmental or other external conditions (Scheuer and Black 2000).

One of the earliest methods developed for estimating infans and juvenile age-at-death from dentition was based on a histologic and roentgenologic study by Logan and Kronfeld (1933). Logan and Kronfeld (1933) aimed to understand the underdevelopment of the jaws and irregularities of teeth, examining 25 human jaws ranging from birth to 15 years of age-at-death (Hillson 1996). Each deciduous and permanent tooth developed and available for analysis was evaluated for enamel formation and completion, tooth eruption, and root completion. Using each tooth, an age range was estimated, with the lower limit from the most recent event to have been achieved and the upper limit from the next event that would have happened but was impeded by death. Due to the minute sample size, the various causes of death, and the unknown background of the children, the method of Logan and Kronfeld (1933) was used until new estimation techniques were developed in the 1960s and 1970s. For this project, the method of Logan and Kronfeld (1933) is considered secondarily to these newer methods and only for confirmation of an estimation of age-at-death.

Logan and Kronfeld's study was revised by Schour and Massler (1941), which was in turn revised by Ubelaker in 1978. Ubelaker adjusted developmental age ranges to consider the timing of dental formation and eruption from 16 published datasets of Native Americans and non-Native Americans (see Ubelaker, 1999: 63 for a complete list of sources). For this project, Ubelaker's developmental chart from the 1999 edition of *Human Skeletal Remains: Excavation, Analysis, Interpretation* is relied upon heavily for estimating age-at-death of infans, juvenile, and young adult individuals. Ubelaker's 21 depictions display estimated mineralization and eruption of deciduous and permanent dentition from in-utero to 35 years of age. Each stage depicted is accompanied by an age estimate and a "± factor" widening the estimated age range in some cases as much as ±3 years. These large, estimated age ranges overlap in many instances and are considered more accurate due to their extensive span. While the compilation for this chart was derived from both Native American and non-Native American references and males and females, this chart is widely used and considered a reliable standard for estimating age-at-death for non-white juvenile individuals.

Moorrees and colleagues (1963) developed additional standards for estimating age-at-death from large samples of radiographs of North American white children. These standards were adapted by Smith in 1991 for easier implementation. Moorrees and colleagues (1963) developed coded stages defined by formation of the crown and root of the dentition (Moorrees et al. 1963; Ubelaker 1999). They compiled means and standard deviations for dental development, estimated for each tooth separately, allowing for comparison of the maturation of different teeth of the same individual (Moorrees et al. 1963). They presented their results as graphs, which are difficult to use for age estimation (Hillson 1996). Smith (1991) scaled the mean ages for each stage of each tooth and from these calculated an overall mean age. For this study, Moorrees and colleagues' (1963) codes and Smith's (1991) mean age ranges for only the mandibular molars are estimated to conserve time and for consistency. As is the case with the other standards developed for estimating the age-at-death of infans and juveniles from dental development, these codes and mean age ranges should be used in conjunction with the various aforementioned methods for increased accuracy.

Estimation of Age-at-Death from Ossification and Epiphyseal Union

Because epiphyseal ossification and union occur at specific ages for specific bones, the observations of ossification and fusion of epiphyses to diaphyses can be used for estimating age. The method is particularly useful for estimation of age-at-death between 10 and 20 years when the dental methods and long bone diaphyseal length methods are less reliable (Ubelaker 1999; White et al. 2012). Once again, applicable reference sources are essential, as ossification and fusion age estimations can vary by individual, sex, population, and method of observation (White et al. 2012). Further, these methods require the preservation of ossifying epiphyses in order to determine if they have “appeared” but have not yet fused. Further, many of the ossification centers have “appeared” but are not yet recognizable and require associated soft tissue to hold them in anatomical position (Scheuer and Black 2000). The preservation and identification of the epiphyses are more likely in forensic investigations than archaeological contexts, where they may not be preserved or collected during excavation.

Nearly all of the research on postnatal ossification was gathered from systematic, non-repeatable, longitudinal radiological studies of mostly white, middle-class children between 1930 and 1960 (Scheuer and Black 2000). This compilation of growth data was originally meant for clinical purposes and thus is more generally applicable for radiological or forensic investigations. In comparison to these longitudinal studies where individual growth differences within a population can be discerned, cross-sectional data collection requires a single measurement or set of measurements for each individual, allowing the studies to include larger numbers of participants and to determine how an individual has developed in comparison with the mean for that age group (Scheuer and Black 2000).

Scheuer and Black (2000) present the developmental ages using terms such as “childhood” and “adolescence,” which roughly correlate to the skeletal biological terms of Infans and Juvenile. Most of the portions of the sphenoid, temporal, and squamous occipital bones fuse before birth, while the other portions of the occipital and the vertebral centra and arches fuse during early childhood (Infans I) (Scheuer and Black 2000). During later childhood (Infans II) and adolescence (early juvenile), the components of the sternum, scapula, and pelvis fuse, and later during adolescence (late juvenile), the epiphyses of the major long bones, those of the hands and feet, and the spheno-occipital synchondrosis fuse (Scheuer and Black 2000). Following adolescence (young adult), the secondary centers of ossification of the vertebrae, scapula, clavicle, sacrum, and pelvis fuse (Scheuer and Black 2000). The more reliable indicators of developmental age are the proximal humerus, medial epicondyle, distal radius, femoral head, distal femur, iliac crest, medial clavicle, sacrum ¼ joint, and lateral sacral joints (Ubelaker 1999).

The fusion of the secondary ossification centers or union of epiphyses is easy to observe if the bones are complete. With fragmentary remains, such as in some archaeological contexts, the ends of long bones and their associated epiphyses may not be preserved or present and it is impossible to determine if they have fused or not. The non-fused diaphyseal surface is characteristically rough and irregular and easy to identify as fused or not (Ubelaker 1999). If the epiphyses are not present, but the diaphyses have non-fusion surfaces, it can be determined that fusion has not transpired, but not definitively if the ossification of the epiphyses has occurred. In these cases, it is easier to determine the older end of an age range, but not the earlier limit.

The reported ages of ossification and fusion are very variable, as the degree of variability increases with sex, age, and with the different methods used to observe the appearance and fusion of epiphyses (Scheuer and Black 2000). Intra- and inter-observer errors increase as the development and fusion is separated into various stages, as well as from observational differences between dry bone and radiographic evaluations. The "fusion" using dry bone usual refers to the fusion at the periphery of the junction, while “fusion” observed in radiographs is noted from the center of the epiphyseal plate (Scheuer and Black 2000). Further, all of the studies of ossification and fusion document marked sexual dimorphism, as appearance and union of epiphyses occur earlier in females than males (Ubelaker 1999; White et al. 2012). As mentioned previously, if the biological sex of the individual is not known, the age range estimate must be widened to consider the early female trends and later male trends. This broadening of the age range increases accuracy, but limits the precision possible if the sex was known. Multiple additional methods, hopefully dental in nature, should be used in conjunction in order to refine the estimated age range.

Estimation of Age-at-Death from Long Bone Diaphyseal Length

Diaphyses have been measured from fetuses, dry bone, radiographs, and ultrasounds, creating a relatively large database for age estimations from diaphyseal length (Scheuer and Black 2000). Because of the variability of growth rates and the primary reference source of living children, utilizing this method on dry bone is not ideal. Any references of skeletal remains have derived from archaeological or forensic material where the age-at-death was estimated using dental development observations and compounding any errors (Ubelaker 1999). White (2000) suggests that estimating age from long bone length should only be used in the absence of dentition and when the reference source is from the same or closely related sample. Diaphyseal length should be considered secondary to dentition because long bone formation is more likely to be affected by environmental and social circumstances, such as nutrition or disease (Scheuer and Black 2000).

For this study, as secondary to the age-at-death estimation from dentition, the method regarding long bone diaphyseal length of Ubelaker (1999) is employed. He used a sample of proto-historic Arikara from South Dakota to estimate age ranges from measured long bone diaphyses (Ubelaker 1999). He argues that the Arikara data are more accurate than other available data, because they were based on the most accurate method of age estimation from Moorrees and colleagues' (1963) standards (Ubelaker 1999). To use Ubelaker's (1999) methodology, measurements of long bone diaphyses (without fused epiphyses) and the width of the ilium fall within ranges of variation that correspond to estimated age ranges. Ubelaker (1999) warns that these standards should be applied to other remains of the Arikara or related Native American tribes, but any population can be compared, as long as the variability between populations is considered. A further limitation of this method includes that the Arikara sample size dramatically decreases with increasing age, as epiphyseal union limits the age estimates from long bone diaphyses of older juveniles. As with the other methods described, in order to estimate juvenile age-at-death as accurately as possible, a multifactorial approach is employed for this project, considering all possible evaluation criteria and paying particular attention to the differences in reliability between methods.

Estimation of Biological Sex

Because of the inability to estimate biological sex for most juvenile remains (Scheuer & Black 2000), the adult individuals solely were evaluated for morphological features indicating biological sex. The dimorphic features of the os coxae are considered the most reliable for estimation of sex in the skeleton (Buikstra and Ubelaker 1994; Phenice 1969), with cranial morphology (Ubelaker 1999; Buikstra and Ubelaker 1994) considered secondarily and finally, long bone metrics. These methods of estimation were considered with attention paid the accuracy and precision of each technique.

Estimation of Biological Sex from the Os Coxae

To evaluate the os coxae for morphological dimorphism, the structures observed and scored include attributes of the subpubic region, greater sciatic notch, and presence of a preauricular sulcus (Phenice 1969; Buikstra and Ubelaker 1994; Walker 2005). For the subpubic region, the structures and features scored include the ventral arc, subpubic concavity, and ischiopubic ramus ridge. The positive expressions of these features support the conclusion of possible female sex and the absence of these features indicate possible male sex. Phenice (1969) presented this visual scoring system to allow researchers to evaluate accurately the os coxae for biological sex with fragmented remains. Phenice (1969:300) concluded that the ischiopubic ramus ridge is the most likely to present ambiguous attributes (i.e., is the least reliable indicator) and the ventral arc is least likely to be ambiguous (i.e., is the most reliable).

The greater sciatic notch is most commonly broad in females and narrow in males, but should not be used as the sole indicator because the shape may be altered due to certain developmental or pathological factors (Buikstra and Ubelaker 1994; Walker 2005). The score of "1" represents typical female morphology (narrow) and the score of "5" is more masculine. The preauricular sulcus is considered more commonly present in females than males (Buikstra and Ubelaker 1994). The score of "1" indicates a wide and deep sulcus, “2” is a wide but shallow sulcus, “3” is a well-defined but narrow sulcus, and “4” is a narrow, shallow, and smooth-walled depression. A “0” indicates the absence of any sulcus or depression. For this study, a combination of all the os coxae scores is considered in order to estimate sex from the pelvis.

Estimation of Biological Sex from Cranial Morphology

Cranial morphology is a less reliable basis for sex estimation compared to the morphological evaluation of the os coxae (Ubelaker 1999). Because of the fragility of the pubis, cranial morphology can be helpful in the absence of os coxae. While males tend to have more robust skulls than females, populational variation is common and can make scoring the skull difficult (Buikstra and Ubelaker 1994). To combat this challenge, the observer should be familiar with the overall trends for the population in question. Size, shape, and robusticity are scored to estimate sex of the individual. The robusticity of the nuchal crest, the size and volume of the mastoid process, the sharpness of the supraorbital margin, the prominence of glabella or supraorbital ridge, and the projection of the mental eminence are evaluated independently to estimate sex. A combination of all the cranial scores is considered in this project to estimate biological sex.

The age of the individual may also affect the appearance of dimorphism. Adolescent os coxae with typical female features can be determined to be female, but a male pattern may represent a female who has not yet developed the female diagnostic characteristics (Buikstra, personal communication, 2014). Also, male skulls presenting male characteristics can be more confidently determined to be male because a gracile skull may in fact be from a male individual not fully developed (Buikstra, personal communication, 2014). Further, there is a tendency for both male and female skulls to demonstrate increasingly masculine morphology with age (Buikstra and Ubelaker 1994; Walker 1995).

Estimating Biological Sex from Long Bone Discriminant Functions

While the morphological assessment of the os coxae is considered the most accurate method for estimating biological sex (Buikstra and Ubelaker 1994), there are many instances when preservation complications hinder any observations and conclusions. Metric analyses using discriminant functions are an option when certain elements (e.g., femur, humerus, clavicle, etc.) are complete and have little postmortem damage. As previously mentioned, difficulties in scoring and interpreting morphological features arise due to variation between human groups; very few morphological features are conclusive no matter the population. The same issue arises with metric analysis, as there are differences in osteometric dimensions among various populations (Stojanowski and Seidemann 1999). Ideally, morphological standards and metric discriminant functions should be used that were derived from populations spatially and temporally nearby. This limitation can be unsurmountable in some cases where standards have not been developed and this problem must be clearly stated within the interpretations of biological sex estimation.

For the very few cases where a bone is preserved in its entirety in this project, I have used the discriminant function computations compiled by Bennett (1993:31–33) with an addition of the function for the talus by Steele (1976), presented in Table 5.1. In order to estimate biological sex, multiply the measurements by their associated coefficients and add the constant (Equation 5.1). Positive scores suggest the biological sex of male, while negative scores suggest female.

(measurementA*coefficientA)
+
(measurementB*coefficientB)
+
(measurementC*coefficientC)
+
Constant
=

Equation 5.1 Discriminant function computation.

For the talus, no constant is used, instead sums greater than 38.75 are estimated male, while less than 38.75 are female (Steele 1976).

Complete Bone	*Measurement*	*Coefficient*	*Constant*
Clavicle	Maximum length	0.21545	
	Sagittal diameter	1.05177	
	Vertical diameter	1.00953	
			-54.61590
Scapula	Height	0.71308	
	Breadth	0.21072	
			-47.61600
Humerus	Epicondylar breadth	0.43094	
	Head diameter	0.61052	
	Midshaft minimum diameter	0.80929	
			-67.18340
Radius	Midshaft sagittal diameter	1.96059	
	Midshaft transverse diameter	0.66338	
			-33.01220
Ulna	Dorso-volar diameter	0.75367	
	Transverse diameter	1.26974	

			-28.60770
Femur	Epicondylar breadth	0.45623	
	Midshaft AP diameter	0.61152	
	Midshaft ML diameter	0.57968	
			-50.56670
Tibia	Distal epiphyseal breadth	0.44964	
	Maximum diameter nutrient foramen	0.44866	
			-37.66930
Calcaneus	Maximum length	0.28425	
	Middle breadth	0.28269	
			-35.19680
Talus	Maximum length	0.42002	
	Maximum width	0.41096	

Table 5.1 Discriminant function coefficients for estimating biological sex (adapted from Bennett 1993 and Steele 1976).

Paleopathological Evaluation

The description, evaluation, and differential diagnosis of osteological and dental pathologies allow for a deeper understanding of the lives of the individuals sampled. More recently, paleopathological investigations have emphasized precision instrumentation and new biochemical and biomedical techniques, such as DNA analysis and radiographic imaging, but macroscopic evaluation remains the primary means to assess skeletal pathology (Grauer 2008). Prior to any pathological evaluation, the researcher must estimate the age-at-death, biological sex, and any population, temporal, or geographic context available for the individuals in question (Ortner 2003). These variables could have profound influence on the evaluation, as certain diseases may impact particular age groups, ethnic populations, or geographic locations.

Following this initial demographic assessment, the researcher must conclude if any of the observed bone changes were the result of antemortem pathological processes or were due to postmortem changes from the burial environment, taphonomic processes, or excavation mishaps (Ortner 2003; Pokines and Symes 2014). Antemortem destruction of bone tends to result in smooth or rounded edges (due to the active bone repair) and reactive bone at lesion margins, while postmortem destruction tends to manifest with linear, jagged edges (Ortner 2003). Postmortem damage (i.e., from a shovel) would expose bone lighter in color that did not have as much time to absorb minerals from the soil (Pokines and Symes 2014). Antemortem, reactive bone may also have a different coloration than the normal bone as, for example, woven bone interacts with the soil differently (Pokines and Symes 2014). By considering the shape of the bone changes in conjunction with the coloration, the observer can estimate if it is the result of antemortem or postmortem processes.

For the changes determined to be due to antemortem processes, the researcher must undertake an evaluation to determine and reconstruct the nature of the pathological processes active on the skeletal remains of the individuals. The first step is to conduct an extensive, in-depth descriptive documentation of all the skeletal elements available for examination (Grauer 2008). The descriptions should include specific identification of the location and distribution of the bone changes and extensive descriptions of these features. The specific location of the bone changes within a skeletal element, as well as the distribution within the entire skeleton, can allow for a more accurate diagnosis of archaeological remains (Ortner 2003). This descriptive inventory ensures future researchers can access the data if the skeletal material is unavailable, and is critical to the eventual differential diagnosis of the pathological changes, as missing bones or elements may prove consequential for narrowing possible pathological conclusions (Ortner 2003).

The second step in the evaluation is to understand the nature of the antemortem pathological processes altering the skeletal elements. Buikstra and Ubelaker (1994) outline nine categories to use in this evaluation: 1) shape abnormalities, 2) size abnormalities, 3) bone loss, 4) abnormal bone formation, 5) fractures and dislocations, 6) porotic hyperostosis/cribra orbitalia, 7) vertebral pathology, 8) arthritis, and 9) miscellaneous conditions. Ortner (2011b) emphasizes the utility of focusing on the first four of these categories. For this study, the paleopathological analysis utilized the detailed descriptions of Aufderheide and Rodriguez-Martin (1998), Ortner (2003), and Waldron (2009). Most occurrences of antemortem trauma were evaluated within the 5th category (fractures and dislocations), but consideration was also paid to evidence of nerve or blood supply disruption and evidence of intentional body shape modification (Ubelaker 1999; Buikstra and Ubelaker 1994). Further, due to the preservation of and the emphasis on the dentition within this study, a specific macroscopic evaluation of any dental pathology was conducted following the descriptions of Hillson (1996, 2005).

Basic Skeletal Abnormalities (Size, Shape, Loss, and Addition)

Abnormal morphologies can be categorized as abnormal bone addition (formation), abnormal bone destruction (loss), failure to form or replace bone, and failure to destroy bone (Ortner 2003). Osteolysis refers to localized bone destruction that changes the shape of the element involved, while osteopenia is a general loss of bone quantity and osteoporosis is a normal quality of bone with a subnormal quantity (Ortner

2003). Abnormal bone addition results from a reaction of osteoblasts to the disease present. Periosteal bone addition (on the outer surface of the bone) is considered periostosis, while osteitis primarily impacts internal vascular and medullary surfaces of bone and spongiosclerosis refers to the hypertrophy of cancellous bone (Ortner 2003). There also may be instances where the abnormal increase in bone thickness is not directly related to bone addition, but instead represents the failure to remove bone during development (Ortner 2003). These bone abnormalities can be observed on the longitudinal axis of a long bone, the cross-sectional axis of a long bone, the outer table of the skull, the diploë (medullary) of the skull, or the inner table of the skull. Many diseases involve more than one type of bone abnormality interacting on more than one examined surface. For example, bone lesions can involve both the abnormal destruction and addition of bone, can occur throughout the skeleton, and can be due to numerous general diseases (Ortner 2003).

Following the extensive discussion of the bone abnormalities throughout the skeleton and on specific elements, the researcher should evaluate the progress of the pathology at the time of death of the individual. Active abnormalities may be composed of woven bone or compact bone forming on the surface of the normal bone (Ortner 2003). Woven bone may be porous, striated, or spiculated in nature, similarly to compact bone growth, which also includes formations of compact bone plaque on the normal bone surface (Ortner 2003). As the woven bone becomes dense, either from the beginning of repair or the instance of a chronic condition, the formation becomes sclerotic in nature (Buikstra and Ubelaker 1994; Ortner 2003). A healed abnormality results in an abnormal shape or size of the bone, as the abnormality is integrated into the original bone surface (Buikstra, personal communication, 2014).

The abnormal bone processes should also be evaluated concerning their primary or secondary nature. Primary processes may be the direct result of the disease or infection, while secondary processes are the result of the primary abnormality (Buikstra, personal communication, 2014). For example, an infection or disease may cause large lesions that destroy the structural integrity of the vertebral bodies (the primary process), causing the secondary collapse. This particular disease or infection was not designed to collapse the vertebral bodies, while another type of infection or disease may primarily target the vertebrae. The differentiation between primary and secondary processes can assist in the eventual differential diagnosis of the condition.

The extensive description of the quality, quantity, and location of abnormal bone formation and bone destruction, bone density, bone size, and bone shape allows for a possible differential diagnosis either by the initial observer or by a researcher in the future. A differential diagnosis involves using the exhaustive descriptions to create a list of potential causes of the abnormalities (Grauer 2008). This narrowing may leave the researcher with numerous possible conditions, which can be further explored using histological evaluation, microscopy, and radiography. Due to the limitation of the paleopathologist to the evaluation of bone tissue, Ortner (2003) suggests that paleopathologists should not diagnose specific diseases or infections from purely macroscopic analysis and instead should consider broader disease categories.

Trauma: Fractures and Dislocations

Trauma can impact the human skeletal system in a variety of ways: 1) a break of bone, whether a partial or complete fracture; 2) a dislocation or displacement of a joint; or 3) nerve and/or blood supply disruption; (Ortner 2003; White et al. 2012). The causes of skeletal trauma range from accidental to deliberate and include violent acts and accidents. Depending on a multitude of factors, including the age and biological sex of the individual, the particular bone involved, and the nature of the trauma, the observable resulting patterns vary. Further, it is essential for the paleopathologist to acknowledge that perimortem trauma may foster similarly to postmortem taphonomic processes upon the bone and that any determination of cause of death or perimortem trauma is nearly impossible (Waldron 2009; Ortner 2011a).

A fracture, in the broadest sense of the word, is any break in the continuity of bone and/or cartilage (Lovell 1997; Waldron 2009; Ortner 2011a). An evaluation of this fracture must include descriptions of the severity, nature, likely causal stress, and possible conditions conducive to its occurrence. The severity of a fracture is categorized as simple (or complete, when the result is two pieces of bone), comminuted (when there are more than two resulting pieces of bone), and incomplete (or infraction, when the break does not go all the way through the bone involved) (Waldron 2009; Ortner 2003). These fractures are the result of a variety and/or combination of stressors upon the bone, including: 1) tension, 2) compression, 3) torsion or twisting, 4) flexion or bending, and 5) shearing (Ortner 2003).

Following the categorization of the severity and causal stress of the fracture, the paleopathologist should note any observable processes of fracture healing and deduce any possible complications that may have arisen as a result of the fracture (Lovell 1997). The healing of a fracture begins immediately and can last up to 7 years (Waldron 2009) depending on several variables including the particular bone involved, the severity of the fracture, the positioning of the broken fragments of bone, and the age, biological sex, and health of the individual (Ortner 2003). Infection is the primary (and a quite serious) complication of a skeletal fracture, but other complications include avascular necrosis, inadequate fusion or non-union of the fracture, shortening and/or deformity, osteoarthritis, and (perhaps the most serious) death (Lovell 1997; Ortner 2003; Waldron 2009).

A dislocation is an additional category of trauma that involves the disruption of or loss of contact between the bony elements and articular cartilage within a joint (Ortner 2003). Many dislocated joints can be reduced and corrected to leave little to no trace of trauma on the skeletal system. In order to be detected in bioarchaeological contexts, the dislocation must have resulted in visible remodeling of the associated bone, usually in areas where self-correction of the dislocation or subluxation is very difficult (e.g., the shoulder and hip joints) (Waldron 2009; Ortner 2003). Bioarchaeologists should consider that while dislocation is usually the result of trauma, there may be congenital factors involved that need to be considered. Further, besides understanding the limitations and disruptions of blood supply and the tearing of associated tendons and ligaments (Ortner 2003), the bioarchaeologists must acknowledge that the archaeologically evident dislocations may be merely a portion of those actually experienced by within the life history of an individual.

Dental Pathology

Dental pathological evaluation is a useful investigatory tool for understanding the health, diets, and lives of deceased individuals. Dental pathology can be the result of exposure to foodstuffs, infectious processes, developmental problems, genetic code, and cultural practices. To assess the dental pathology for each individual examined, the examiner described and documented the macroscopic presence of periodontal disease, dental caries, enamel hypoplasia, dental calculus, and dental modification

Periodontal disease is caused by the inflammation of the soft tissues and bone around a tooth. In skeletal remains, an advanced case of periodontitis, which includes the loss of the periodontal ligament, could result in the remodeling of the tooth socket (horizontal or lateral bone loss) and recession of the alveolar bone (Hillson 2005, 1996). Support for the tooth may have been compromised, resulting in the loss of the associated tooth. As with any instance of tooth loss, the scholar must identify any bone remodeling to confirm antemortem tooth loss in comparison to the lack of remodeling, which indicates the tooth was lost postmortem. An abscess is when the inflammation and associated pus was localized on the buccal or lingual alveolar surface, causing a disintegration and cavity in the tissue, usually near the root apices (Hillson 2005). Adult periodontitis is quite common in older individuals, as bone loss gradually progresses with age.

While periodontitis causes the alteration of the alveolar bone, dental caries are the result of demineralization of the enamel, dentine, and cementum structures. Caries also progress slowly and have a correlation with advanced age (Hillson 2005). The caries that are visible macroscopically are usually the result of a late stage of lesion development; the earlier demineralization takes place under the surface and is not visible (Hillson 2005). Caries are formed by the acids of the fermentation process of carbohydrates, suggesting a strong association between the formation of carious lesions and a diet high in sugar (Hillson 2005). The dietary connection is the reason that it is very common practice for bioarchaeologists and paleopathologists to record dental caries in archaeological samples analyzed for the reconstruction of the transition from hunter-gatherer to agriculturalist lifeways (Hillson 2001).

For this project, caries were documented as present or absent and type of lesion, and then photographed. Caries can be classified into two types depending on their location on the tooth surface, as they have different etiologies. Coronal caries are lesions of the enamel of the crown surface, either within the occlusal fissures or at areas of contact (usually the mesial or distal surfaces) with other teeth (Hillson 2001, 2005). Root surface caries are lesions at the cement-enamel junction (CEJ) and on the root surfaces, usually exposed due to periodontal disease (Hillson 2001, 2005).

When dental plaque becomes mineralized, it becomes dental calculus. These mineralized deposits are usually macroscopically visible on the surface of the teeth (Hillson 1996, 2005). Further, calculus can contain microscopic traces of food, allowing archaeologists to reconstruct ancient diets (Dobney and Brothwell 1987). For this project, the calculus is categorized into two groups: supra-gingival and sub-gingival. Supra-gingival calculus is present on the enamel of the of the crown as a band indicating the gingival margin and may extend further over the crown (Hillson 1996). Sub-gingival calculus is on the root surface and difficult to distinguish from the cement surface in many archaeological specimens (Hillson 1996). The amount of calculus present on the dental surfaces is scored as slight, medium, or considerable, following Brothwell (1981). Because the attachment of calculus is perilous in archaeological contexts, the absence of calculus does not indicate that the individual was free of plaque and calculus during their life.

Dental enamel hypoplasia is the result of disturbances in the development of dental enamel, usually because of disease or poor nutrition during this period of growth. Archaeologists study these developmental interruptions to understand periods of stress during childhood and past lifeways (Roberts and Manchester 2007; Skinner and Goodman 1992; Goodman and Rose 1991; Goodman and Armelagos 1985). Macroscopically, hypoplasias most often are characterized on the surface of the tooth crown by the occurrence of transverse lines, pits, or grooves, also known as linear enamel hypoplasia (LEH). Using high magnification, scholars can view a wider range of disturbances and their specific locations and corresponding developmental ages (Hillson 2005). Because of the scope of this project, only the macroscopic recording of the enamel hypoplasias was conducted, documenting the number and type of teeth involved, as well as the appearance and severity (Roberts and Manchester 2007; Mays 1998).

Differential Diagnosis

Only following the careful and detailed description of the type, location, and distribution of the bone abnormalities, can the differential diagnosis be attempted. Classification in paleopathology, as in biology, aims to understand the relationship between the individual and disease, using a system that minimizes ambiguity in the assignment to a category (Ortner 2011a). For biologists or doctors, classification includes the understanding of the cause of the disease and the pathogenesis of the disorder, but for paleopathologists this task is substantially more difficult as few diseases leave any indication on the human skeleton and most that do leave similar reactions (White et al. 2012; Ortner 2011a, 2011b). Further, the paleopathologist is limited to the skeletal remains of the individual; they cannot interview the patient or experiment with a treatment. In a traditional differential diagnosis, the doctor would compile a detailed list of specific diseases that might cause the symptoms, listed in order of probability. For paleopathologists, it is best to exercise caution in specificity and use more broad categories of disease (Waldron 1994, 2009, Ortner 2003, 2011a). For this project, the categories follow those of Ortner (2003): trauma, infectious diseases, circulatory disturbances, reticuloendothelial and hematopoietic disorders, metabolic disorders, endocrine disturbances, congenital and neuromechanical disorders, dysplasias, tumor and tumor-like disorders, joint disorders, dental and jaw disorders, and miscellaneous disorders. For this project, the differential diagnoses remained in these broad categories, unless the type of abnormality was relatively easy to identify, such as trauma, arthritis, and infection.

Cultural Body Modification

In addition to accidental (or violent) trauma, modification ("deformation") from cultural practices or surgical interventions can be evident on skeletal remains. Dental and cranial modification are the two most common examples of intentional modification of the shape of bone relating to the cultural practices and beliefs of ancient Maya communities. Dental modification ("mutilation"), as a result of cultural practices, is particularly common in ancient Maya bioarchaeological samples. Some practices may involve the alteration of the dentition with filing or inlays and other may be less deliberate with dental modification from habitual behaviors such as pipe smoking or the use of the teeth as a tool (Buikstra and Ubelaker 1994).

This study classifies dental modification following the types of Romero (1970) and the categories of Buikstra and Ubelaker (1994). Romero (1970) catalogued over 1000 teeth from the Instituto Nacional de Antropologia e Historia of Mexico and assembled data regarding the intentional antemortem modification of human dentition. He classified the modifications practiced by prehistoric Americans into 59 types based on three modes of modification: 1) the contour of the edge of the dental crown, 2) the labial surface of the crown, and 3) both the contour of the edge and labial surfaces of the crown (Romero 1970). Buikstra and Ubelaker (1994) suggests bioarchaeologists assign the observed dental modifications to 5 categories: 1) surface modification of filing, 2) surface modification of drilling (with or without inlays), 3) dental restorations and appliances, 4) dental wear associated with artifact use or production, 5) tooth ablation. Dentition analyzed for this project were clearly described, the modification sketched, and photo documentation taken before assigning to the Romero types and the categories of Buikstra and Ubelaker.

Artificial modification of the developing cranium is most often a result of the cultural practice of long-term compression through cradleboarding, massaging, or binding (White et al. 2012). Cranial modification is nearly ubiquitous in ancient societies as far back as 45,000 BC in the Middle East (White et al. 2012; Ortner 2003; Aufderheide and Rodríguez-Martín 1998; Ubelaker 1999). Bioarchaeologists and paleopathologists evaluating cranial modification should provide a detailed description (and photographs) of the modified skull shape and conjectures concerning possible shaping techniques used. Descriptive terminology used in this project follow those of Neumann (1942), Stewart (1973, 1950, 1941), Ubelaker (1999), and Buikstra and Ubelaker (1994). In particular, Neumann (1942) outlines major forms of modification, including: 1) lambdoid, 2) occipital, 3) bifronto-occipital, 4) fronto-parieto-occipital, 5) fronto-vertico-occipital, and 6) parallelo-fronto-occipital. The type of modification identified can lead to an understanding of the cultural practice involved, whether flattening by boards or circumferential binding (Allison et al. 1981; Buikstra and Ubelaker 1994).

Finally, two particular practices, trephination/trepanation and amputation, significantly modify a bone's shape, allowing for bioarchaeologists to observe and discuss the cultural implications of surgical intervention or therapeutic procedures. Amputation may be observed in the bioarchaeological record from the missing of bones or parts of bones, usually from a limb. Bioarchaeologists must be particularly careful when suggesting the act of amputation, as missing elements are common in archaeological excavations. Special observations should be made of any presence of precision cutting, healing, or infection of the associated bone tissue (White et al. 2012). Trephination, a surgery where holes or sections are removed from the cranial vault, is a practice known from ancient cultures of most of the earth's continents (White et al. 2012; Buikstra and Ubelaker 1994). This project follows the coding of Buikstra and Ubelaker (1994:59), which emphasizes the documentation of the "location, certainty of identification, technique, evidence of healing, and size of the removed section". The possible techniques include the scraping away of bone, and the removal of sections or creation of holes by carving grooves, using bores-and-cuts (the drilling of small holes around a section to be removed), and rectangular incisions (White et al. 2012; Buikstra and Ubelaker 1994).

Mortuary Analysis and Burial Typology

Mortuary archaeologists implement typologies in order to classify and analyze the burial customs of past societies. Unfortunately, rarely are these typologies or classification systems coordinated or consistent. Cists, crypts, chambers, and vaults are all examples of terminology that various scholars use with a multitude of different definitions. Inspired by Rathje's (1970) analysis of the socio-political implications of lowland Maya burial patterns, Welsh (1988) presented a unified classification scheme of ancient Maya burial contexts. His extensive report includes appendices of the contexts he compiled, documenting all known data, provenance, skeletal position, and amount/type of grave goods/furniture.

Burial Type

Welsh (1988:15) presents the subtleties in the terms “burial” (interments of human skeletal material and associated artifacts in a grave) and “cache” (one or more objects, including human bone, intentionally interred as an offering). He concludes, and I agree, that any interred offerings containing human remains, including caches*,* should qualify as a burial, due to the fact that they allow scholars to infer methods of interment or disposal of the dead. Following Welsh (1988), I consider all contexts that contain interred human remains burial contexts, which allows for a more nuanced analysis of mortuary behavior. Burial types used in this project include grave interment, cache, problematic deposit, and miscellaneous human skeletal material. Problematic deposits are those that contain human bone, but it is unclear if the intention of burial was as a cache offering or grave internment (Becker 1993).

Burial Manner

Welsh (1988:35) includes manner, positioning, and grave goods within the broader category of burial method. Burial manner refers to the distinctions of: cremation, primary burial, secondary burial, single individual interment, or multiple individuals interment. A primary burial refers to an interment where the remains are found at least mostly complete and articulated. This designation of primary indicates that the individual was not moved or manipulated in antiquity. As seen in many ancient Maya contexts, when a head or long bone has been removed from the interment in antiquity, but the remaining skeleton is articulated, it is still considered a primary burial. A secondary burial refers to an interment where the individual has intentionally been altered, manipulated, or moved after death, but before burial in that particular context. Usually in a secondary burial, the individual has been intentionally disarticulated, sometimes placed in an urn or between bowls, and then placed in the found context.

Another important component of method includes whether the interred is considered single or multiple. Single individual interments are common in ancient Maya contexts and usually primary, where only one individual is found in the context. Interments of multiple individuals usually consist of a parent buried with a child, secondary interments accompanying a primary individual, or sacrificed individuals.

Body Positioning and Orientation

The skeletal positioning of the individual within a primary burial is another important component of burial method to consider (Welsh 1988:37). In the Maya region, individuals have been found in a variety of flexed or extended positions. An individual may be flexed to the right or left and usually will be in smaller grave contexts, while an extended individual usually is found in burials of larger construction. An extended individual may be supine, which refers to the individual being laid to rest on their back, with their anterior facing up. The prone position refers to the individual laying face down in the grave context. Also important to note is the orientation of the individual's head, which reflects the orientation of the burial of the individual (Welsh 1988:52), as recorded cardinally: north, south, east, west, or in between (e.g., east-southeast). Both body positioning and head orientation are important components of burial method to document, in order to determine any site or regional patterns (or differences) and to what degree position and orientation relate to other mortuary data, including grave location or construction.

Associated Artifacts

Associated grave goods are evaluated regarding their type, quantity, and positioning within the burial context. Welsh's (1988:102) categories of goods include: 1) pottery, 2) polychrome or stuccoed pottery, 3) jade beads or ear flares, 4) jade figurines, 5) shell beads or ear flares, 6) shells, 7) flint and obsidian, 8) groundstones, 9) animal bone or teeth, 10) clay objects such as whistles, 11) pearls, coral, or mica, 12) textiles, furs, or wooden objects, 13) stingray spines, 14) codices, 15) mosaic masks, and 16) *copal* (tree resin used as incense). The associated artifacts are documented to determine if they serve a particular function within the grave, if they reflect social or political status of the individual, or if they are an indicator of religious or ritual practices.

Welsh (1988:64) chooses to analyze urn burials or bowl-over-skull burials separately from other aspects of burial method to highlight these categories as more than simply a burial type. I include the presence of an urn or a bowl covering a skull (or skull between two bowls or resting in a bowl) within the category of associated grave goods, due to the fact that they are in fact non-skeletal associated artifacts that may convey function, status, or ritual information during mortuary analysis.

Burial Location

Burial locations can range from altars, benches, stair blocks, and platforms to entire household shrines and temples. Welsh (1988:25) classifies burial location in to five main types: 1) housemounds or house platforms, 2) elite or vaulted residences, 3) palaces,

4) ceremonial and religious buildings, and 5) plazas. It is important to note that it may be difficult to discern the particular type of residence where the burial is located due to preservation or documentation. In these cases, the location is simply residential. Ceremonial and religious include household shrines, ceremonial platforms, and temples. Further, the plaza local includes burial within the plaza itself, but also burial in association with stelae or altars.

Grave Construction

Welsh (1988:15) also provides the terminological distinction between "burial" (see above) and "grave", which he defines as any type of receptacle designed for the interment of the dead. Based on 1170 graves at 16 Maya sites, Welsh (1988:16–18) presents his classification system for the construction of graves, which I adopted here. Welsh illustrates six basic types, with varieties included. I have made minor changes to the labeling of some of the varieties for clarify and coherence. When designated, the grave construction is presented as "type, variety" (i.e., simple, simple, or crypt: simple).

1) Simple: an interment in an unlined pit or construction fill
    a. Simple: formless grave in construction fill;
    b. Pit: unlined hole dug into soil, bedrock, fill, or rubble;
    c. Ceiling slab: a portion of the interred (usually the head) is positioned on a stone slab of a previously constructed grave;
    d. Blocked up room: associated with the simple variety, but referring to a grave in an infilled room;

    e. Unclassifiable: any interment placed between two stone features (benches, walls, etc.) to give the appearance of a stone-lined grave;

2) *Chultun*: a large chamber dug into soil or bedrock with or without an associated shaft (no varieties)

3) Cist: a grave with at least one stone-lined wall, cap, or floor; the stone intentionally, yet perhaps haphazardly placed to distinguish it from other graves; rarely capped or completely stone-lined

    a. Haphazard: grave with intentional, but randomly placed stones;
    b. Partial: same, yet less random than the haphazard variety;
    c. Head: a grave with a stone or lining on, under, or around head of the interred;
    d. Capped: unlined or partially-lined grave, with the presence of capstones resting on the sidewalls;
    e. Uncapped: partially or completely lined grave lacking a capstone;

4) Crypt- a grave with partially or completely stone-lined walls, covered by capstones

    a. Unclassifiable: because of post-interment disturbance (natural or looters), the construction is uncertain, but clearly a crypt;
    b. Simple: a grave with (sometimes plastered) lined walls and capstone roof; height: 10-75 cm;

    c. Elaborate: a grave with (sometimes plastered) cut and dressed stone slab walls and capstones, sometimes with stone floors, niches, benches and/or antechambers; height: 40 to 135 cm;

5) Tomb: an elaborate stone-lined or rock-cut chamber, sometimes with a shaft and/or antechamber, may be vaulted, plastered, and/ or painted; height: 135 or more cm.
    a. Unclassifiable: because of post-interment disturbance (natural or looters), the construction is uncertain, but clearly a tomb;
    b. Rock cut: a (usually plastered and painted) chamber cut from the bedrock with shaft and steps;
    c. Stone lined: a chamber lined with stone, perhaps vaulted or capped, sometimes with shaft or steps;
6) Unclassifiable: graves without information (or too disturbed) to be classified.

Integrating Mortuary Analysis and Biological Identity

This study uses an interdisciplinary approach to bioarchaeological study that incorporates the physical analysis of the human remains with archaeological data, specifically evidence of the mortuary behavior (Goldstein 2006). As Rathje (1970:360) argued, “burials and associated artefacts were not randomly distributed but varied in direct relation to other aspects of Classic Maya society.” Rathje (1970) and Welsh (1988) were particularly focused on the degree of wealth presented within the burial context (via grave goods) and the correlations to social status in Maya society. While still a consideration, this study focuses more on the spatial dimension of mortuary practices, considering the placement of the human remains (burial manner, body positioning, burial location) and its relation to cultural practices, such as ancestor worship and human sacrifice.

In addition to a paleopathological evaluation of the skeletal remains, mortuary behavior can allow for inferences regarding ritual behavior, specifically in this case, human sacrifice. Welsh (1988) emphasizes four forms of Maya human sacrifice that is visible through mortuary behavior: 1) adult and child burials; 2) primary interments accompanied by secondary (sacrificial) individual(s); 3) dedicatory cache burials; and 4) sacrifice by “mutilation,” specifically decapitation. The paleopathological evaluation may speak to perimortem trauma, including decapitation, while the mortuary analysis can examine the spatial relationship between multiple interred individuals and the intention behind the burial type and body positioning.

While the Maya did not use necropolises or cemeteries to inter their dead, the placement in many different types of structures and location was not haphazard nor merely convenient. Many Maya burials found suggest that the burial occurred during the renovation or construction of a structure, ranging from temples to housemounds. The majority of Maya burials in residential buildings were covered by a new floor or platform or even an entirely new house construction. Further, other structures were constructed with the function of housing and honoring the deceased. First found in residential group plazas at Tikal (Becker 1971), but now widespread at many Maya sites, are buildings on the eastern edge of the plaza seemingly constructed for the purpose of interring the dead.

These “residential temples” (Haviland 1981) or “ceremonial eastern structures” (Coggins 1975) are referred to by Welsh (1988), and classified as such in this project, as “household shrines.” The correlate in the city ceremonial center or central plaza was the grand temple constructed for interment, usually also on the eastern edge of the plaza.

Another type of construction consisted of an architectural element placed over the burial, such as a platform, altar, staircase, bench, etc. Burials were found frequently in or covered by benches in residential structures, household shrines or temples, and palaces. The benches may have been constructed to commemorate the deceased in residential buildings or palaces, functioning as altars on which to perform rituals. It remains possible that bench burials were dedicatory or sacrificial in nature, as children were interred in benches at San Jose, Uaxactun, and Altun Ha (Welsh 1988). While not the subject of the ancestor veneration, these interments may represent the action of veneration with their placement in honor of a deceased ancestor.

Rathje (1970) and Welsh (1988) also evaluated their research in terms of regional and temporal context. Welsh (1988) found specific patterns of burial type and body positioning in the lowlands (interments and consistent head orientation). Rathje (1970) compared the mortuary behavior within the Classic period, finding significant differences between the early period and the late period. To elucidate any temporal differences between the mortuary behavior for this project, particular attention will be paid in this study to the associated temporal context.

Biological Profiles and Osteobiographies

Bioarchaeologists expand upon the biological identity of forensic anthropology and integrate archaeological context to create the biological profile or osteobiography of the individual studied. In forensic human identification methodology, one of the first steps in analysis is an estimation of the biological identity of the human remains (Scheuer and Black 2007; Schultz and Dupras 2008). The four components of the biological identity are considered: biological sex, age-at-death, stature, and "ethnic origin" (Scheuer and Black 2007:202). For this study, I compile age-at-death, biological sex, antemortem or perimortem trauma, body modification, pathology, and dental health for the biological identity. To create a biological profile, in addition to the elements of the biological identity, the bioarchaeologist adds observations of any pathologies or unusual observations of the skeletal remains, as well as the mortuary and archaeological context.

Biological identity is essentially the same as Saul's osteobiography (Saul and Saul 1989), which is considered a methodological means to obtain biological details of an individual's life. This project presents osteobiographies similar to Robb's (2002) definition of osteobiography, incorporating mortuary, architectural, iconographic, and artifactual evidence into the biological profile to better understand the life (and death) of the individual within a particular social context, also referred to as the individual's complex social identity.

Adapted from Stodder and Palkovich's (2014)'s organization of *The Bioarchaeology of Individuals*, I present a condensed biological profile of the individual in table form (Table 5.2). The osteobiography follows, including a detailed description of the osteological, stable isotope, mortuary, archaeological, iconographic, architectural, and artifactual associated evidence. The multidimensional bioarchaeological approach allows for an in-depth examination of the individual's social identity.

Individual/Burial ID #:	
Laboratory ID #:	
Site:	
Associated Period/Date:	
Year Excavated:	
Archaeological Reports:	
Dentition Sampled:	
Burial Location and Construction:	
Burial Type, Manner, and Positioning:	
Associated Artifacts:	
Preservation:	
Age-at-Death Estimation:	
Biological Sex Estimation:	
Observations:	
Stable Isotope Results:	

Table 5.2 Example of the biographical profile table used in this study.

Chapter Summary

In this chapter, I presented the bioarchaeological methodology used in this project for compiling biological profiles. The components for biological identity included estimated age-at-death, biological sex, antemortem or perimortem trauma, body modification, pathology, and dental health. The mortuary analysis methodology is presented next, with the classification system and specific terminology solidified by Welsh (1988) and how it was adapted for this project. It describes each component for the analysis of mortuary behavior from the burial context of each individual (i.e., the burial type, burial manner, burial location, grave construction, burial orientation/positioning, and associated burial goods). It then expands upon the utility of bioarchaeology, highlighting how the skeletal analysis of the human remains can be integrated with evidence of the mortuary behavior to understand cultural practices, such as ancestor veneration and human sacrifice, and their relation to the social identity of the deceased.

CHAPTER 6: STABLE ISOTOPE ANALYSIS METHODOLOGY

Since its introduction in the 1970s, stable isotope analysis has become an integral approach utilized by bioarchaeologists in the evaluation of human skeletal remains from archaeological sites, most recently contributing to studies of residential mobility and population migration. Isotopes can be defined as atoms of one element that have differing atomic masses due to the variation in numbers of neutrons between them (Katzenberg 2008). Unlike radioactive or unstable isotopes (e.g., ^{14}C), stable isotopes of the same element (e.g., ^{12}C, ^{13}C) do not decay over time (Larsen 1997; Katzenberg 2008; Tykot 2006). The different atomic masses of the isotopes influence how the isotope reacts in various physical and biochemical processes (Brown and Brown 2011), such as photosynthesis. In circumstances where one isotope (e.g., the lighter isotope) becomes enriched more quickly than their counterparts, this process is known as fractionation and results in isotope abundance ratios (e.g., $^{13}C/^{12}C$) that differ from their prevalence in nature; values that are higher in the prevalence of the heavier isotope in comparison to the original standard are termed enriched, while those lower in the heavier isotope (or higher in the lighter isotope) than the standard are termed depleted. These differences are expressed in standardized notation as ratios relative to specific international standards using the delta notion (δ), expressed in units per mil (thousand, ‰) (Tykot 2006) (Equation 6.1).

$$\delta^{13}C_{sample} = \left(\frac{^{13}C/^{12}C_{sample}}{^{13}C/^{12}C_{standard}} - 1 \right) \times 1000$$

$$\delta^{18}O_{sample} = \left(\frac{^{18}O/^{16}O_{sample}}{^{18}O/^{16}O_{standard}} - 1 \right) \times 1000$$

Equation 6.1 Standardized notation of ratios.

The tissues of plants and animals, as well as specific components of the surrounding environment (e.g., rainfall v. stream water) may have distinct isotope ratio values, and during consumption by living organisms these values are passed on to the consumer, wherein subsequent fractionation may occur. Thus, the identification of isotope ratio values within a consumer's body tissues gives insight into the food and water they consumed, allowing the reconstruction of a variety of dietary components during their lives. Chief among these in the study of humans are the use of carbon ($\delta^{13}C$) for evaluating dietary composition (specifically maize consumption) (e.g., Larsen 1997; Katzenberg 2080; Larsen 2002); nitrogen ($\delta^{15}N$) for understanding the role of marine foods, access to animal protein in relation to social status, and infant feeding and weaning patterns (e.g., Whittington and Reed 1997b; Wright and Schwarcz 1998; Katzenberg 2008); and strontium ($^{87}Sr/^{86}Sr$) and oxygen ($\delta^{18}O$) for illuminating residence, individual migration, and population movement (e.g., Grupe et al. 1997; Larsen 1997; Balasse et al. 2002; Schweissing and Grupe 2003; Hodell et al. 2004; Larsen 2006; Price, Tiesler, et al. 2006; Price, Burton, et al. 2006; Turner et al. 2009; Price et al. 2010; Britton et al. 2011; Theden-Ringl et al. 2011; Kenoyer et al. 2013). Bone chemistry and stable isotope analysis have endowed bioarchaeologists with the methodology to evaluate the diet, demography, and life histories of past populations from the human skeletal material in archaeological contexts.

Stable isotope analysis can be undertaken using two different types of tissues: bone collagen (the organic component of bone) and hydroxyapatite (the mineral portion of bone, commonly referred to as bone carbonate). The collagen comprises about 30% of the dry bone, and is nearly 35% carbon and 11-16% nitrogen by weight (van Klinken 1999; Bethard 2012). When interested in the stable isotope analyses of these elements, scholars may choose to prepare collagen samples. Stable carbon analyses using collagen samples ($\delta^{13}C_{co}$) are representative of the protein portion of the diet, while those using the carbonate ($\delta^{13}C_{ap}$) tend to reflect the entirety of the diet (Ambrose and Norr 1993; Tieszen and Fagre 1993).

As nearly 70% of dry bone weight and as much as 96% of tooth enamel (Bethard 2012), hydroxyapatite may be favored for the analyses of carbon, strontium, and oxygen stable isotopes. While bone collagen and hydroxyapatite from bone are particularly susceptible to diagenetic alternation in harsh depositional environments, the hydroxyapatite from tooth enamel is better preserved in the archaeological record. The hydroxyapatite from enamel is more resistant to taphonomic processes in the acidic soils of the tropic environment (such as the Maya region) and more likely to be preserved after longer periods of time (e.g., the isotopic results from 1.8 million-year-old *Paranthropus robustus* enamel by Sponheimer and colleagues [2006]).

Furthermore, because tooth enamel does not remodel following mineralization, the isotopic values will be representative of the dietary components ingested by an individual during the years of enamel formation. Because teeth mineralize at different times (i.e., the first molar between 0 and 3 years and the third molar 7 and 16 years), the isotopic value of the enamel of each tooth can indicate any changes in location during various periods of juvenile growth (Table 6.1 andTable 6.2) (White et al. 2000, 2002, 2004). Stable isotope ratios of archaeological human dental enamel can be compared to ratios known to be present in the local region near the burial location, which allows the identification of changes in the location of subsistence, and by extension the location of residence, of the sampled individuals and indicate a timeframe for any such changes (White et al. 2000, 2004).

Maxillary Permanent Teeth	**I1**	**I2**	**C**	**PM1**	**PM2**	**M1**	**M2**	**M3**
Initial Calcification	3-4mo	10-12mo	4-5mo	1.5-1.75yr	2-2.25yr	at birth	2.5-3yr	7-9yr
Crown Completed	4-5yr	4-5yr	6-7yr	5-6yr	6-7yrs	2.5-3yr	7-8yr	12-16yr
Age Range if Sampled	3mo-5yrs	10mo-5yr	4mo-7yr	1.5-6yr	2-7yr	birth-3yr	2.5-8yr	7-16yr

Table 6.1 Maxillary dental enamel formation timeline (adapted from Hillson 1996).

Mandibular Permanent Teeth	**I1**	**I2**	**C**	**PM1**	**PM2**	**M1**	**M2**	**M3**
Initial Calcification	3-4mo	3-4mo	4-5mo	1.5-2yr	2.25-2.5yr	at birth	2.5-3yr	8-10yr
Crown Completed	4-5yr	4-5yr	6-7yr	5-6yr	6-7yrs	2.5-3yr	7-8yr	12-16yr
Age Range if Sampled	3mo-5yrs	3mo-5yrs	4mo-7yr	1.5-6yr	2.25-7yr	birth-3yr	2.5-8yr	8-16yr

Table 6.2 Mandibular dental enamel formation timeline (adapted from Hillson 1996).

Stable Isotope Baselines

Strontium Geological Baselines for the Maya Region

The strontium isotope ratio of ^{87}Sr to ^{86}Sr (written $^{87}Sr/^{86}Sr$) of an enamel sample reflects the strontium that has "journeyed" through various environmental processes into the meal of an individual and into their skeletal tissues (Bentley 2006). There are four naturally occurring strontium isotopes, three of which are non-radiogenic (^{84}Sr, ^{86}Sr, and ^{88}Sr). ^{87}Sr is radiogenic, or formed gradually through the β-decay of ^{87}Rb, and thus the amount of ^{87}Sr present is a result of the starting concentration of ^{87}Rb and the age of the geological source. As described by Bentley (2006:139), "Rocks that are very old (>100 mya) with high original Rb/Sr have $^{87}Sr/^{86}Sr$ ratios generally above 0.710, and rocks formed recently (<1–10 mya) with low Rb/Sr ratios have low $^{87}Sr/^{86}Sr$ ratios generally less than 0.704." This correlation allows for an adaptation of geologic maps to include tentative $^{87}Sr/^{86}Sr$ ratios. Because of the high atomic mass of strontium, little fractionation occurs during the biological or geological processes (e.g., inclusion in groundwater/soil and thus in local flora and fauna) that lead to its presence in biological tissues. Thus, unlike in light stable isotope systems (e.g., $\delta^{13}C$ and $\delta^{18}O$), comparison to a standard is not necessary and the $^{87}Sr/^{86}Sr$ is presented as a raw ratio. As the $^{87}Sr/^{86}Sr$ ratio of dental enamel reflects the geographic area of residence during dental development, comparing this ratio to that in their bones or established baseline values for the geographic region can allow for interpretations of personal mobility.

An understanding of the geology of the Maya region and greater Mesoamerica is integral to interpreting the $^{87}Sr/^{86}Sr$ results of this and any related study. For the Maya area, the Yucatan Peninsula and the Petén region of Guatemala (Figure 6.1) is predominantly composed of a carbonate shelf with limestone outcroppings, increasing in age from north (Pliocene-Pleistocene) to south (late Cretaceous) (Hess et al. 1986; Hodell et al. 2004). Carbonates are high in strontium, which is deposited at the time of formation from the marine environment, allowing geologists to determine the age-related trend of strontium isotopic characteristics following well-defined historical changes in seawater ratios (Price et al. 2010; Hodell et al. 2004; Price, Tiesler, et al. 2006; Price et al. 2008; Hess et al. 1986). Thus, the youngest deposits of the northern coastline have the highest $^{87}Sr/^{86}Sr$ ratios at the modern marine value of 0.70920, while the ratio of the oldest, southern, Cretaceous carbonates is the lowest with 0.07070 (Hodell et al. 2004).

Hodell and colleagues (2004) analyzed modern samples of water, bedrock, soils, and plants to detail any variation throughout the Maya region and reported regional baseline “clusters” of $^{87}Sr/^{86}Sr$ ratios. They determined distinct $^{87}Sr/^{86}Sr$ signatures among five Maya geocultural areas Figure 6.2: the northern lowlands, the southern lowlands, the volcanic highlands and Pacific coast, the metamorphic province, and the Maya Mountains of Belize (Hodell et al. 2004).

As previously mentioned, from the southern lowlands to the northern lowlands, the $^{87}Sr/^{86}Sr$ ratios increase as the age of the carbonates decreases. Hodell and colleagues (2004) report the $^{87}Sr/^{86}Sr$ values for the northern lowlands as between 0.70775 and 0.70921 with a mean of 0.70853, and the southern lowlands as between 0.70693 and 0.70845 with a mean of 0.70770. Archaeologists (Wright 2005a, 2005b; Price, Burton, et al. 2006; Price et al. 2010, 2015) have contributed to these baseline ranges specific values

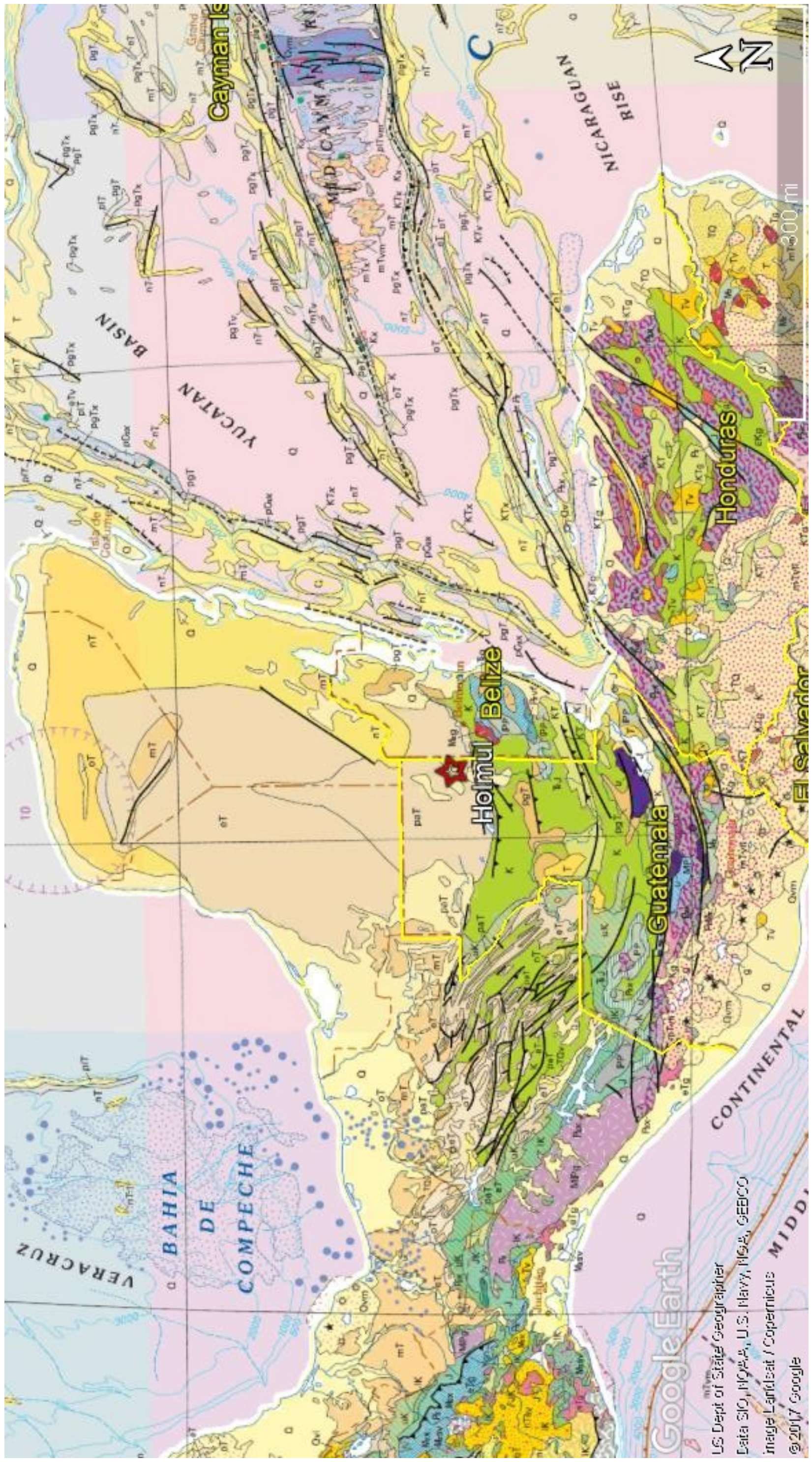

Figure 6.1 Geology of the Maya region.
(Google Earth Pro; Garrity and Soller 2009)

Figure 6.2 Strontium isotope regions defined by Hodell et al. 2004.

for archaeological sites within the region (Figure 6.3). At the major site of Tikal in the southern lowlands, Wright (2005b) used 83 archaeological human enamel samples to identify a mean local $^{87}Sr/^{86}Sr$ ratio of 0.7081, which aligns with the $^{87}Sr/^{86}Sr$ ratio of 0.7078 from limestone and faunal remains (Price et al. 2015). Price and colleagues (2015) explain the higher ratio among the human samples as the probable result of imported sea salt, presumably from the coasts of Yucatan or Belize; sea salt carries the modern global seawater ratio of 0.7092. For the site of Palenque, the local $^{87}Sr/^{86}Sr$ ratio was determined to be 0.70780 from snail shells (Price et al. 2015), as compared to the local limestone of 0.70784 (Hodell et al. 2004). Price and colleagues (2008, 2015) present further $^{87}Sr/^{86}Sr$ ratios for additional sites in the southern lowlands, such as Piedras Negras (0.7080), Seibal (0.7075), Calakmul (0.7077), Yaxha (0.7079), Aguateca (0.7075), Yaxchilán (0.7082), and Bonampak (0.7077).

For the northern lowlands, the $^{87}Sr/^{86}Sr$ range of Hodell and colleagues (2004) was expanded with greater detail in the area of the Chicxulub Basin of northwestern Yucatan by Gilli and colleagues (2009). The $^{87}Sr/^{86}Sr$ ratios from around the basin were determined from rock and water samples and were applied to enhance the understanding of the ratios of the most notable Maya sites in the northern lowlands, Mayapan and Chichén Itzá (Gilli et al. 2009). The bedrock samples around Mayapan range from 0.70896 to 0.70908 (Gilli et al. 2009), while the ratio given by Price and colleagues (2008) from human and faunal remains is 0.7088. Gilli and colleagues (2009) found greater variability in the vicinity of Chichén Itzá, with a range of 0.7078 to 0.7089. Price and colleagues (2008, 2015) report the value of 0.7087 from biological remains local to

Figure 6.3 $^{87}Sr/^{86}Sr$ ratios of the Maya Region with strontium zones. Adapted from Price et al. 2010:26. Data from Hodell et al. 2004, Krueger 1985, and the Laboratory for Archaeological Chemistry.

Chichén Itzá. They also report ratios for many sites in the Yucatan, including Campeche (0.7082), Cobá (0.7082), Tulum (0.7080), and Ek' Balam (0.7086) (Price et al. 2008, 2010, 2015).

Because the Pacific coast is composed of Quaternary alluvium that was eroded from the volcanic highlands, it is difficult to differentiate the $^{87}Sr/^{86}Sr$ values of the two regions. Hodell and colleagues (2004) demonstrate that the volcanic highlands have the lowest ratios in the Maya region, with an average ratio of 0.70415 and the smallest range (±0.00023) in the Maya region. This specificity allows bioarchaeologists to clearly detect migrants that are from the volcanic highlands buried elsewhere, or individuals from other regions buried in the volcanic highlands. Unfortunately, it is difficult to differentiate migrants from other volcanic zones in Mesoamerica, such as the Mexican Volcanic Belt to the west, using $^{87}Sr/^{86}Sr$ alone. Hodell and colleagues (2004) suggest supplementing the analysis of sites from the Guatemalan highlands, such as Kaminaljuyu, with archaeological evidence and additional isotopic results, such as oxygen or lead. Price and colleagues present the $^{87}Sr/^{86}Sr$ data for Kaminaljuyu (0.7052) and Abaj Takalik (0.7041) in the highlands.

Hodell and colleagues (2004) found that the Metamorphic Province had the greatest variability with a range of $^{87}Sr/^{86}Sr$ ratios from 0.70417 to 0.72017, although the mean of 0.7043 indicates that the lower ratios within the region are more common. The region is geologically diverse with various subareas, such as the Lake Izabal area (0.70789 [no error- only one sample]), the Motagua River Valley (0.70598 ± 0.0018), and the Copan area (0.70644 ± 0.00044) (Hodell et al. 2004). Price and colleagues (2010) reported a local range at Copan of 0.7063 to 0.7074 from faunal remains, which was verified by samples from commoner burials at Copan.

The final region established by Hodell and colleagues (2004) is that of the Maya Mountains of Belize, which is formed by late Paleozoic sedimentary and volcanic rocks, leading to high $^{87}Sr/^{86}Sr$ values that are easily distinguished from the Maya lowlands and Guatemalan highlands. Although only three samples were recorded from the region, $^{87}Sr/^{86}Sr$ ratios range between 0.71192 and 0.71524, with a mean of 0.71327. Elsewhere in Belize, $^{87}Sr/^{86}Sr$ ratios tend to align within the southern lowland range, such as at Nohmul (0.7086), Colha (0.7082), Lubaantun (0.7070), and Barton Ramie (0.7087) (Price et al. 2008).

Strontium Geological Baselines for Greater Mesoamerica

For greater Mesoamerica, specifically Mexico west of the Yucatan, the geology is categorized into principal morphotectonic provinces (Figure 6.4), including the Sierra Madre Occidental, the Sierra Madre Oriental, the Altiplano, the Mexican Volcanic Belt, and the Sierra Madre del Sur (de Cserna 1989; Torres-Alvarado et al. 2000; Ferrusquía-Villafranca et al. 2010). The complex geology of the region, which includes highlands of recent volcanic rock and Paleozoic sediments, as well as a range of metamorphic rocks, causes great variation in $^{87}Sr/^{86}Sr$ ratios.

The Sierra Madre Occidental mountain range was formed during the Oligocene and early Miocene from an intense volcanic episode (Torres-Alvarado et al. 2000). This western range, with its young, rhyolitic and andesitic volcanic rocks, has lower $^{87}Sr/^{86}Sr$ ratios of 0.71033 to 0.71387, with a mean of 0.7058 (Torres-Alvarado et al. 2000). The eastern mountain range, the Sierra Madre Oriental, is composed of Mesozoic sedimentary deposits with $^{87}Sr/^{86}Sr$ ratios between 0.704 and 0.710 and a mean of 0.707 (Torres-

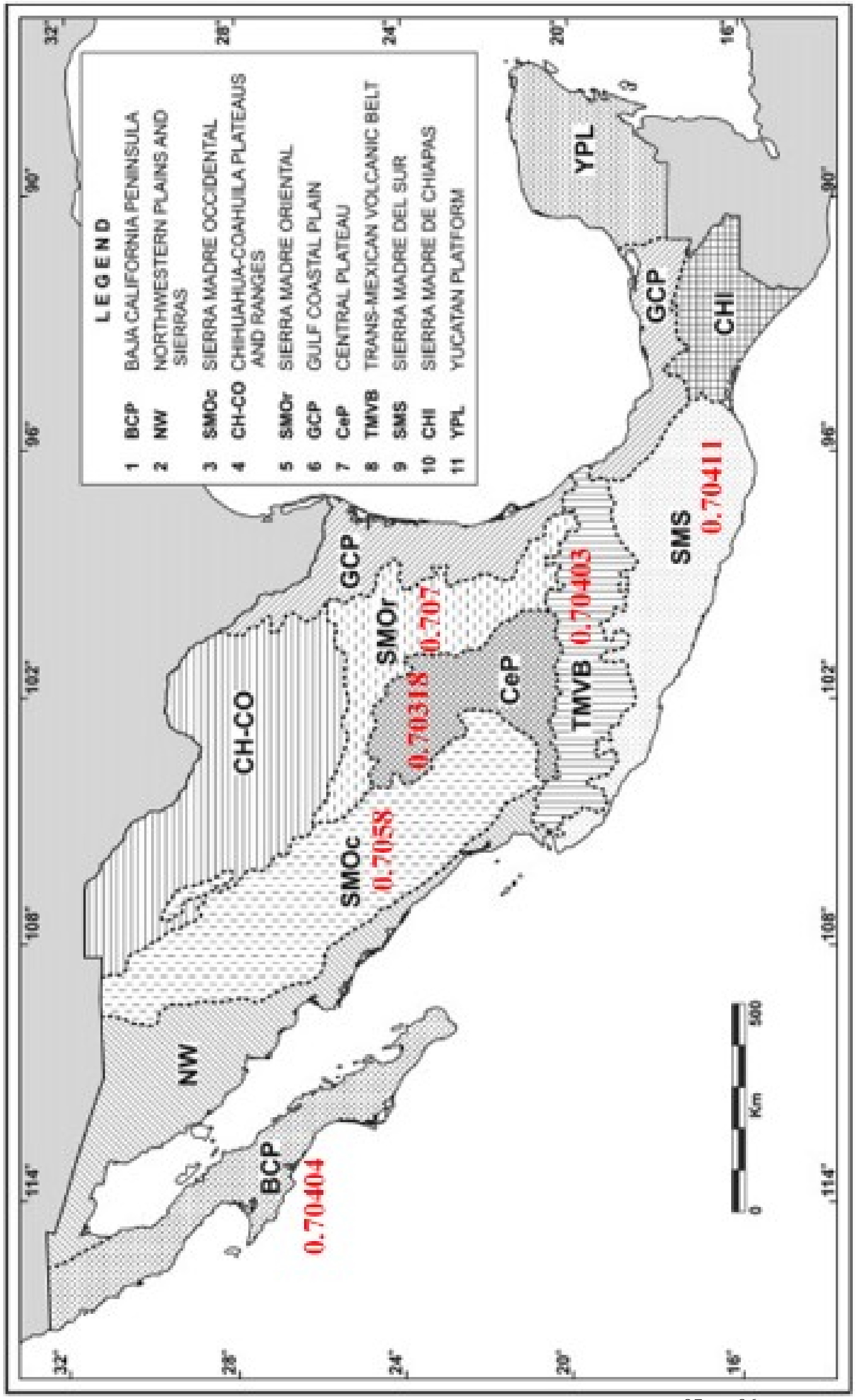

Figure 6.4 The Morphotectonic Provinces of Mexico with mean $^{87}Sr/^{86}Sr$ reported by Torres-Alvarado et al. 2000 (Map from Ferrusquía-Villafranca et al. 2010:56).

Alvarado et al. 2000). Unfortunately, this range is from only 5 geological samples of low quality limiting the accuracy of this regional characterization. The Altiplano region, consisting of the high plans of Central Mexico between the Occidental and Oriental, has $^{87}Sr/^{86}Sr$ ratios between 0.70286 and 0.70395 with a mean of 0.70318 (Torres-Alvarado et al. 2000). To the south of the Altiplano runs the Mexican Volcanic Belt, an east-west chain that results from subduction along the Middle American Trench (Torres-Alvarado et al. 2000). The $^{87}Sr/^{86}Sr$ ratios for this region range from 0.703003 to 0.70841 with a mean of 0.70403 (Torres-Alvarado et al. 2000). Even farther south is the Sierra Madre del Sur, which was formed by Tertiary volcanism and contains Cenozoic, Mesozoic, and even older rocks (Torres-Alvarado et al. 2000). Because of the heterogeneity of the geology, there is considerable local variability in $^{87}Sr/^{86}Sr$ ratios, but the range reported is between 0.70220 and 0.70670 with a mean of 0.70411 (Torres-Alvarado et al. 2000). The lowest ratios found in Mesoamerica are from the Tuxtla Mountains of Veracruz, which are in the range of 0.703 to 0.704 (Price et al. 2008).

In order to grapple with the large strontium isotope ranges for greater Mesoamerica, bioarchaeologists have tested numerous human and faunal bone and enamel specimens, both modern and archaeological (Figure 6.5 $^{87}Sr/^{86}Sr$ ratios for Greater Mesoamerica (Price et al. 2010:26).). These $^{87}Sr/^{86}Sr$ data show that local variation in biologically available Sr ratios is typically significantly less than that of geological strontium within a region, allowing greater precision by bioarchaeologists in using the data for confirming baselines and comparing biological samples (White et al.

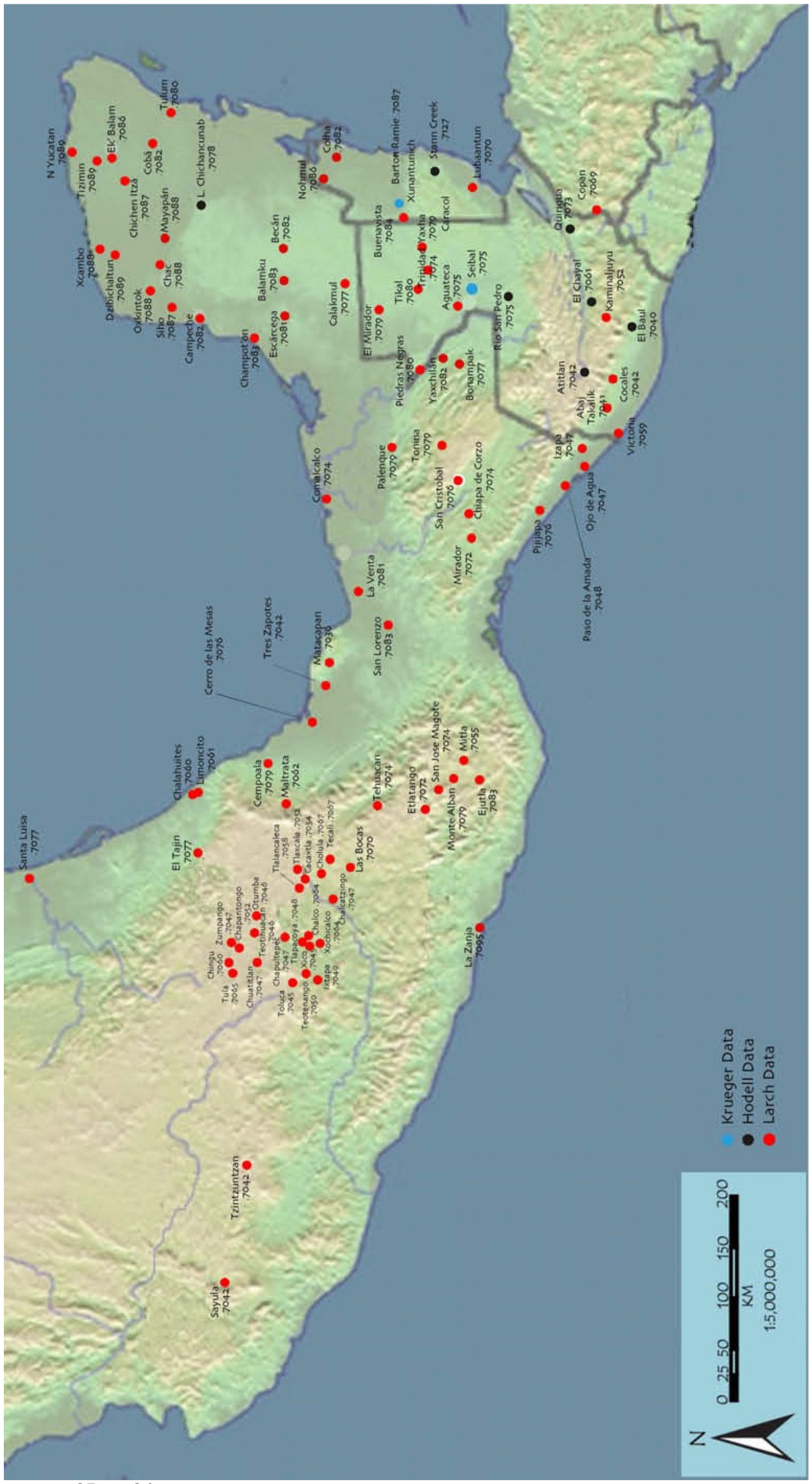

Figure 6.5 $^{87}Sr/^{86}Sr$ ratios for Greater Mesoamerica (Price et al. 2010:26).

2007). White and colleagues (2007) and Price and colleagues (2008, 2010) compiled specific $^{87}Sr/^{86}Sr$ ranges and means for various archaeological sites throughout greater Mesoamerica. In the central highlands of Mexico (or the Basin of Mexico), $^{87}Sr/^{86}Sr$ ratios range between 0.7046 and 0.7055 with specific average values for Teotihuacan of 0.7046, Chapantongo (Hidalgo) of 0.7052, Xico (Valley of Mexico) of 0.7045, and Tzintzuntzan (Michoacan) of 0.7042 (White et al. 2007). For the site of Monte Alban in the Valley of Oaxaca, the average $^{87}Sr/^{86}Sr$ ratio is 0.7074 (White et al. 2007) and median is 0.7075 (Price et al. 2008), which are near the range for the geological samples from its region of the Sierra Madre del Sur. Price and colleagues (2008) report values for the Gulf lowlands at the sites of San Lorenzo (0.7083) and La Venta (0.7081).

Oxygen Baselines for the Maya Region and Greater Mesoamerica

Oxygen isotope ratios ($\delta^{18}O$) from bone and enamel reflect the ratio of precipitated meteoric water ingested by an individual; these ratios may characterize the region of inhabitance (Longinelli and Padalino 1980). In Mesoamerica, oxygen isotope ratios ($\delta^{18}O$) vary depending on the rainfall within the region (Figure 6.6), allowing for isotopically distinct ranges (each with about 2‰ internal variability) among the regions of Western Mexico, Valley of Oaxaca, the Gulf coast, southern highlands, northern lowlands, southern/central lowlands, Belize lowlands, central highlands/basin of Mexico, and the Pacific coast (White et al. 2002, 2004, 2007; Price et al. 2010; Lachniet and Patterson 2009). Baseline ratios have been established for water sources proximate to specific sites in these regions, including Teotihuacan, Altun Ha, Kaminaljuyu, Tzintzuntzan, Rio Azul, and Monte Alban (White et al. 1998; Wright and Schwarcz

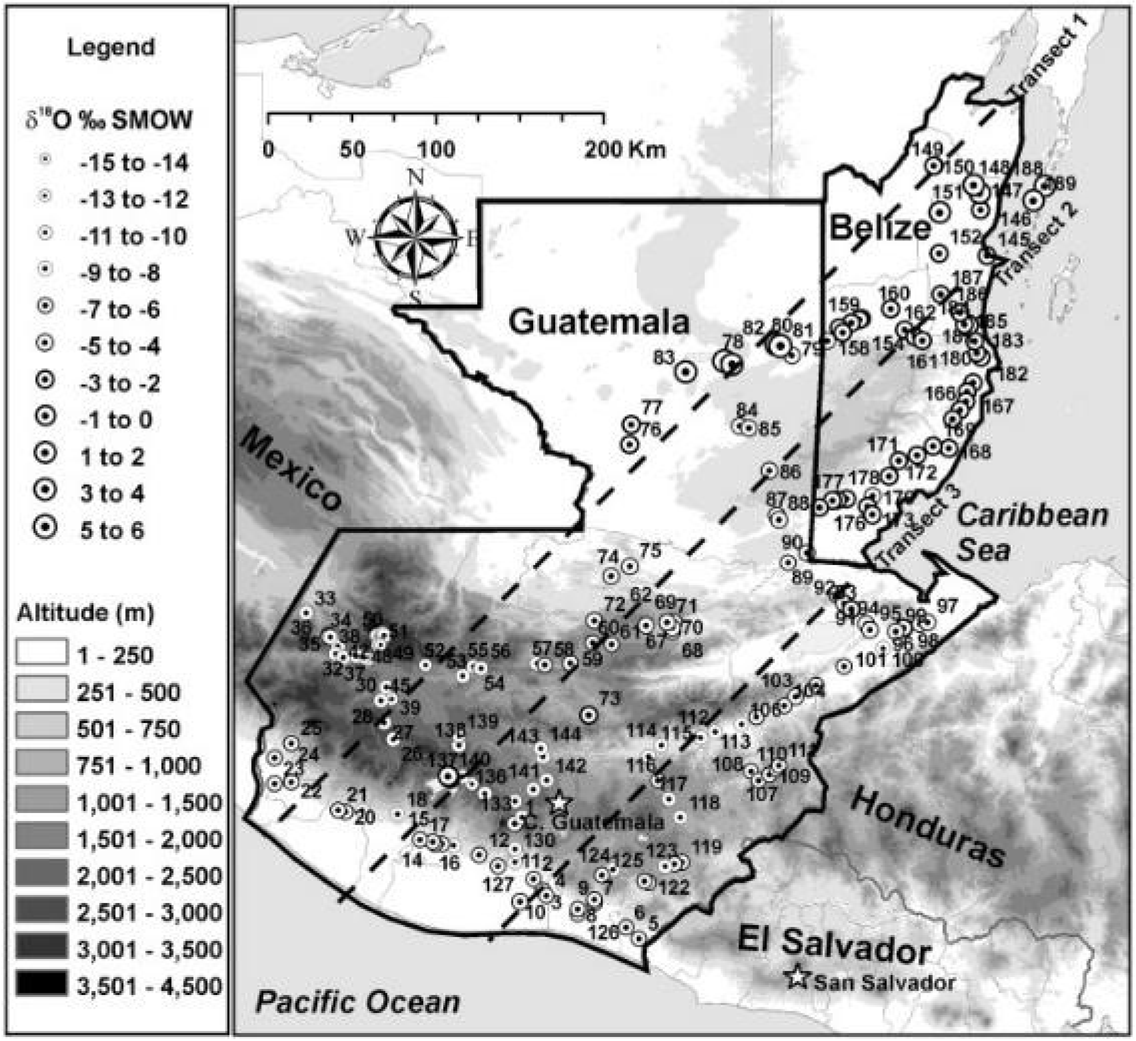

Figure 6.6 Guatemalan oxygen isotope values from water samples from Lachniet and Patterson (2009:436).

1998; White et al. 2000, 2002). Price and colleagues (2010) compiled the available data, adding baseline ratios for Calakmul, Campeche, Chapantongo, Copan, Maltrata, Palenque, Palmarejo, Tikal, Aloyac, Cholula, and Balberta (Figure 6.7). In general, sites on the Belize coast have the highest oxygen ratio values, while highland sites (such as Kaminaljuyu) have lower ratios and ratios of Petén sites lie in between (Price et al. 2010).

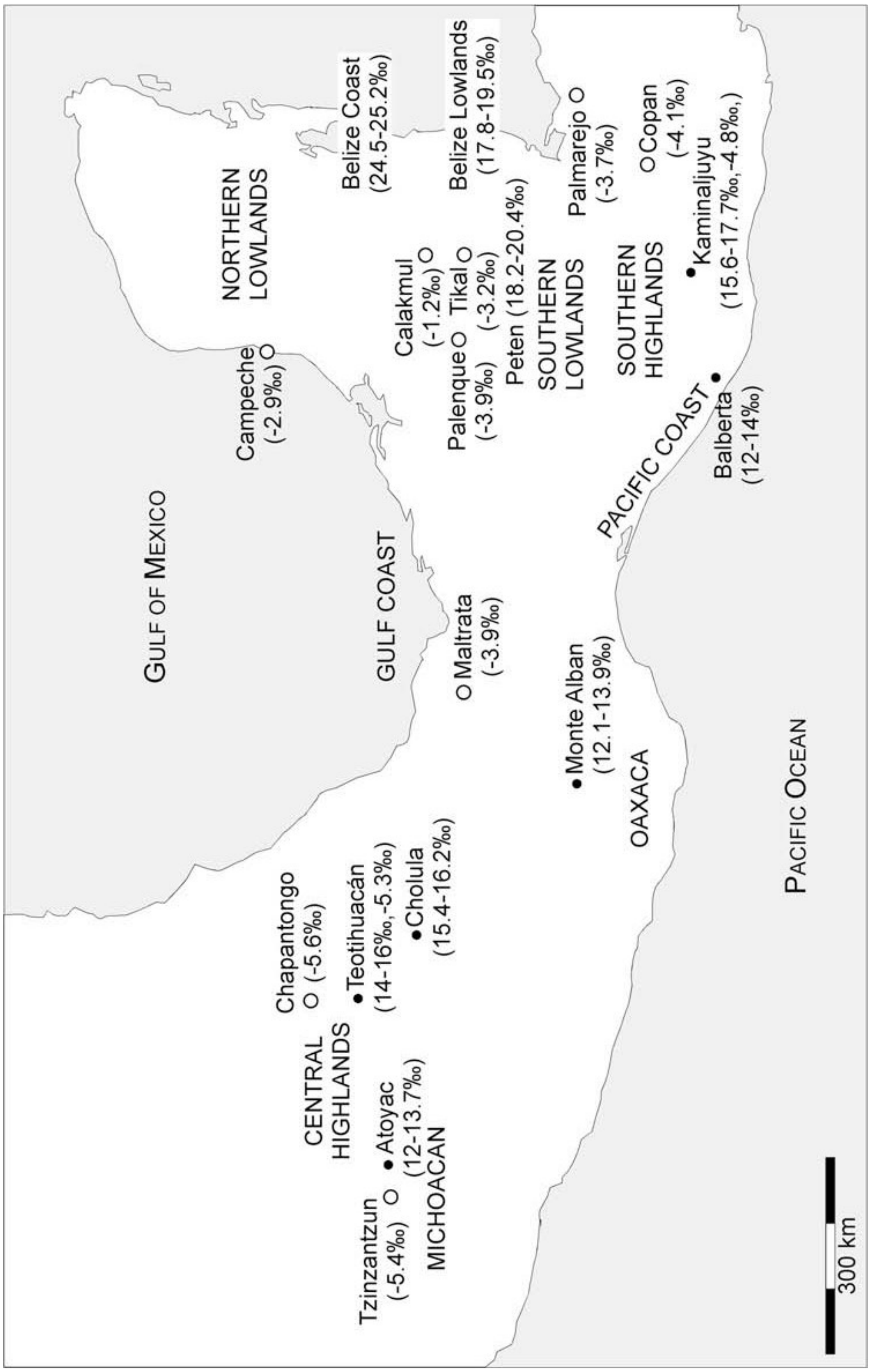

Figure 6.7 Oxygen isotope ratios for Mesoamerica (Price 2010:23). Phosphate results (White et al. 2004, 2000, 1998) with black circle, carbonate (Wright and Schwarcz 1999, Buikstra et al. 2004, Price et al. 2007) with open circle.

In the highlands of Mexico, ratios are lower with the ratios of Teotihuacan and Cholula having slightly higher values than Michoacan and Monte Alban to the west and south Price et al. 2010). These ratios follow the general trend also observed in carbonate samples where more enriched oxygen ratios characterize the coast and in the lowlands, while more depleted ratios are found inland and in the highlands. As there is high regional variability (2‰) within oxygen stable isotope ratios, the analysis of $\delta^{18}O$ cannot necessarily be used to pinpoint region of geographic origin, but instead is more useful in identifying individuals with non-local isotope ratios, especially in comparison with the available strontium ratios for the same individuals.

Carbon Isotopic Analysis and Diet Zones of the Maya Region

In the Maya area, carbon stable isotope analysis has been applied mostly to understanding the proportion of maize consumed, as it was the only C_4 plant consumed in large quantities in the area. Many studies of $\delta^{13}C$ have demonstrated that there was substantial variation in Maya maize consumption both temporally (Figure 6.9) and geographically (Figure 6.8; Table 6.3) (Gerry 1993; Wright and White 1996; Gerry and Krueger 1997; White 1999; Tykot 2002). In a few cases (i.e., Pacbitun and Piedras Negras), more elite individuals had higher $\delta^{13}C$, but this has not been found to be a constant correlate to high social status among the Maya (White et al. 1993; Scherer et al. 2007; Wright et al. 2010). Wright and colleagues (2010) suggest that $\delta^{13}C$ could be used to differentiate diet zones and mobility between them, but most usefully as supporting evidence for strontium and oxygen results.

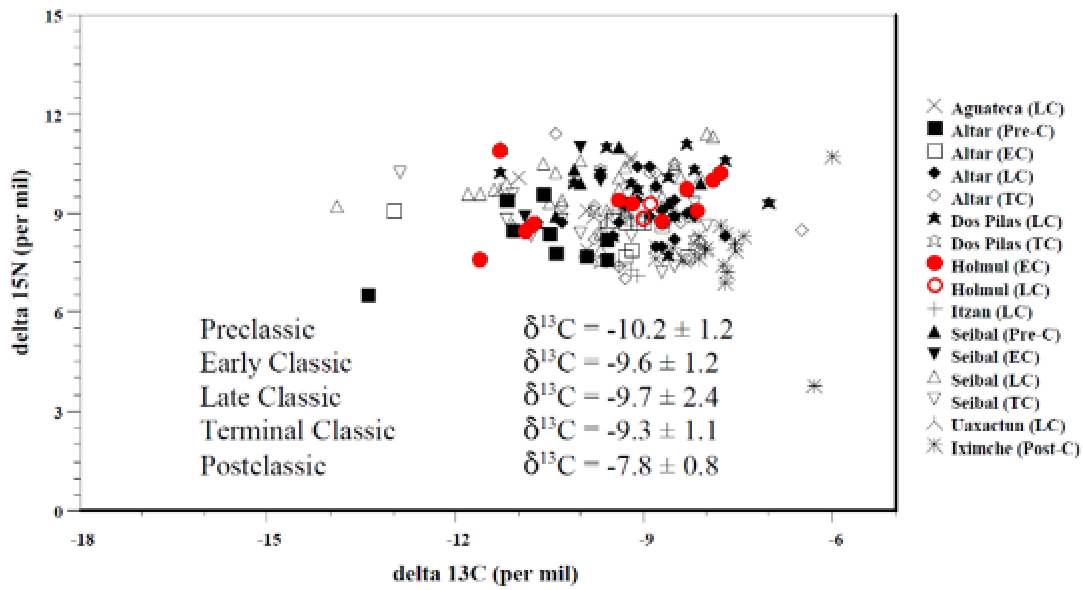

Figure 6.9 Bone collagen stable isotope data for Maya sites in the Peten and Guatemala with means of the periods. Holmul data from Gerry 1993 in red (adapted from Tykot 2002:9).

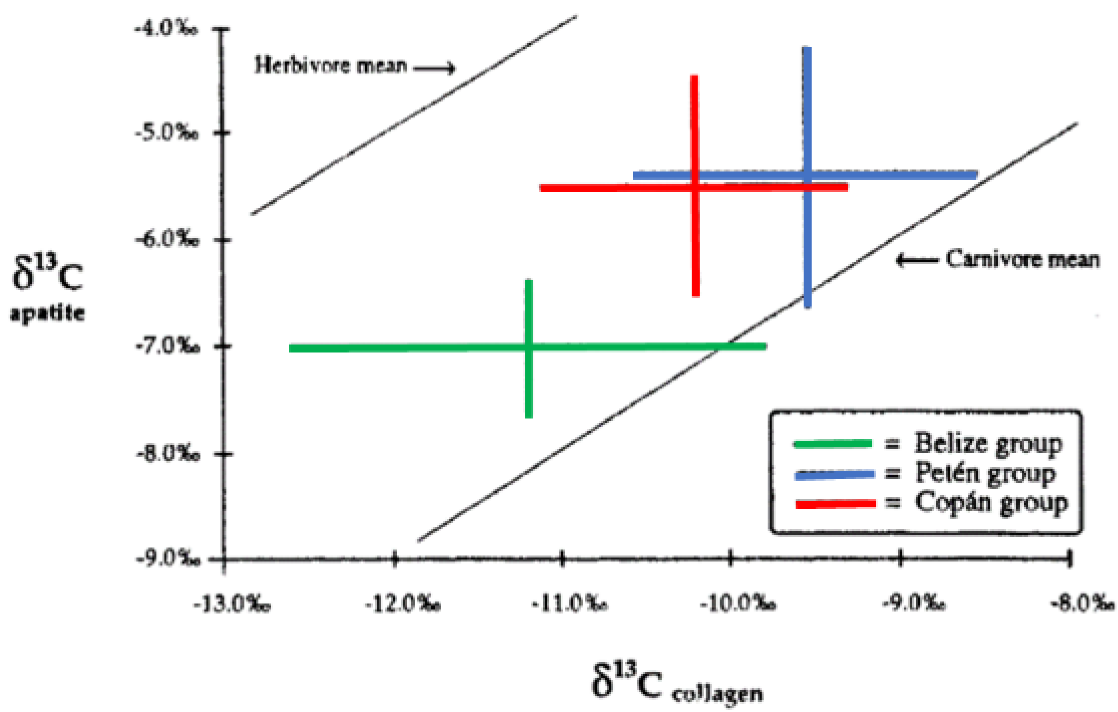

Figure 6.8 Carbon isotopic separation based by regional group. Mean is at the center of the crossline plots with the lines representing plus or minus 1 s.d. (adapted from Gerry and Krueger 1997: 205).

Zone, Site, or Region	*mean*	*s.d.*	*median*	*reference*
Belize River Zone	-5.4	1.49	-5.26	Freiwald 2011:265-266
Macal River Zone	-6.4	1.47	-6.31	Freiwald 2011:265-266
Southern Lowland Zone	-3.4	0.4	-3.36	Freiwald 2011:265-266
Central Lowland Zone	-3.9	1.45	-3.36	Freiwald 2011:265-266
Holmul Site	-4.3	0.68	-	Gerry 1993:168
Petén Region	-5.4	1.17	-	Gerry 1993:168
Belize Region	-7	0.56	-	Gerry 1993:168
Copan Region	-5.5	1.01	-	Gerry 1993:168

Table 6.3 Comparative $\delta^{13}C_{ap}$ results (values are per mil ‰).

Laboratory Methodology

Dental Enamel Preparation and Sampling

Sample collection occurred in 2014 at the Holmul Archaeological Project laboratory facilities in Antigua, Guatemala and were exported in 2015 and 2016 in accordance with Guatemala's cultural heritage laws. Additional samples were selected in 2015 from the Osteological Collections at the Peabody Museum of Archaeology and Ethnology at Harvard University.

The teeth selected for isotopic testing were based on their preservation and characteristics. Ideally, first molars (maxillary or mandibular) were sampled because they are developed first in childhood and being the largest molars, allow for less destruction of the tooth when sampled. If the first molar was not available, the second molar was sampled. If the first or second molars are not available to sample, it is possible and productive to analyze the dental enamel from third molars, premolars, or canines (Slater et al. 2014). The dentition selected for isotopic sampling did not include those with inlays or dental modification, dental pathology and major postmortem damage. All of the dentition was photographed prior to destructive analysis.

The protocol used for tooth carbonate preparation and extraction was based on that of Balasse and colleagues (2002). This methodology requires very small amounts of biological apatite from tooth enamel for the stable isotope analysis (Bethard 2012). For all of the isotopic tests, a less than 30 mg sample of enamel was required from each tooth.

The enamel preparation and sampling were performed in the Environmental Archaeology Laboratory in the Department of Archaeology at Boston University. Prior to the drilling of the enamel, the teeth were sonicated in deionized water and the enamel was cleaned manually with the use of a Dremel tool with a carbide drill tip to remove any diagenetic contamination on the surface. For each tooth, 20-30 mg of enamel was removed with a diamond burr; half of the enamel was designated for strontium isotope analysis and half for oxygen and carbon isotope analysis. The enamel powder was placed in 1.5 ml microcentrifuge tubes and agitated with a vortexer with approximately 1.5 ml of 2-3% NaOCl. The tubes stood overnight in the Clorox solution to remove collagen from the enamel powder. The NaOCl was washed from the enamel powder through a repeated process of adding distilled water, vortexing the sample, spinning in the centrifuge, and decanting the solution. After four rinses, the sample in each tube was reacted with 0.1 M acetic acid for four hours to remove adsorbed carbonates. The acetic acid was then removed through the same process of four rinses. The samples were frozen and left to dry overnight in a vacuum.

Stable Carbon and Oxygen Isotope Analysis

The prepared enamel samples for oxygen and carbon isotopic analysis were processed in the Boston University Stable Isotope Laboratory using a GV Instruments IsoPrime isotope ratio mass spectrometer (IRMS) and its associated MultiFlow device to report the oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) values (see Revesz et al. (2001) for a similar protocol). The samples were combusted into gas and ionized to be detected by the mass spectrometer, and measured against the known standards, Carera Z and NBS-20, of the Vienna Peedee Belemnite (VPDB) (Coplen 1994; Balasse et al. 2002; Price et al. 2010). The results were normalized to the USGS 18 and 19 standards, using 2-point normalization.

Strontium Isotope Analysis

The prepared enamel samples were transferred to the Thermal Ionization Mass Spectrometry (TIMS) Facility at Boston University to undergo strontium extraction in their clean lab. The procedure was derived from a protocol by Denise K. Honn, a former manager of the facility, and supervised by current laboratory manager, Nilotpal Ghosh. The microcentrifuge tubes of the powered samples were re-weighed for greater precision. To transfer each sample into a Teflon beaker, 1 mL of 1.5N of hydrochloric acid (HCl) was added to the microcentrifuge tube to prevent static sample loss common to clean lab facilities. The sample underwent a dissolution process using the smallest possible amount of HCl needed. Before finally drying down the fully dissolved sample, a known concentration of ^{84}Sr (300 nanograms) was added or “spiked”. This process creates an internal standard, so the total amount of strontium in the sample can be calculated. The spiked sample was then fully dried and dissolved in 500 μL of 3.5 N nitric acid.

In order to separate the strontium within the samples from other interfering elements, each sample was passed through cation exchange columns filled with strontium exchange resin (Balasse et al. 2002). Following the preparation of the columns, the strontium specific resin was added, and the sample dissolved in nitric acid was loaded into the column. The columns were repeatedly washed with 3.5 N nitric acid, which binds strontium to the resin, to flush non-strontium elements into a waste beaker. Finally, the columns are flushed with Milli-Q water, which allows the strontium to detach from the resin and empty into a separate, clean beaker. The samples were then dried down to prepare for loading on the TIMS filaments.

Thirty-eight samples were loaded on to pre-outgassed single rhenium filaments for $^{87}Sr/^{86}Sr$ analysis at the BU TIMS facility. The filaments were loaded onto a turret along with multiple samples of Sr standards (SRM987) which have an established $^{87}Sr/^{86}Sr$ ratio. The turret was then placed into the ion source of a ThermoFinnigan Triton TIMS and pumped down to a high vacuum to begin analysis. During the period of analysis, 11 runs of the SRM 987 strontium isotopic standard were run with a mean value of 0.710278±0.000005 and the typical accepted range for this standard between laboratories is between 0.71022 to 0.71028. Five samples failed to run (HOL-16-6, HOL-16-7, HOL-16-9, CIV-16-36, and CIV-16-38), and an additional sample (SUF-16-31) ran poorly with the error of 0.000253.

Due to mechanical issues with BU's ThermoFinnigan Triton TIMS, the remaining fifteen samples were transported to the Boston College TIMS Facility for analysis. These samples were loaded on to filaments for the Isotopx Phoenix TIMS instrument in the Boston College facility, supervised by Mike Tappa. At Boston College, the uncertainty is reported as the greater value between the 2SE internal precision of the run or the external reproducibility (2SD) of the standard (SRM 987). All of the samples ran with better internal precision than the external reproducibility (excepting HAM-16-48), the uncertainty reported for the samples at BC is 0.000007. Both the Boston College and Boston University used the same batch of strontium standard, as the Boston College TIMS Facility was also founded by Dr. Ethan Baxter, the former director of the Boston University TIMS Facility.

The TIMS separates atoms based on mass and accelerates them towards a mass analyzer and ion collector to detect the count of each isotope. Each sample is heated via current to just above 1400° C for maximum ionization. The Faraday cup configuration collected data on $^{88}Sr/^{86}Sr$, $^{87}Sr/^{86}Sr$, $^{85}Rb/^{86}Sr$, $^{84}Sr/^{86}Sr$, and $^{84}Sr/^{88}Sr$ for each sample in 20 blocks of 20 cycles (a total of 400 times). For any interference from ^{87}Rb, it was corrected by applying an $^{87}Sr/^{85}Rb$ value of 0.38595 to each gathered strontium ratio. To correct any fractionation, the $^{88}Sr/^{86}Sr$ ratio was normalized to 8.375209, and applied to each ratio. Further data reduction included eliminating outliers and subtracting the ^{84}Sr spike from the samples. The data from both the Boston College and Boston University TIMS facilities were reduced in the same way, using the same reduction methods and spreadsheet, and was found to be comparable.

Chapter Summary

Bone chemistry and stable isotope analysis have provided the tools for bioarchaeologists to evaluate the diet, residential mobility, and life histories of past populations from the human skeletal remains in archaeological contexts. This chapter presented the comparative baseline information for stable isotope analysis of the Maya region and Greater Mesoamerica. The laboratory methods for preparing the enamel samples followed, including a discussion of the mass spectrometry process.

CHAPTER 7: STABLE ISOTOPE RESULTS AND STATISTICAL ANALYSIS

One method for identifying non-local individuals is to use chemical signals of geographic origin recorded within dental enamel. In the following chapter, each isotopic dataset, $^{87}Sr/^{86}Sr$, $\delta^{18}O$ and $\delta^{13}C$, is evaluated separately for statistical outliers. Following the removal of $^{87}Sr/^{86}Sr$ ratio outliers, the local ratio signature is presented for the Holmul region, as well as for the sites of Holmul, Cival, La Sufricaya, K'o, and Hamontun. The three lines of isotopic data are combined in pairs using bivariate plots to corroborate any outliers previously identified. The statistical outliers are evaluated for their likelihood of being non-local individuals and these results will be considered within the osteobiographies of the next chapter and in discussing their social and political identities.

Strontium Isotope Results

Burial ID	**Site**	**Sample ID**	**$^{87}Sr/^{86}Sr$**	**2-Sigma**	**[Sr] ppm**
HOL.T.06.09.01	Holmul	HO-16-1	0.70812	0.000004	92.2
HOL.T.24.23.07.01	Holmul	HO-16-2	0.70809	0.000007	11.2
HOL.T.28.04.09.01	Holmul	HO-16-3	0.70808	0.000004	42.8
HOL.T.30.20.09.01	Holmul	HO-16-4	0.70847	0.000006	22.5
HOL.T.37.09.01.01	Holmul	HO-16-5	0.70853	0.000007	20.8
HOL.T.30.33.09.01	Holmul	HO-16-6	-	-	-
HOL.T.47.05.09-04.01	Holmul	HO-16-7	-	-	-
HOL.T.28.33.09.01	Holmul	HO-16-8	0.70817	0.000012	27.9
HOL.T.50.27.09.01	Holmul	HO-16-9	-	-	-
HOL.L.20.21.09.01.02	Holmul	HO-16-10	0.70842	0.000066	40.3
HOL.L.20.15.09.01	Holmul	HO-16-11	0.70823	0.000022	29.6
HOL.L.20.21.09.01.01	Holmul	HO-16-12	0.70827	0.000016	34.9
HOL.T.84.14.09.01	Holmul	HO-16-13	0.70825	0.000009	28.8
HOL.T.78.42.09.01	Holmul	HO-16-14	0.70815	0.000014	28.8
58596.0.2	Holmul	HO-16-15	0.70780	0.000012	78.8
58599.0.02	Holmul	HO-16-16	0.70834	0.000020	10.8

58599.0.1	Holmul	HO-16-17	0.70828	0.000009	31.6
58600.0.2	Holmul	HO-16-18	0.70816	0.000014	34.4
58601.0.01	Holmul	HO-16-19	0.70823	0.000091	38.6
58605.01	Holmul	HO-16-20	0.70815	0.000011	45.7
58607.1.1	Holmul	HO-16-21	0.70835	0.000010	36.3
58618.0.1	Holmul	HO-16-22	0.70828	0.000007	14.0
58620.01	Holmul	HO-16-23	0.70825	0.000007	40.5
58622.0.1	Holmul	HO-16-24	0.70821	0.000011	21.8
HOL.T.93.27.09.01	Holmul	HO-16-68*	0.70831	0.000004	12.1
HOL.T.100.03.09.01	Holmul	HO-16-69*	0.70844	0.000004	16.7
HOL.T.98.04.09.01	Holmul	HO-16-70*	0.70807	0.000003	20.4
SUF.T.11.06.09.01	La Sufricaya	SU-16-25	0.70851	0.000006	23.1
SUF.ST.09.02.09.03.01	La Sufricaya	SU-16-26	0.70842	0.000010	28.6
SUF.ST.20.27.09.01	La Sufricaya	SU-16-27	0.70848	0.000005	20.3
SUF.T.23.54.09.01	La Sufricaya	SU-16-28	0.70809	0.000007	26.2
SUF.T.23.66.09.01	La Sufricaya	SU-16-29	0.70852	0.000010	16.2
SUF.T.03.09.01	La Sufricaya	SU-16-30	0.70830	0.000008	27.7
SUF.L8.01.09.01	La Sufricaya	SU-16-31	0.70875	0.000253	38.2
CIV.T.22.13.09.01	Cival	CI-16-32	0.70813	0.000007	25.9
CIV.T.28.11.09.01	Cival	CI-16-33	0.70783	0.000004	127.8
CIV.T.45.11.09.01	Cival	CI-16-34	0.70793	0.000005	37.5
CIV.T.45.11.09.02	Cival	CI-16-35	0.70818	0.000009	29.0
CIV.T.55.03.09.01	Cival	CI-16-36	-	-	-
CIV.T.63.03.09.01	Cival	CI-16-37	0.70844	0.000006	15.4
CIV.T.61.04.09.01	Cival	CI-16-38	-	-	-
CIV.T.01.09.01	Cival	CI-16-39*	0.70783	0.000005	49.1
CIV.T.01.04.09.01	Cival	CI-16-40*	0.70792	0.000004	37.5
KOL.T.26.03.09.01	K'o	KO-16-41*	0.70797	0.000002	32.3
KOL.L.07.01.09.01	K'o	KO-16-42*	0.70842	0.000004	15.4
KOL.L.02.00.09.01	K'o	KO-16-43*	0.70841	0.000006	12.2
KOL.T.17.01.09.01	K'o	KO-16-44*	0.70837	0.000004	95.0
KOL.T.32.06.09.01	K'o	KO-16-45*	0.70845	0.000004	15.0
KOL.T.32.10.09.01	K'o	KO-16-46*	0.70840	0.000004	18.3
HAM.T.07.08.09.01	Hamontun	HA-16-47*	0.70806	0.000003	29.5
HAM.T.05.08.09.01	Hamontun	HA-16-48*	0.70817	0.000018	26.7
HAM.LT.30.01.09.01	Hamontun	HA-16-49*	0.70814	0.000005	30.7
HAM.T.28.02.14.01	Hamontun	HA-16-50*	0.70835	0.000003	30.9

Table 7.1 $^{87}Sr/^{86}Sr$ results. *Analyzed at the Boston College TIMS Facility.

On the right side of Figure 7.1, the $^{87}Sr/^{86}Sr$ ratios of all enamel samples (Table 7.1) are graphed in columns, with the Holmul samples in dark blue, the La Sufricaya samples in orange, the Cival samples in grey, the K'o samples in yellow, and the Hamontun samples in green. On the far left of the graph are the box-and-whisker plots for Hodell and colleagues' (2004) $^{87}Sr/^{86}Sr$ ratios of flora, rock, soil, and water from the southern lowlands and the northern lowlands. The northern lowlands* box-and-whisker is the ratios of flora, rock, and soil, removing the water ratios. They suggest using this selected sample because of the greater range of $^{87}Sr/^{86}Sr$ in water than bedrock, flora, and soil, and the large overlap of the water results between the northern and southern lowlands. They expect less overlap between these two regions due to the contribution from food consumption connected to the bedrock. When the water results are removed, the $^{87}Sr/^{86}Sr$ results demonstrate a near linear trend between the two regions.

The box plots (lacking whiskers) to the right of the Hodell and colleagues' (2004) plots are derived from the reported $^{87}Sr/^{86}Sr$ interquartile ranges (IQR= middle 50% of data) compiled by Price and colleagues (2015) for the regions of the central Maya area and northern lowlands. This data was produced not from soil, rock, plant, and water, but from archaeological human and faunal skeletal remains. The data for the high and low whiskers is not available.

All five IQR boxes are extended to the right in bands, overlapping the $^{87}Sr/^{86}Sr$ results from this study to demonstrate the possible regions of origin for the individuals. The lowest band in light blue represents the southern lowlands region of Hodell and colleagues (2004). The high and low whiskers are quite large, overlapping a large portion

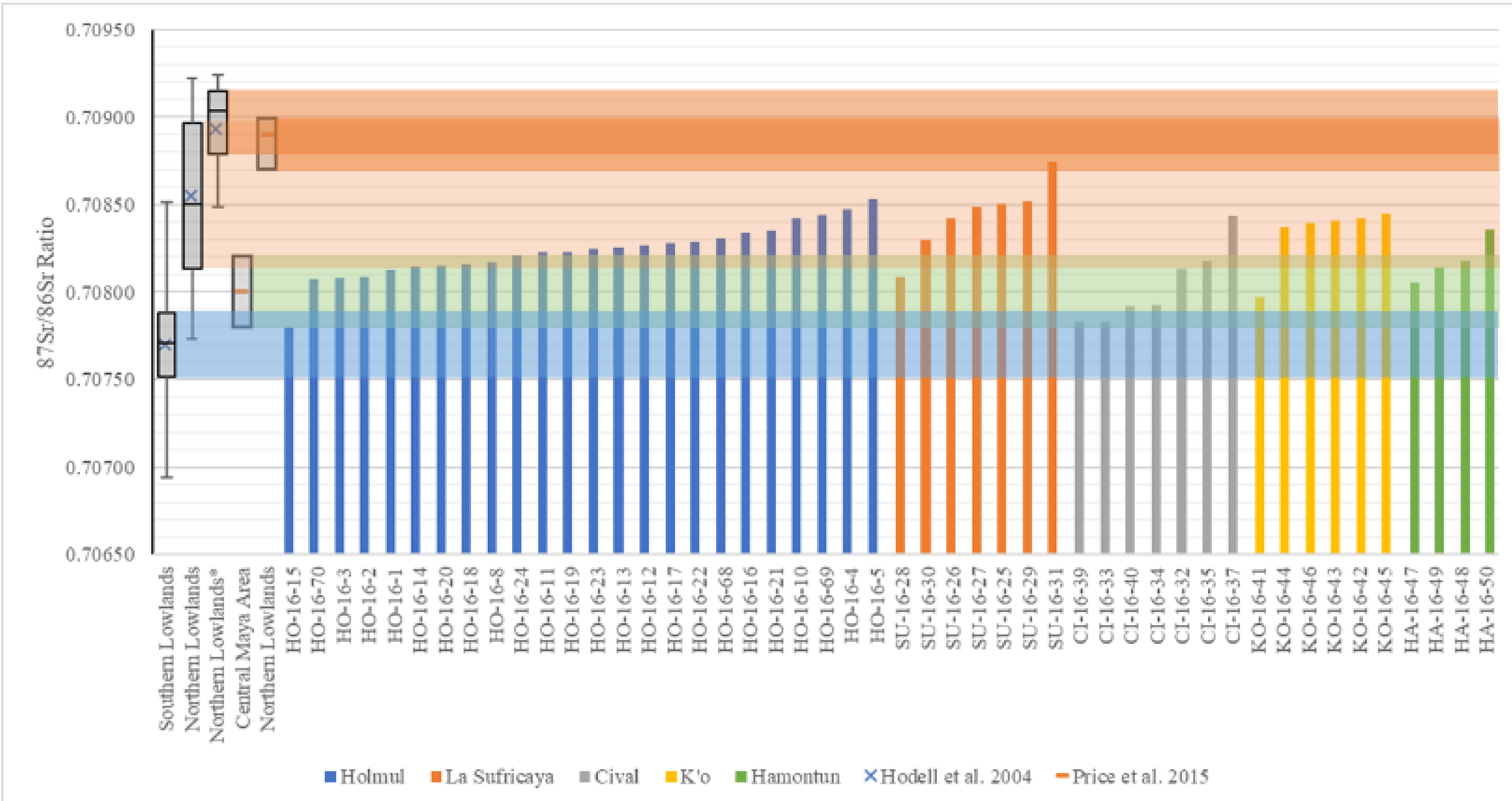

Figure 7.1 $^{87}Sr/^{86}Sr$ ratios of the complete Holmul region dataset (columns to the right) compared with box-and-whisker plots for Hodell et. al's 2004 northern lowland and southern lowland ratios (from modern flora, rock, soil, and water samples) and the IQRs (from archaeological faunal and human skeletal remains) for the central Maya area and northern lowlands reported by Price et al. 2015. *Northern lowlands box-and-whisker plot is from samples of flora, rock, and soil, with water samples removed.

of their northern lowland region and including the central Maya area IQR of Price and colleagues (2015) extended in green. Further, the IQRs of these two regions also overlap. These overlaps are expected as the boundaries of these regions are not agreed upon and the data may include some migrant individuals. Further the overlap of the central Maya area and the southern lowlands is expected as they are frequently considered the same region, with the northern lowlands quite removed to the north.

The upper two bands are from the IQRs of the northern lowlands of Price and colleagues (2015) and Hodell and colleagues (2004) with water samples removed. None of this study's results fall within these IQRs, although one (HO-16-5) falls in the range of the low whisker for northern lowlands, water results removed.

Many ratios from this study fall within the band of the IQR of Hodell and colleagues' (2004) northern lowland region with water results included. I hesitate to conclude that these individuals were from the northern lowland region as Hodell and colleagues (2004) suggested removing the water results, and because the IQR of Hodell and colleagues' (2004) northern lowlands (plant, soil, and rock only) and Price and colleagues' (2015) northern lowlands (skeletal remains) are quite similar. It is as possible that the results from this study that fall in this intermediate zone are within the low whisker range of Price and colleagues' (2015) northern lowlands and the high whisker range of their central Maya area. It is also worthwhile to note that five out of the six results for the site of K'o fall outside of the IQR 50% for the central Maya area and southern lowlands, which may reinforce the idea that a site's local $^{87}Sr/^{86}Sr$ ratio, may fall outside of the 50%, yet within the whiskers.

Identifying Statistical Outliers

All of the $^{87}Sr/^{86}Sr$ results fall within the ranges for the Maya lowlands, with no migrants from elsewhere in the Maya region (highlands, or coasts, etc.) or greater Mesoamerica. It is likely that any outliers within site-specific results are from elsewhere in the lowlands.

The interquartile range (IQR) is presented in Figure 7.2. The IQR is presented in two box-and-whisker plots, calculated both by excluding the median and including the median, if the number of values is odd. Excluding the median is the default in most statistical programs, allowing for a more accurate (and conservative) consideration of the population and its outliers. Including the median narrows the IQR, revealing more possible outliers in a more liberal (and less accurate) approach. These plots follow the Tukey standard, where values are outliers if they fall outside a distance of 1.5 times the IQR beyond the upper or lower hinge; the high and low whiskers represent the largest and smallest values, respectively, within 1.5 IQR of the box hinges.

When the box-and-whisker plots are constructed with the IQR excluding the median, they identify two outliers, one in the Holmul dataset (58596.0.2) and one in the K'o dataset (KOL.T.26.03.09.01). Chauvenet's criteria (Taylor 1982) concurs with the IQR identification of the outliers in the Holmul and K'o datasets. When the box-and-whisker plots are constructed with the IQR including the median, they identify two additional outliers in the La Sufricaya dataset (SUF.L8.01.09.01 and SUF.T.23.54.09.01). Additional tests, such as Chauvenet's criteria, did not confirm either outlier status. Tentatively, these can be considered outliers and will be discussed while considering the

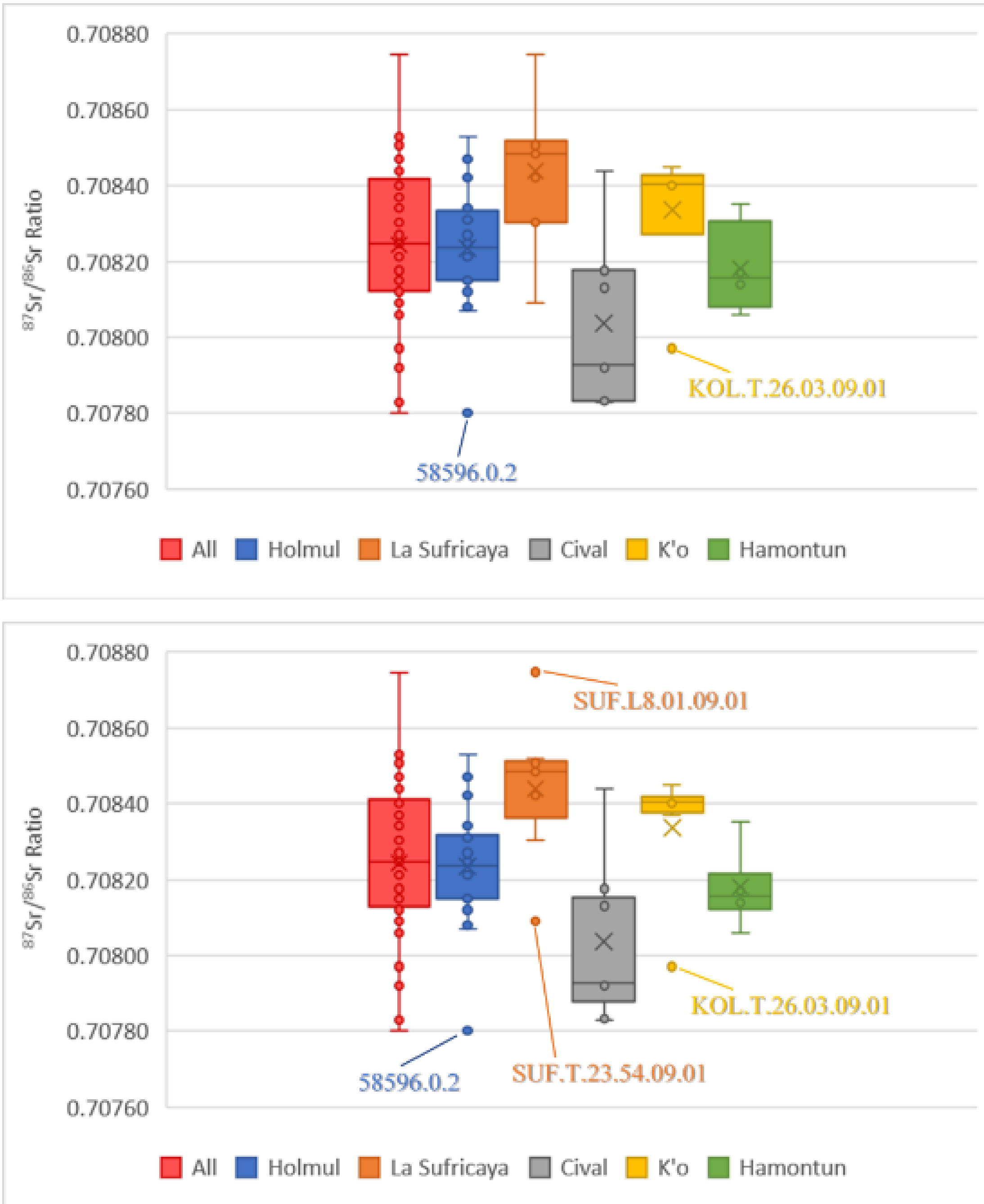

Figure 7.2 Box-and-whisker plots for the complete $^{87}Sr/^{86}Sr$ datasets (exclusive median above, inclusive median below).

other isotopic results and the archaeological context. For SUF.L8.01.09.01 the 2-sigma was higher than usual (0.000253), which suggests that this outlier might be a result of a testing error. It is important to note that when the complete dataset is considered, the IQR (nor Chauvenet's criteria) does not indicate any possible outliers, which further suggests that any outliers suggested may be due to the small samples sizes and are most likely still from the Holmul region.

Preliminary statistics for the complete datasets are presented in Table 7.2 and without the four possible outliers in Table 7.3.

	n	*min*	*max*	*mean*	*s.d.*	*median*	*IQR (50%)*
Holmul	24	0.70780	0.70853	0.70824	0.00016	0.70824	0.70815-0.70833
La Sufricaya	7	0.70809	0.70875	0.70844	0.00020	0.70848	0.70830-0.70852
Cival	7	0.70783	0.70844	0.70804	0.00022	0.70793	0.70783-0.70818
K'o	6	0.70797	0.70845	0.70834	0.00018	0.70840	0.70827-0.70843
Hamontun	4	0.70806	0.70835	0.70818	0.00013	0.70816	0.70808-0.70831
All Sites	48	0.70780	0.70875	0.70824	0.00020	0.70825	0.70813-0.70841

Table 7.2 $^{87}Sr/^{86}Sr$ results by site, including outliers (values are per mil ‰).

	n	*min*	*max*	*mean*	*s.d.*	*median*	*IQR (50%)*
Holmul	23	0.70807	0.70853	0.70825	0.00013	0.70825	0.70815-0.70834
La Sufricaya	5	0.70830	0.70852	0.70845	0.00009	0.70848	0.70836-0.70851
Cival	7	0.70783	0.70844	0.70804	0.00022	0.70793	0.70783-0.70818
K'o	5	0.70837	0.70845	0.70841	0.00003	0.70841	0.70838-0.70843
Hamontun	4	0.70806	0.70835	0.70818	0.00013	0.70816	0.70808-0.70831
All Sites	44	0.70783	0.70853	0.70825	0.00018	0.70826	0.70814-0.70841

Table 7.3 $^{87}Sr/^{86}Sr$ results by site, excluding outliers (values are per mil ‰).

Estimating Local $^{87}Sr/^{86}Sr$ Ratios

With or without outliers, there is a statistically significant difference among the five sites as determined by one-way ANOVA (outliers included: $F(4,43) = 5.19712$, $p = 0.0016637$; outliers removed: $F(4,39) = 8.690471$, $p = 0.000041$), as presented in Table

7.4 andTable 7.5. Two-sample *t*-tests assuming unequal variances were performed for all pairs to determine which site was significantly different. The Bonferroni correction (Bonferroni 1936) was applied to account for the increased Type 1 error rate. Following this correction, when the complete dataset was considered (including outliers) only one pair was statistically different: La Sufricaya and Cival. When outliers were removed, the *t*-tests (using the Bonferroni correction) suggest that numerous pairs were statistically different: Holmul and La Sufricaya, Holmul and K'o, Cival and K'o, and La Sufricaya and Cival. With the outliers removed, it becomes more likely, as demonstrated by these *t*-tests, that the site means may represent "local" means, especially for Holmul, La Sufricaya, Cival, and K'o (although La Sufricaya and K'o have similar means).

Groups	Count	Sum	Average	Variance
Holmul	24	16.9976582	0.708236	2.42E-08
La Sufricaya	7	4.959069	0.708438	4.14E-08
Cival	7	4.95625124	0.708036	5.00E-08
K'o	6	4.25001249	0.708335	3.21E-08
Hamontun	4	2.83272415	0.708181	1.59E-08

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	6.35E-07	4	1.59E-07	5.19712	0.0016637	2.588836
Within Groups	1.31E-06	43	3.06E-08			
Total	1.95E-06	47				

Table 7.4 One-way ANOVA of $^{87}Sr/^{86}Sr$ dataset with outliers included.

Groups	Count	Sum	Average	Variance
Holmul	23	16.28986	0.708255	1.61E-08
La Sufricaya	5	3.542232	0.708446	7.93E-09
Cival	7	4.956251	0.708036	5.00E-08
K'o	5	3.542039	0.708408	8.50E-10
Hamontun	4	2.832724	0.708181	1.59E-08

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	6.58E-07	4	1.64E-07	8.690471	0.000041	2.612306
Within Groups	7.38E-07	39	1.89E-08			
Total	1.4E-06	43				

Table 7.5 One-way ANOVA of $^{87}Sr/^{86}Sr$ dataset with outliers excluded.

As illustrated in Figure 7.1, all of the individuals from the Holmul region have $^{87}Sr/^{86}Sr$ ratios that fall within the IQR or the whiskers (1.5xIQR) of Hodell and colleagues' (2004) southern lowlands and northern lowlands regions (water samples removed). If most of the population was born locally and ingested local foods, there should be a normal distribution of $^{87}Sr/^{86}Sr$ within the population (Wright 2012). With this expectation in mind, statistical analyses using human data should be able to estimate a local $^{87}Sr/^{86}Sr$ ratio of the Holmul region, and of the sites with statistically significant means.

In order to estimate a local $^{87}Sr/^{86}Sr$ ratio for the site of Holmul, the outlier individual (58596.0.2) identified by the box-and-whisker plot in Figure 7.2, was removed from the complete dataset to produce a trimmed dataset. The trimmed dataset has a mean (and median) of 0.70825, with an IQR (50%) of 0.70815-0.70834. Similarly, to estimate a local $^{87}Sr/^{86}Sr$ ratio for the site of K'o, the outlier individual (KOL.T.26.03.09.01) removed, resulting in a trimmed dataset with a mean (and median) of 0.70841 and an IQR (50%) of 0.70838-0.70843. For La Sufricaya, the removal of the tentative outliers (SUF.L8.01.09.01 and SUF.T.23.54.09.01) produced a mean of 0.70845 and a median of 0.70848, with an IQR (50%) of 0.70836-0.70851. There were no statistically suggested outliers for the Cival dataset, and so the mean remains 0.70804 with the median 0.70793 and the IQR (50%) of 0.70783-0.70818. The Hamontun mean (although not statistically different from the other site means) is 0.70818, with the median of 0.70816 and the IQR (50%) of 0.7080-0.70831.

For the local $^{87}Sr/^{86}Sr$ ratio of the Holmul region, the removal of the site-specific outliers only adjusted the mean from 0.70824 to 0.70825, and the lower end of the IQR from 0.70813 to 0.70814. This minor adjustment is expected, as the box-and-whisker plot (and Chauvenet's criteria) of the complete dataset did not suggest any outliers. Further, the Holmul regional mean is nearly identical to the Holmul site mean, which is expected as over half of the samples in the complete dataset were excavated from Holmul. The site and regional means and IQR (Table 7.6) can be added to the larger, comparative data for the Maya region and greater Mesoamerica (Table 7.7).

	$^{87}Sr/^{86}Sr$ Mean	**IQR (50% of data)**	**n**	**sample type**
Holmul Region	0.70825	0.70814-0.70841	44	human
Holmul	0.70825	0.70815-0.70834	23	human
La Sufricaya	0.70845	0.70836-0.70851	5	human
Cival	0.70804	0.70783-0.70818	7	human
K'o	0.70841	0.70838-0.70843	5	human
Hamontun	0.70818	0.70808-0.70831	4	human

Table 7.6 Holmul region and sites "Local" $^{87}Sr/^{86}Sr$ means and IQR (outliers removed).

Regional Comparison of the $^{87}Sr/^{86}Sr$ Ratio Means

When considering the $^{87}Sr/^{86}Sr$ means from the sites of the Holmul region (Table 7.6), the values fall within the geological ranges identified from the southern lowlands and northern lowlands (Hodell et al. 2004). None of the individuals had $^{87}Sr/^{86}Sr$ ratios from elsewhere in the Maya region or greater Mesoamerica. However, because the $^{87}Sr/^{86}Sr$ ratio of an individual reflects the complexity in their diet, it is not a direct correlation to the geologically-derived regional baselines. The difference is demonstrated

Region	Site	Mean	IQR (50% of data)	n	Sample Type	Source
Northern Lowlands		0.70855	0.70813-0.70897	32	rock, soil, flora, water	Hodell et al. 2004
Northern Lowlands		0.70893	0.70847-0.70901	13	rock, water, flora	Hodell et al. 2004
Northern Lowlands		0.7089	0.7087–0.7090	93	human, fauna	Price et al. 2015
	Xcambo	0.7089			human, fauna	Price et al. 2015
	Mayapan	0.7088			human, fauna	Price et al. 2010
	Chichen Itza	0.7087			human, fauna	Price et al. 2015
	Coba	0.7082			human, fauna	Price et al. 2015
	Ek' Balam	0.7086			human, fauna	Price et al. 2015
	Campeche	0.7082			human, fauna	Price et al. 2015
	Dzibichaltun	0.7089			human, fauna	Price et al. 2010
	Tulum	0.7080			human, fauna	Price et al. 2015
Gulf Coast		0.7080	0.7076–0.7083	8	human, fauna	Price et al. 2015
	San Lorenzo	0.7085			human, fauna	Price et al. 2015
	La Venta	0.7081			human, fauna	Price et al. 2015
Southern Lowlands		0.70770	0.70748-0.70786	86	rock, soil, flora, water	Hodell et al. 2004
Central Maya Area		0.7080	0.7078–0.7082	168	human, fauna	Price et al. 2015
	Tikal	0.70812		86	human, fauna	Wright 2012
	Piedras Negras	0.7080			human, fauna	Price et al. 2015
	Calakmul	0.7077			human, fauna	Price et al. 2015
	Tonina	0.7079			human, fauna	Price et al. 2015
	Palenque	0.7079			human, fauna	Price et al. 2015
	El Mirador	0.7079			human, fauna	Price et al. 2010
	Yaxha	0.7079			human, fauna	Price et al. 2010
	Seibal	0.7075			human, fauna	Price et al. 2015
Maya Mountains of Belize		0.7150		12	human	Freiwald et al. 2014
Maya Mountains of Belize		0.7179		9	fauna	Freiwald et al. 2014

Maya Mountains of Belize	0.71327	0.71192-0.71514	3	water	Hodell et al. 2004
Stann Creek	0.7127			human, fauna	Price et al. 2015
Belize River Zone (Belize)	0.7086		17	flora, fauna	Freiwald 2011
Buenavista	0.7084			human, fauna	Price et al. 2010
Cahal Pech	0.70865		19	human	Freiwald 2011
Baking Pot	0.70866		22	human	Freiwald 2011
Barton Ramie	0.70862		17	human	Freiwald 2011
Macal River Zone (Belize)	0.7100		3	flora, fauna	Freiwald 2011
Chaa Creek	0.70950		8	human	Freiwald 2011
Vaca Plateau (Belize)	0.7077		4	flora, fauna	Freiwald 2011
Pacific Guatemala	0.7041	0.7041–0.7044	9	human, fauna	Price et al. 2015
Volcanic Highlands and Pacific Coast	0.70413	0.70400-0.70421	32	rock, flora, water, ash	Hodell et al. 2004
Abaj Takalik	0.7041			human, fauna	Price et al. 2015
Volcanic Highlands (Guatemala)	0.7047	0.7043–0.7053	26	human, fauna	Price et al. 2015
Kaminaljuyu	0.7052			human, fauna	Price et al. 2015
Metamorphic Province (without Montagua Valley)	0.70819	0.70727-0.70790	25	rock, flora, water, rainfall	Hodell et al. 2004
Metamorphic Province	0.7068	0.7064–0.7071	45	human, fauna	Price et al. 2015
Montagua Valley (& Copan)	0.70650	0.70530-0.70681	27	rock, flora, water, ash	Hodell et al. 2004
Copan	0.7069			human, fauna	Price et al. 2015
Oaxaca	0.7075	0.7075–0.7076	10	human, fauna	Price et al. 2015
Monte Alban	0.7079			human, fauna	Price et al. 2015
San Jose Magote	0.7074			human, fauna	Price et al. 2010
Valley of Mexico/Central Highlands	0.70470	0.7046–0.7051	86	human, fauna	Price et al. 2015
Teotihuacan	0.7046			human, fauna	Price et al. 2015

Chapantongo	0.7052			human, fauna	Price et al. 2015
Tula	0.7065			human, fauna	Price et al. 2010
Cholula	0.7067			human, fauna	Price et al. 2010
West Mexico	0.7039	0.7039–0.7040	15	human, fauna	Price et al. 2015
Tzintzuntzan	0.7042			human, fauna	Price et al. 2015

Table 7.7 Compiled Mesoamerican site and regional $^{87}Sr/^{86}Sr$ means (and IQR when available).

at Tikal, where the geological baseline mean was 0.7078, but the $^{87}Sr/^{86}Sr$ mean from human remains was higher at 0.70812 (Wright 2005b). Wright (2005b) explains this difference as a result of the inclusion of sea salt in the diet, which, with its higher $^{87}Sr/^{86}Sr$ ratio of 0.7092, would raise the skeletal ratio above that of the geological one. Further, any imported food may skew the human results away from the geological baseline ratios. However, Price and colleagues (2015) confirm that they generally observe excellent correlation between the geological and skeletal ratios. Thus, when comparing strontium signatures, it is more accurate to use local $^{87}Sr/^{86}Sr$ ratio means derived from human remains at specific archaeological sites and consider broadly the regional IQR or complete range of the geological $^{87}Sr/^{86}Sr$ ratios.

Similarly to Tikal, for the sites within the Holmul region, the $^{87}Sr/^{86}Sr$ ratio means are higher than that of the southern lowlands. While diet variation or an increase salt intake could also account for this difference, the means are still higher than the $^{87}Sr/^{86}Sr$ ratio means of skeletal data from the Central Maya area (0.7080) and nearby Tikal. Further, the Holmul region means are slightly above the IQR the central Maya area based on skeletal data (Price et al. 2015). However, the IQR is just 50% of the data, so being outside the IQR does not rule out that the Holmul region means fit within the Central Maya area. Instead, a closer look at the geology of the northern Petén might explain the higher $^{87}Sr/^{86}Sr$ ratio means in the Holmul region.

Using the Geological Map of North America by the US Geological Survey and Google Earth Pro, the northeastern Petén (Figure 7.3) is composed of mostly Paleocene (paT) sedimentary rock, with pockets of Quaternary (Q) deposits. An even closer look

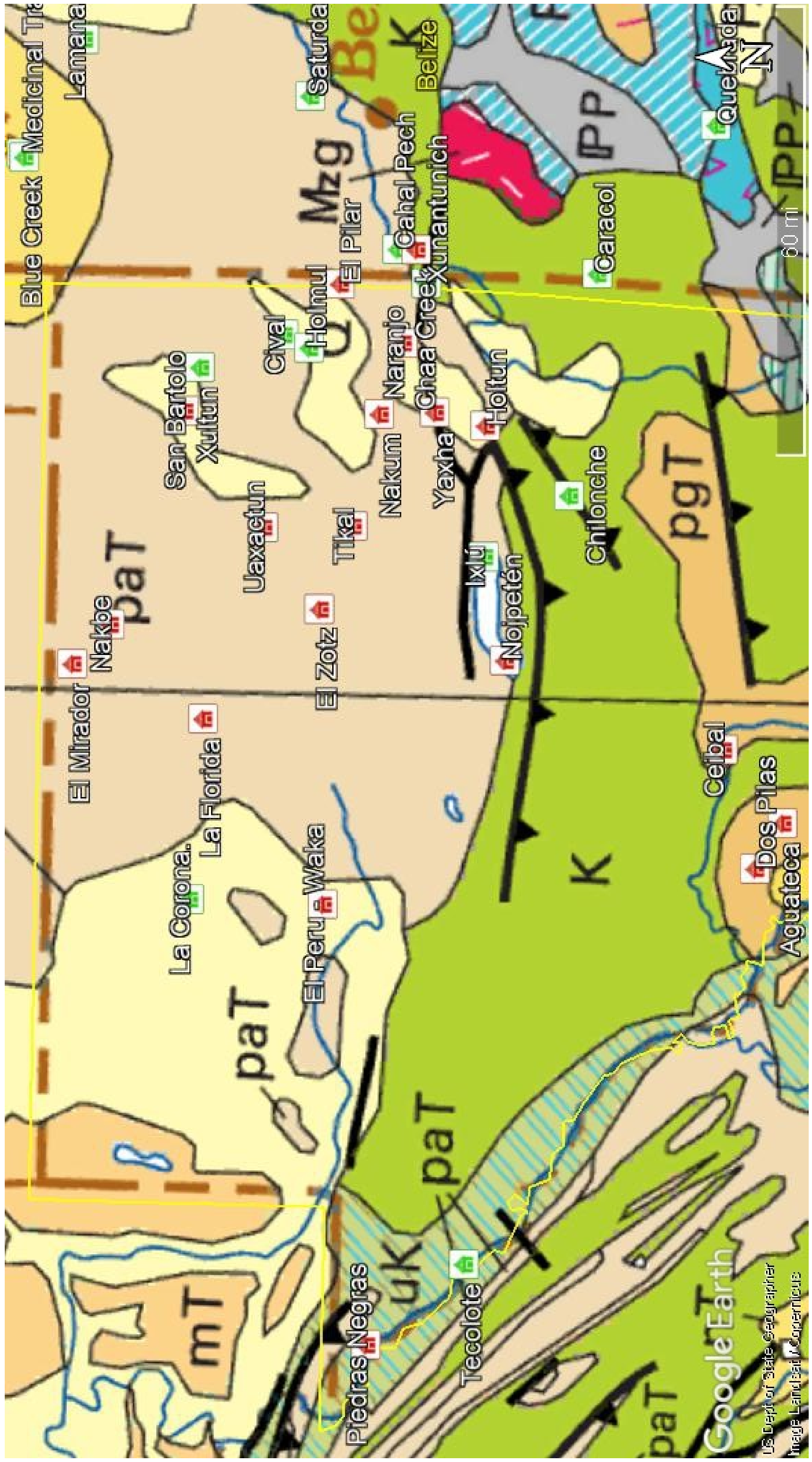

Figure 7.3 Northern Petén geology.
(Google Earth Pro; Garrity and Soller 2009; Burnham 2017)

Figure 7.4 Geology of the Holmul region.
(Google Earth Pro; Garrity and Soller 2009)

shows most of the sites of the Holmul region within one of these Quaternary pockets, and Tikal to the west in a section of Paleocene rock (Figure 7.4). As the Paleocene (66–23.03 million years ago) rocks are older than the Quaternary (2.58 million years ago to present), it correlates that the $^{87}Sr/^{86}Sr$ ratios of the Holmul region would be higher than that of Tikal. Further, outside of the Maya lowlands, La Venta, an Olmec archaeological site on the Gulf coast of modern-day state of Tabasco, Mexico, is located on an area of Quaternary bedrock, with an $^{87}Sr/^{86}Sr$ ratio mean of 0.7081, which is similar to Holmul's of 0.70825. On the other hand, Cival is located just outside of the Quaternary bedrock under Holmul, in an area of Paleocene sedimentary rock, similar to that of Tikal. Cival's $^{87}Sr/^{86}Sr$ ratio mean (0.70804) is lower than that of Holmul (and the Holmul regional mean) and closer to the reported Central Maya area $^{87}Sr/^{86}Sr$ ratio mean of 0.7080. While the diet of the individuals in the Holmul region increases the $^{87}Sr/^{86}Sr$ ratio means, it is also a result of residing upon the pocket of younger, Quaternary sedimentary rock. The similar La Venta $^{87}Sr/^{86}Sr$ ratio mean supports this conclusion and emphasizes the difficulty of using $^{87}Sr/^{86}Sr$ ratio means from geologic sampling in identifying regional origin.

Possible Origins of the $^{87}Sr/^{86}Sr$ Outliers

As the Holmul region, excepting Cival, is located on the area of Quaternary rock, the $^{87}Sr/^{86}Sr$ site-specific outliers accordingly are lower than that of site means. Both the Holmul outlier (58596.0.2) and the K'o outlier (KOL.T.26.03.09.01), with the $^{87}Sr/^{86}Sr$ ratios of 0.70780 and 0.70797 respectively, are most likely from elsewhere in the southern lowlands (based on geological data) or Central Maya area (skeletal data).

Comparable site $^{87}Sr/^{86}Sr$ ratio means based on skeletal sampling include every reported site in the southern lowlands: Piedras Negras (0.7080), Calakmul (0.7077), Tonina (0.7079), Palenque (0.7079), El Mirador (0.7079), and Yaxha (0.7070). For the tentative outliers of La Sufricaya, SUF.T.23.54.09.01 also is lower than the Holmul region mean and the La Sufricaya mean, suggesting a geographical origin elsewhere in the southern lowlands. The La Sufricaya high outlier, SUF.L8.01.09.01 ($^{87}Sr/^{86}Sr$ ratio of 0.70875), is possibly from the northern lowlands, with the closest site $^{87}Sr/^{86}Sr$ means from skeletal sampling at Mayapan (0.7088) or Chichen Itza (0.7087). It is also likely that this high outlier is a result of TIMS error. Further, when considering all of the individuals from the Holmul region as one large sample, no outliers were identified. It remains possible there are no outliers and no evident non-local individuals. Any of the possible non-local individuals from the site-specific outliers are further discussed in conjunction with other isotopic tests, as well as archaeological evidence.

Oxygen Isotope Results

The $\delta^{18}O_{ap}$ results are presented in Table , along with the tooth sampled for each individual. The exception is for CIV.T.28.11.09.01, where the results were not replicable and thus invalid. The carbonate values (“ap”) are reported measured against the known standard of the Vienna Peedee Belemnite (VPDB). In the second column of ratios, the VPDB results have been converted to values comparable to Vienna Standard Mean Ocean Water (VSMOW) by adding 21.0‰ (Iacumin et al. 1996). While this

BURIAL ID	SAMPLE ID	TOOTH	$\delta^{18}O_{AP}$ (VPDB)	$\delta^{18}O$ (VSMOW)[+]	$\delta^{18}O_{AP}$ (VPDB)*	$\delta^{18}O$ (VSMOW)[+*]
HOL.T.06.09.01	HO-16-1	M2	-3.5	17.5	-3.9	17.1
HOL.T.24.23.07.01	HO-16-2	M1	-3.0	18.0	-3.7	17.3
HOL.T.28.04.09.01	HO-16-3	M1	-6.9	14.1	-7.6	13.4
HOL.T.30.20.09.01	HO-16-4	M1	-4.3	16.7	-5.0	16.0
HOL.T.37.09.01	HO-16-5	C	-4.4	16.6	-5.1	15.9
HOL.T.30.33.09.01	HO-16-6	C	-4.6	16.4	-5.3	15.7
HOL.T.47.05.09-04.01	HO-16-7	M3	-3.9	17.1	-3.9	17.1
HOL.T.28.33.09.01	HO-16-8	M1	-4.5	16.5	-5.2	15.8
HOL.T.50.27.09.01	HO-16-9	M2	-6.8	14.2	-7.1	13.9
HOL.L.20.21.09.01.02	HO-16-10	M3	-4.7	16.3	-4.7	16.3
HOL.L.20.15.09.01	HO-16-11	M1	-6.0	15.0	-6.7	14.3
HOL.L.20.21.09.01.01	HO-16-12	M1	-3.4	17.6	-4.1	16.9
HOL.T.84.14.09.01	HO-16-13	PM	-4.5	16.5	-4.8	16.2
HOL.T.78.42.09.01	HO-16-14	C	-3.4	17.6	-4.1	16.9
58596.0.2	HO-16-15	M1	-3.9	17.1	-4.6	16.4
58599.0.02	HO-16-16	M1	-3.2	17.8	-3.9	17.1
58599.0.1	HO-16-17	M1	-3.9	17.1	-4.6	16.4
58600.0.2	HO-16-18	M1	-4.8	16.2	-5.5	15.5
58601.0.01	HO-16-19	M1	-5.3	15.7	-6.0	15.0
58605.01	HO-16-20	M1	-4.5	16.5	-5.2	15.8
58607.1.1	HO-16-21	M1	-4.7	16.3	-5.4	15.6
58618.0.1	HO-16-22	M1	-3.5	17.5	-4.2	16.8
58620.01	HO-16-23	M2	-3.9	17.1	-4.2	16.8
58622.0.1	HO-16-24	M1	-5.5	15.5	-6.2	14.8
HOL.T.93.27.09.01	HO-16-68	M1	-4.9	16.1	-5.6	15.4
HOL.T.100.03.09.01	HO-16-69	M1	-5.8	15.2	-6.5	14.5

HOL.T.98.04.09.01	HO-16-70	M1	-4.8	16.2	-5.5	15.5
SUF.T.11.06.09.01	SU-16-25	M1	-4.9	16.1	-5.6	15.4
SUF.ST.09.02.09.03.01	SU-16-26	M1	-5.1	15.9	-5.8	15.2
SUF.ST.20.27.09.01	SU-16-27	M1	-6.0	15.0	-6.7	14.3
SUF.T.23.54.09.01	SU-16-28	M1	-4.9	16.1	-5.6	15.4
SUF.T.23.66.09.01	SU-16-29	M1	-4.3	16.7	-5.0	16.0
SUF.T.03.09.01	SU-16-30	M2	-4.1	16.9	-4.4	16.6
SUF.L8.01.09.01	SU-16-31	M3	-3.9	17.1	-3.9	17.1
CIV.T.22.13.09.01	CI-16-32	M1	-5.3	15.7	-6.0	15.0
CIV.T.45.11.09.01	CI-16-34	M2	-4.8	16.2	-5.2	15.8
CIV.T.45.11.09.02	CI-16-35	M2	-4.8	16.2	-5.1	15.9
CIV.T.55.03.09.01	CI-16-36	M1	-4.3	16.7	-5.0	16.0
CIV.T.63.03.09.01	CI-16-37	M1	-5.5	15.5	-6.2	14.8
CIV.T.61.04.09.01	CI-16-38	PM	-5.1	15.9	-5.5	15.5
CIV.T.01.09.01	CI-16-39	M1	-5.0	16.0	-5.7	15.3
CIV.T.01.04.09.01	CI-16-40	M1	-5.0	16.0	-5.7	15.3
KOL.T.26.03.09.01	KO-16-41	M1	-5.0	16.0	-5.7	15.3
KOL.L.07.01.09.01	KO-16-42	M1	-4.3	16.7	-5.0	16.0
KOL.L.02.00.09.01	KO-16-43	M1	-4.0	17.0	-4.7	16.3
KOL.T.17.01.09.01	KO-16-44	M1	-4.1	16.9	-4.8	16.2
KOL.T.32.06.09.01	KO-16-45	M1	-6.1	14.9	-6.8	14.2
KOL.T.32.10.09.01	KO-16-46	M1	-2.9	18.1	-3.6	17.4
HAM.T.07.08.09.01	HA-16-47	M1	-5.9	15.1	-6.6	14.4
HAM.T.05.08.09.01	HA-16-48	M2	-4.4	16.6	-4.7	16.3
HAM.LT.30.01.09.01	HA-16-49	PM1	-4.9	16.1	-5.3	15.7
HAM.T.28.02.14.01	HA-16-50	PM1	-5.2	15.8	-5.6	15.4

Table 7.8 $\delta^{18}O_{ap}$ results. Values are per mil ‰. $^{+}$ carbonate (VPDB) values converted to be comparative to reported phosphate (VSMOW) values. *values are adjusted for weaning.

research will be analyzing the VPDB results, the conversion is available here for researchers who wish to compare the values to their phosphate datasets.

In the last two columns of Table 7.8, I present adjusted values for the $\delta^{18}O$ ratios to account for the effect of weaning on the results. Wright and Schwarcz (1998) found that, when comparing the dentition from the same (archaeological) Maya individual, third molars are 0.7‰ more depleted than first molars. As breast milk is more enriched in ^{18}O than drinking water, $\delta^{18}O$ will be lower in teeth developed following weaning. Wright and Schwarcz (1998) found that the shift towards lower values (i.e., the weaning point) occurred between the mineralization of the premolar and the third molar, roughly between the ages of six and nine. White and colleagues (2002) followed this formula, correcting canines by the same amount of as first molars (-0.7‰), as the teeth develop at similar times. White, Spence, and Longstaffe (2002, 2004) adjust premolars -0.35‰, as they are formed during the weaning process. I have extended this logic to lower the second molars by the same amount as the premolars (-0.35‰). The preliminary statistics for the $\delta^{18}O_{ap}$ data is presented in Table 7.9 and Table 7.10 (adjusted for weaning).

Site	*n*	*min*	*max*	*mean*	*s.d.*	*median*
Holmul	27	-6.9	-3.0	-4.5	1.02	-4.5
La Sufricaya	7	-6.0	-3.9	-4.7	0.71	-4.9
Cival	8	-5.5	-4.3	-5.0	0.36	-5.0
K'o	6	-6.1	-2.9	-4.4	1.08	-4.2
Hamontun	4	-5.9	-4.4	-5.1	0.63	-5.1
All Sites	52	-6.9	-2.9	-4.7	0.89	-4.7

Table 7.9 Unadjusted $\delta^{18}O_{ap}$ Results by Site (Values are per mil ‰).

	N	*min*	*max*	*mean*	*s.d.*	*median*
Holmul	27	-7.6	-3.7	-5.1	1.04	-5.1
La Sufricaya	7	-6.7	-3.9	-5.3	0.92	-5.6
Cival	8	-6.2	-5.0	-5.5	0.43	-5.6
K'o	6	-6.8	-3.6	-5.1	1.08	-4.9
Hamontun	4	-6.6	-4.7	-5.5	0.79	-5.4
All Sites	52	-7.6	-3.6	-5.2	0.93	-5.2

Table 7.10 Adjusted $\delta^{18}O_{ap}$ results by site (values are per mil ‰).

However, as there is at least a variability of ±2‰ for $\delta^{18}O$ among local individuals at any site (Wright and Schwarcz 1998; Kenoyer et al. 2013), the adjustment for the weaning effect does not significantly impact the broader questions regarding mobility of the population. In this study, $\delta^{18}O$ is used to illuminate any potential outliers and corroborate the outliers of $^{87}Sr/^{86}Sr$ analysis. By adjusting for weaning and varying the graphical representation of the data, possible $\delta^{18}O$ outliers are highlighted.

For the $\delta^{18}O$ results, the interquartile range (IQR) is presented with and without weaning adjustment, as well as the box-and-whisker plots calculated including and excluding the median. These plots follow the Tukey industry standard, where values are outliers if they fall outside (high or low) 1.5 times the IQR. When unadjusted for weaning and plotted with an exclusive or inclusive median (Figure 7.5), two individuals were statistical outliers, HOL.T.28.04.09.01 and HOL.T.50.27.09.01. When adjusted for weaning, only HOL.T.28.04.09.01 remains a statistical outlier, and only when plotted with an inclusive mean (Figrue 7.6). Thus, conservatively, HOL.T.28.04.09.01 is a $\delta^{18}O$ outlier, while a more liberal conclusion might include HOL.T.50.27.09.01. A comparison with the $^{87}Sr/^{86}Sr$ and archaeological context might be able to clarify the individual's status as a local or non-local.

The one-way ANOVA of the unadjusted and adjusted $\delta^{18}O_{ap}$ datasets (Table 7.11) reveal that there is no statistically significant difference between the five sites (unadjusted: $F(4,47) = 0.788653$, $p = 0.538409$; adjusted: $F(4,47) = 0.448080$, $p = 0.773231$). And thus, each site sample separately cannot be used to suggest site-specific means. Following external confirmation of the $\delta^{18}O_{ap}$ results, any outliers will be compared to baseline data in the Maya region and greater Mesoamerica, but for this study, any statistically suggested outliers will be crosschecked with the $^{87}Sr/^{86}Sr$ outliers to confirm outlier status.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.531426	4	0.632856	0.788653	0.538409	2.56954
Within Groups	37.71526	47	0.802452			
Total	40.24668	51				

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.61208	4	0.40302	0.448080	0.773231	2.56954
Within Groups	42.27356	47	0.899437			
Total	43.88564	51				

Table 7.11 One-way ANOVA of complete $\delta^{18}O_{ap}$ dataset
(unadjusted above, adjusted below).

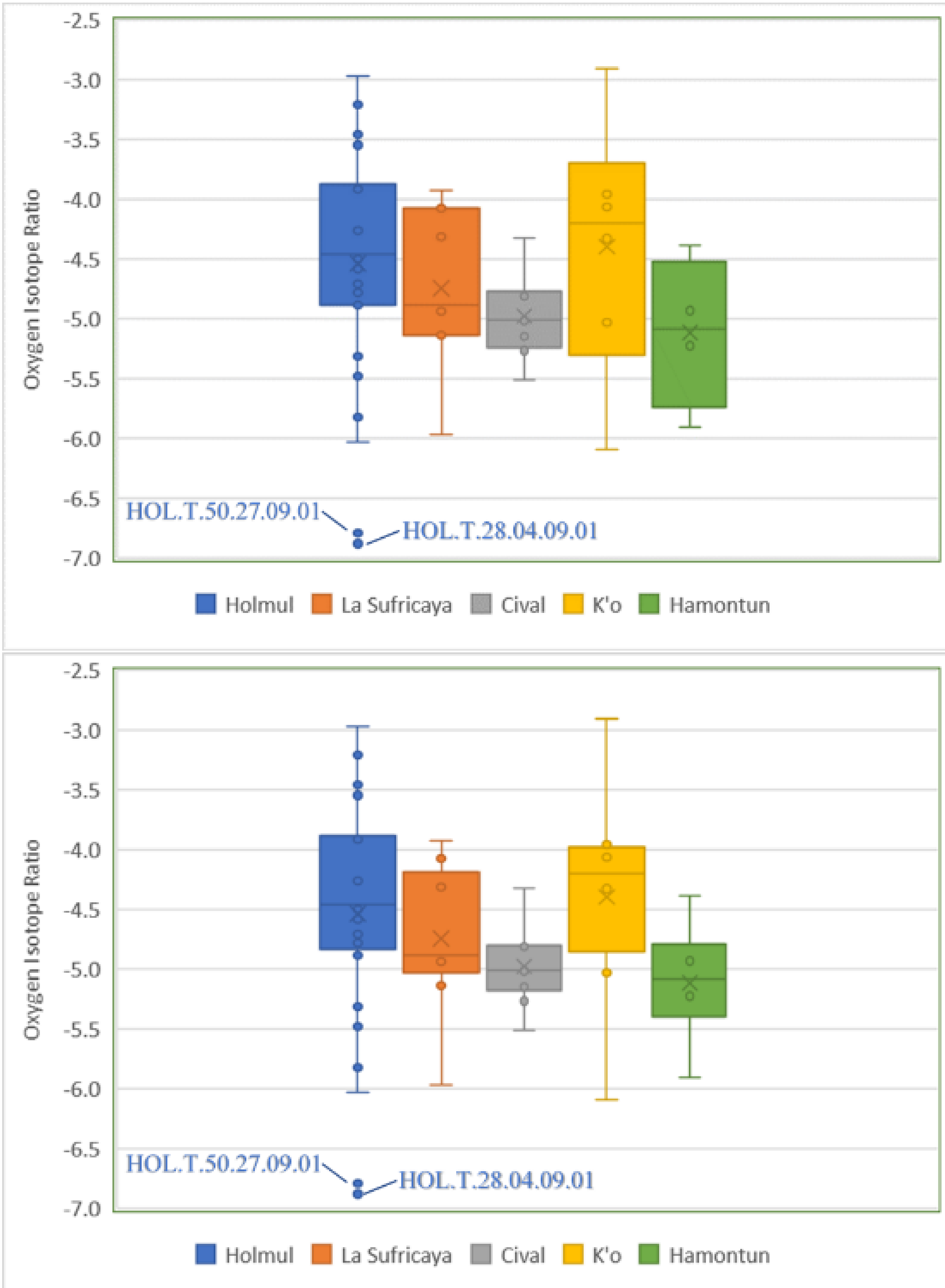

Figure 7.5 Box-and-whisker plot of unadjusted $\delta^{18}O_{ap}$ dataset (exclusive median above and inclusive median below).

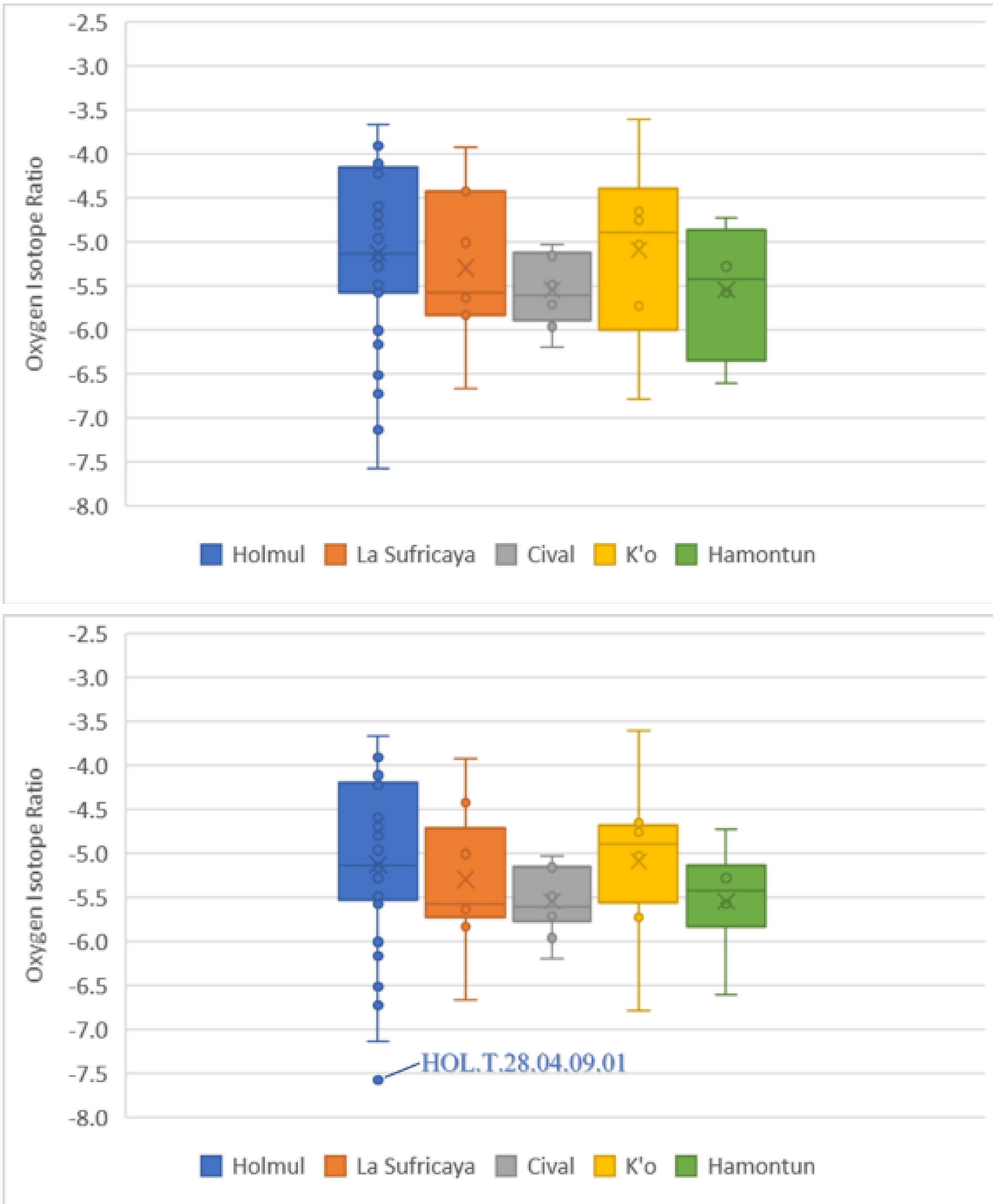

Figure 7.6 Box-and-whisker plot of adjusted $\delta^{18}O_{ap}$ dataset (exclusive median above and inclusive median below).

Carbon Isotope Results

BURIAL ID	SAMPLE ID	TOOTH	$\delta^{13}C_{AP}$
HOL.T.06.09.01	HO-16-1	M2	-3.3
HOL.T.24.23.07.01	HO-16-2	M1	-3.4
HOL.T.28.04.09.01	HO-16-3	M1	-4.1
HOL.T.30.20.09.01	HO-16-4	M1	-5.4
HOL.T.37.09.01	HO-16-5	C	-8.2
HOL.T.30.33.09.01	HO-16-6	C	-6.4
HOL.T.47.05.09-04.01	HO-16-7	M3	-5.3
HOL.T.28.33.09.01	HO-16-8	M1	-4.9
HOL.T.50.27.09.01	HO-16-9	M2	-2.5
HOL.L.20.21.09.01.02	HO-16-10	M3	-2.0
HOL.L.20.15.09.01	HO-16-11	M1	-5.1
HOL.L.20.21.09.01.01	HO-16-12	M1	-1.2
HOL.T.84.14.09.01	HO-16-13	PM	-4.0
HOL.T.78.42.09.01	HO-16-14	C	-3.1
58596.0.2	HO-16-15	M1	-3.5
58599.0.02	HO-16-16	M1	-2.0
58599.0.1	HO-16-17	M1	-3.4
58600.0.2	HO-16-18	M1	-2.6
58601.0.01	HO-16-19	M1	-4.0
58605.01	HO-16-20	M1	-2.6
58607.1.1	HO-16-21	M1	-3.0
58618.0.1	HO-16-22	M1	-2.1
58620.01	HO-16-23	M2	-3.6
58622.0.1	HO-16-24	M1	-5.8
HOL.T.93.27.09.01	HO-16-68	M1	-3.1
HOL.T.100.03.09.01	HO-16-69	M1	-3.9
HOL.T.98.04.09.01	HO-16-70	M1	-2.7
SUF.T.11.06.09.01	SU-16-25	M1	-5.6
SUF.ST.09.02.09.03.01	SU-16-26	M1	-6.9
SUF.ST.20.27.09.01	SU-16-27	M1	-5.8
SUF.T.23.54.09.01	SU-16-28	M1	-4.8
SUF.T.23.66.09.01	SU-16-29	M1	-4.9
SUF.T.03.09.01	SU-16-30	M2	-6.8
SUF.L8.01.09.01	SU-16-31	M3	-6.6
CIV.T.22.13.09.01	CI-16-32	M1	-6.9

CIV.T.28.11.09.01	CI-16-33	M2	-6.9
CIV.T.45.11.09.01	CI-16-34	M2	-5.5
CIV.T.45.11.09.02	CI-16-35	M2	-5.7
CIV.T.55.03.09.01	CI-16-36	M1	-5.8
CIV.T.63.03.09.01	CI-16-37	M1	-6.2
CIV.T.61.04.09.01	CI-16-38	PM	-4.6
CIV.T.01.09.01	CI-16-39	M1	-6.2
CIV.T.01.04.09.01	CI-16-40	M1	-3.5
KOL.T.26.03.09.01	KO-16-41	M1	-7.1
KOL.L.07.01.09.01	KO-16-42	M1	-6.8
KOL.L.02.00.09.01	KO-16-43	M1	-5.6
KOL.T.17.01.09.01	KO-16-44	M1	-6.7
KOL.T.32.06.09.01	KO-16-45	M1	-6.9
KOL.T.32.10.09.01	KO-16-46	M1	-3.8
HAM.T.07.08.09.01	HA-16-47	M1	-5.8
HAM.T.05.08.09.01	HA-16-48	M2	-8.5
HAM.LT.30.01.09.01	HA-16-49	PM1	-4.3
HAM.T.28.02.14.01	HA-16-50	PM1	-3.8

Table 7.12 $\delta^{13}C_{ap}$ results (values are per mil ‰).

The complete $\delta^{13}C_{ap}$ results are presented in Table 7.12, with the preliminary statistics in Table 7.13.

Site	*n*	*min*	*max*	*mean*	*s.d.*	*median*
Holmul	27	-8.2	-1.2	-3.8	1.54	-3.4
La Sufricaya	7	-6.9	-4.8	-5.9	0.88	-5.8
Cival	9	-6.9	-3.5	-5.7	1.09	-5.8
K'o	6	-7.1	-3.8	-6.1	1.25	-6.7
Hamontun	4	-8.5	-3.8	-5.6	2.13	-5.0
All Sites	53	-8.5	-1.2	-4.8	1.74	-4.9

Table 7.13 $\delta^{13}C_{ap}$ results by site (values are per mil ‰).

The IQRs for the $\delta^{13}C_{ap}$ results are presented in Figure 7.7, with box-and-whisker plots calculated including and excluding the median. These plots follow the Tukey industry standard, where values are outliers if they fall outside (high or low) 1.5 times the IQR. Only when plotted with inclusive medians, three individuals are statistical outliers, HOL.T.37.09.01, CIV.T.01.04.09.01, and KOL.T.32.10.09.01. Conservatively, these three individuals are not statistical outliers when excluding the median. The D'Agostino-Pearson test and Chauvenet's criterion suggest that HOL.T.37.09.01 is a statistical outlier. CIV.T.01.04.09.01 was also supported as an outlier by Chauvenet's criterion. Multiple outlier tests (Shapiro Wilk, Ryan-Joiner, D'Agostino-Pearson) support the inclusive median IQR outlier identification of KOL.T.32.10.09.01. A comparison with the $^{87}Sr/^{86}Sr$ results, $\delta^{18}O$ results archaeological context might be able to clarify further these individuals' status as a local or non-local.

There is a statistically significant difference between sites as determined by one-way ANOVA ($F(4,48) = 6.023701$, $p = .000519$) as presented in Table 7.14. The *t*-tests (Two-Sample Assuming Unequal Variances), corrected using the Bonferroni correction (Bonferroni 1936), found statistically significant differences in the data of these pairs: Holmul and Cival and Holmul and K'o. The Holmul $\delta^{13}C_{ap}$ is statistically different (less depleted) than Cival and K'o, suggesting that the individuals at Holmul were eating more C_4 plants than those at Cival and K'o.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	48.3334	4	12.08335	6.023701	0.000519	2.565241
Within Groups	96.28645	48	2.005968			
Total	144.6198	52				

Table 7.14 One-way ANOVA of complete $\delta^{13}C_{ap}$ dataset.

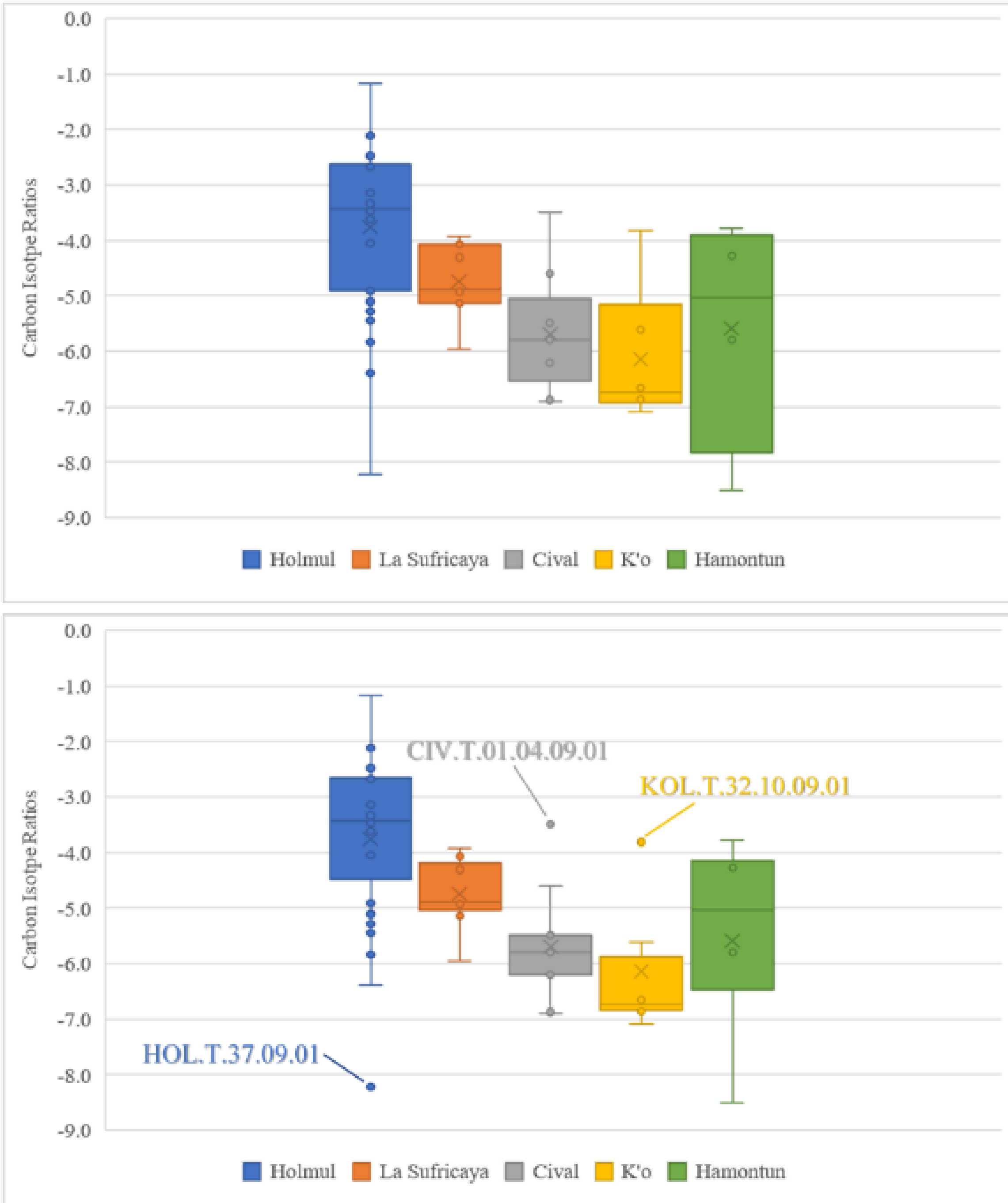

Figure 7.7 Box-and-whisker plot of $\delta^{13}C_{ap}$ dataset
(exclusive median above, inclusive median below).

To highlight any differences in $\delta^{13}C_{ap}$ over time, I have separated the burials (Table) into three groups: 1) Preclassic; 2) Early Classic, including Early/Late Classic; and 3) Late Classic, including Late/Terminal Classic. I have not included the three burials with unclear temporal context.

Period	*Temporal Detail*	*Burial ID*	$\delta^{13}C_{ap}$
	?	SUF.T.03.09.01	-6.8
Unknown	?	CIV.T.55.03.09.01	-5.8
	Classic?	58620.01	-3.6
	Middle Preclassic	CIV.T.45.11.09.01	-5.5
	Middle Preclassic	CIV.T.45.11.09.02	-5.7
	Late Preclassic	CIV.T.22.13.09.01	-6.9
	Late Preclassic?	CIV.T.63.03.09.01	-6.2
	Late Preclassic?	CIV.T.61.04.09.01	-4.6
	Late Preclassic	CIV.T.01.09.01	-6.2
Preclassic	Late Preclassic	CIV.T.01.04.09.01	-3.5
	Late Preclassic	HAM.T.05.08.09.01	-8.5
	Preclassic (850-800 BC)	CIV.T.28.11.09.01	-6.9
	Preclassic?	HAM.T.07.08.09.01	-5.8
	Preclassic?	HAM.LT.30.01.09.01	-4.3
	Preclassic?	HAM.T.28.02.14.01	-3.8
	Late/Terminal Preclassic	KOL.L.07.01.09.01	-6.8
	Early Classic	SUF.ST.09.02.09.03.01	-6.9
	Early Classic	SUF.ST.20.27.09.01	-5.8
	Early Classic	KOL.L.02.00.09.01	-5.6
	Early Classic AD 0-200	58601.0.01	-4.0
	Early Classic AD 200-600	58596.0.2	-3.5
	Early Classic AD 200-600	58599.0.02	-2.0
Early Classic	Early Classic AD 200-600	58599.0.1	-3.4
	Early Classic AD 200-600	58600.0.2	-2.6
	Early Classic AD 200-600	58605.01	-2.6
	Early Classic AD 200-600	58607.1.1	-3.0
	Early Classic (AD 400-500)	HOL.T.84.14.09.01	-4.0
	Early Classic (AD 550-600)	HOL.L.20.21.09.01.02	-2.0
	Early Classic (AD 550-600)	HOL.L.20.15.09.01	-5.1

	Early Classic (AD 550-600)	HOL.T.78.42.09.01	-3.1
	Early Classic/Late Classic (AD 600-650)	HOL.T.93.27.09.01	-3.1
	Terminal Early Classic	KOL.T.32.06.09.01	-6.9
	Terminal Early Classic	KOL.T.32.10.09.01	-3.8
	Early Classic/Late Classic (AD 550-650)	HOL.T.100.03.09.01	-3.9
Late Classic	Late Classic	HOL.T.06.09.01	-3.3
	Late Classic	HOL.T.28.04.09.01	-4.1
	Late Classic	HOL.T.30.20.09.01	-5.4
	Late Classic	HOL.T.30.33.09.01	-6.4
	Late Classic	SUF.T.23.54.09.01	-4.8
	Late Classic	SUF.T.23.66.09.01	-4.9
	Late Classic	SUF.L8.01.09.01	-6.6
	Late Classic	KOL.T.26.03.09.01	-7.1
	Late Classic AD 650-750	58622.0.1	-5.8
	Late Classic (AD 650-750)	HOL.T.98.04.09.01	-2.7
	Late Classic?	58618.0.1	-2.1
	Late/Terminal Classic	HOL.T.24.23.07.01	-3.4
	Late/Terminal Classic	HOL.T.47.05.09-04.01	-5.3
	Late/Terminal Classic	HOL.T.28.33.09.01	-4.9
	Late/Terminal Classic	KOL.T.17.01.09.01	-6.7
	Late/Terminal Classic?	HOL.T.50.27.09.01	-2.5
	Terminal Classic	HOL.T.37.09.01	-8.2
	Terminal Classic	SUF.T.11.06.09.01	-5.6

Table 7.15 $\delta^{13}C_{ap}$ separated by time period.

For $\delta^{13}C_{ap}$ separated by time period (Table 7.15; Figure 7.8), there is a statistically significant difference between groups (Table 7.16) as determined by one-way ANOVA ($F(2,46) = 5.011611$, $p = 0.010739$). The *t*-tests revealed that there is a statistically significant difference only between Preclassic and Early Classic values. This result suggests that there is a statistically significant difference in food consumption between these two periods. The $\delta^{13}C_{ap}$ values were more depleted in the Preclassic than in the later period of the Early Classic, suggesting an increase in C_4 consumption over time. The

$\delta^{13}C_{ap}$ of the Early Classic and Late Classic periods are not different, which concurs with the findings by Gerry (1993), including his observation of a slight decline in C_4 consumption from the Early Classic to the Late Classic. Following external confirmation of the $\delta^{13}C_{ap}$ results, any outliers will be compared to geographic trends in the Maya region and greater Mesoamerica.

Groups	*Count*	*Sum*	*Average*	*Variance*
Preclassic	13	-74.6522	-5.74248	2.029742
Early Classic	18	-71.4964	-3.97202	2.269625
Late Classic	18	-89.7658	-4.98699	2.913354

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	24.50625	2	12.25312	5.011611	0.010739	3.199582
Within Groups	112.4676	46	2.444947			
Total	136.9738	48				

Table 7.16 ANOVA of $\delta^{13}C_{ap}$ grouped by time period.

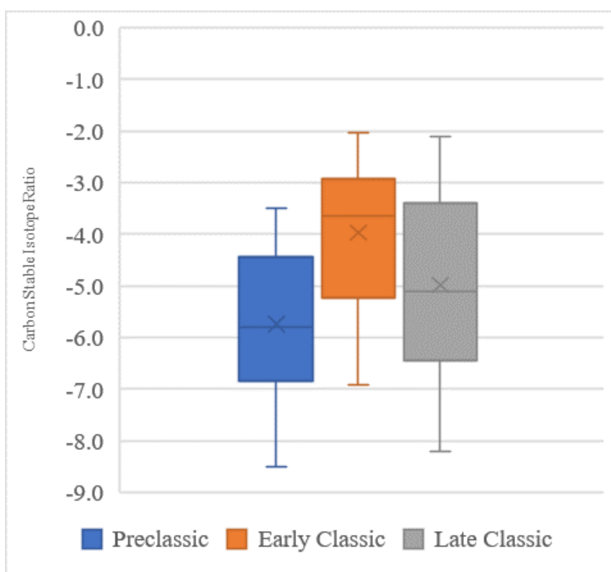

Figure 7.8 $\delta^{13}C_{ap}$ box-and-whisker plots separated by time period.

Combining Strontium, Oxygen, and Carbon Isotopic Results

Burial ID	$^{87}Sr/^{86}Sr$	$\delta^{18}O_{ap}$*	$\delta^{13}C_{ap}$
58596.0.2	**0.70780**	-4.6	-3.5
KOL.T.26.03.09.01	**0.70797**	-5.7	-7.1
SUF.T.23.54.09.01	**0.70809**	-5.6	-4.8
SUF.L8.01.09.01	**0.70875**	-3.9	-6.6
HOL.T.28.04.09.01	0.70808	**-7.6**	-4.1
HOL.T.50.27.09.01	-	**-7.1**	-2.5
HOL.T.37.09.01	0.70853	-5.1	**-8.2**
CIV.T.01.04.09.01	0.70792	-5.7	**-3.5**
KOL.T.32.10.09.01	0.70840	-3.6	**-3.8**

Table 7.17 Outliers from all isotope statistical tests (*adjusted values). **Bold** indicates the test indicating outlier.

For all individuals identified as possible statistical outliers in any one of the three isotopic tests, the stable isotope results are listed in Table 7.17, with the isotopic ratio type suggesting the outlier status marked in bold. To elaborate further on their status as "non-local," the various isotope analyses were combined in multiple bagplots using Free Statistics Software by the Office for Research Development and Education, which uses R (Wessa 2017). A bagplot is a bivariate box-and-whisker plot, visualizing characteristics of bivariate distribution (Rousseeuw et al. 1999). The center of the graph marks the depth median or point with highest Tukey depth. It is surrounded by a bag, which is the inner polygon that contains the n/2 observations with largest depth, containing 50% of the data points. The fence is not typically plotted, but is equal to the bag inflated by 3. The loop is the outer polygon depicted, which is drawn by marking the data points between the bag and the fence. Any observations outside the fence are considered outliers. Bagplot can be used to visualize the location (Tukey median), spread (size of the bag), correlation (orientation of the bag), skewness (shape of bag and the whiskers), and the tails of the data (long whiskers and outliers).

For the complete dataset, when the $^{87}Sr/^{86}Sr$ ratios were plotted against the adjusted $\delta^{18}O$ ratios (Figure 7.9), one outlier was identified, SUF.L8.01.09.01. This individual's $^{87}Sr/^{86}Sr$ ratio was considered an outlier using the IQR calculated with an inclusive median. Further, the TIMS 2-sigma for this individual's $^{87}Sr/^{86}Sr$ was high, suggesting an inaccurate result. When this ratio was removed from the complete dataset, the bagplot (Figure 7.10) suggested no outliers. No outliers were revealed in the bagplots of the ratio pairings of $^{87}Sr/^{86}Sr$ and $\delta^{13}C$ (Figure 7.11) and $\delta^{13}C$ and $\delta^{18}O$ (Figure 7.12).

For the Holmul site dataset, when the $^{87}Sr/^{86}Sr$ ratios were plotted against the adjusted $\delta^{18}O$ ratios (Figure 7.13), one outlier was identified: 58596.0.2. When $^{87}Sr/^{86}Sr$ and $\delta^{13}C$ were visualized by bagplot (Figure 7.14), three outliers were identified: 58596.0.2, HOL.T.37.09.01, and HOL.T.30.20.09.01. The plotting of $\delta^{18}O$ and $\delta^{13}C$ ratios suggested no outliers (Figure 7.15). 58596.0.2 was the only Holmul outlier suggested by the $^{87}Sr/^{86}Sr$ box-and-whisker plot, and now is identified again in the bagplots of the $^{87}Sr/^{86}Sr$ ratio plotted against both $\delta^{18}O$ and $\delta^{13}C$ ratios. This was expected, as the $^{87}Sr/^{86}Sr$ ratio would have influenced its outlier status in the bagplots, but the neither the $\delta^{18}O$ nor $\delta^{13}C$ ratios dismissed its status as an outlier, and thus it can be considered a likely non-local individual moving forward. HOL.T.37.09.01 was an outlier for the Holmul site $\delta^{13}C$ box-and-whisker plots including the median, which has contributed to its identification as an outlier in the bagplot. The $^{87}Sr/^{86}Sr$ ratio for HOL.T.37.09.01 was the largest in the dataset at 0.70853. While not statistically an outlier in the box-and-whisker plot of the $^{87}Sr/^{86}Sr$ ratios, when plotted with the $\delta^{13}C$ ratios in the bagplot, its status as a possible non-local can be suggested. Similarly, HOL.T.30.20.09.01 was the second highest $^{87}Sr/^{86}Sr$ ratio for the Holmul dataset. While not suggested as an outlier for any of the box-and-whisker plots, when the $^{87}Sr/^{86}Sr$ and $\delta^{13}C$ ratio datasets were combined, it is presented as an outlier, and thus can be considered a possible non-local individual.

Lastly for the Holmul site, the $\delta^{18}O$ ratio (unadjusted for weaning) box-and-whisker plot suggested that HOL.T.50.27.09.01 may be an outlier. Unfortunately, this cannot be corroborated through an $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ bagplot, as the $^{87}Sr/^{86}Sr$ test was inconclusive and needs to be re-run. The bagplot of $\delta^{18}O$ and $\delta^{13}C$ ratios did not suggest any outliers. Archaeological context will be considered when assessing the possibility that this individual was non-local and a future $^{87}Sr/^{86}Sr$ result may contribute to the discussion. HOL.T.28.04.09.01 was also identified as an outlier in the $\delta^{18}O$ ratio, unadjusted for weaning (inclusive and exclusive median), as well as when adjusted for weaning and including the median. Neither the bagplot of $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ ratios, nor that of $\delta^{18}O$ and $\delta^{13}C$ ratios concurred with its identification as an outlier. It is more likely that the low $\delta^{18}O$ ratio for the individual was a result of diet variation or sample processing error.

Unfortunately, the sample sizes for the other sites within the Holmul region limited the ability to create their site-specific bagplots. As the individuals KOL.T.26.03.09.01 and SUF.T.23.54.09.01 were suggested as outliers by the $^{87}Sr/^{86}Sr$ ratio box-and-whisker plots, it is more likely that they are non-locals than

CIV.T.01.04.09.01 and KOL.T.32.10.09.01, which were suggested as outliers by the $\delta^{13}C$ ratio plots. $\delta^{13}C$ ratios are highly variable and rarely used to suggest geographic origin. Thus, I would not consider CIV.T.01.04.09.01 and KOL.T.32.10.09.01 to be possible non-local individuals. Future statistical testing may be able to confirm the status of these four individuals.

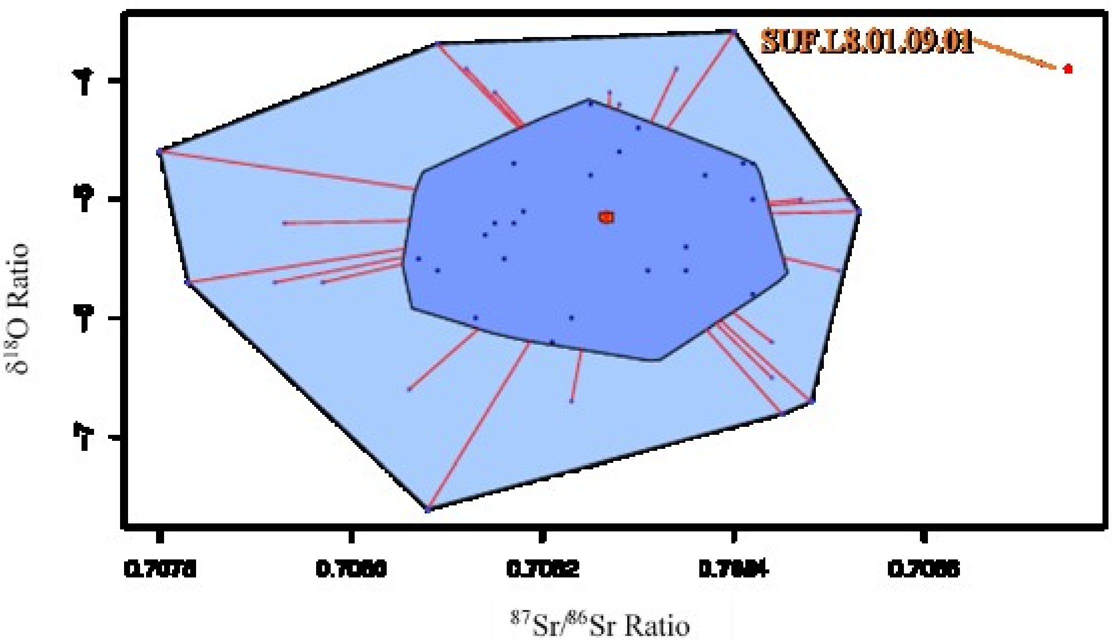

Figure 7.9 Bagplot of complete $^{87}Sr/^{86}Sr$ & $\delta^{18}O$ datasets.

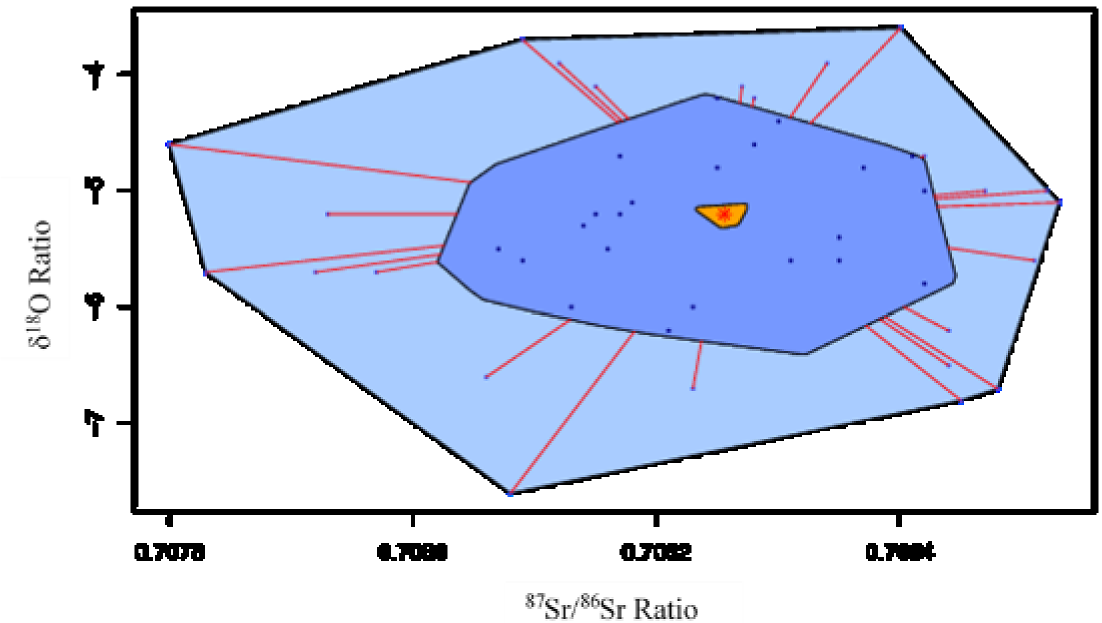

Figure 7.10 Bagplot of complete $^{87}Sr/^{86}Sr$ & $\delta^{18}O$ datasets, following removal of the outlier with error (SUF.L8.01.09.01).

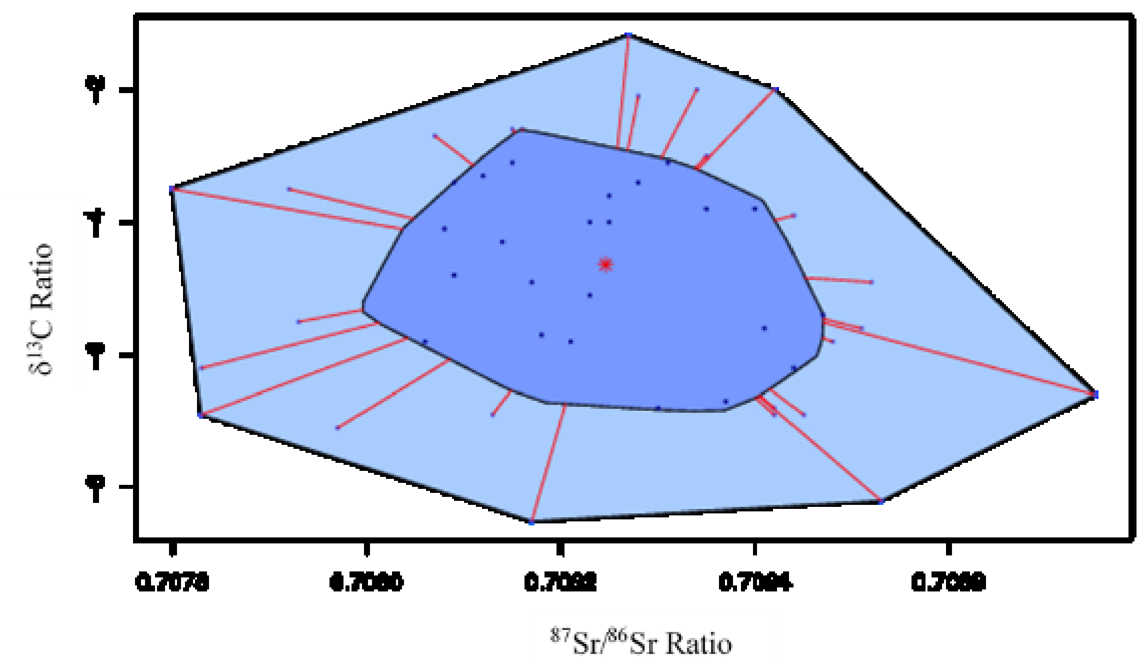

Figure 7.11 Bagplot of complete $^{87}Sr/^{86}Sr$ & $\delta^{13}C$ datasets.

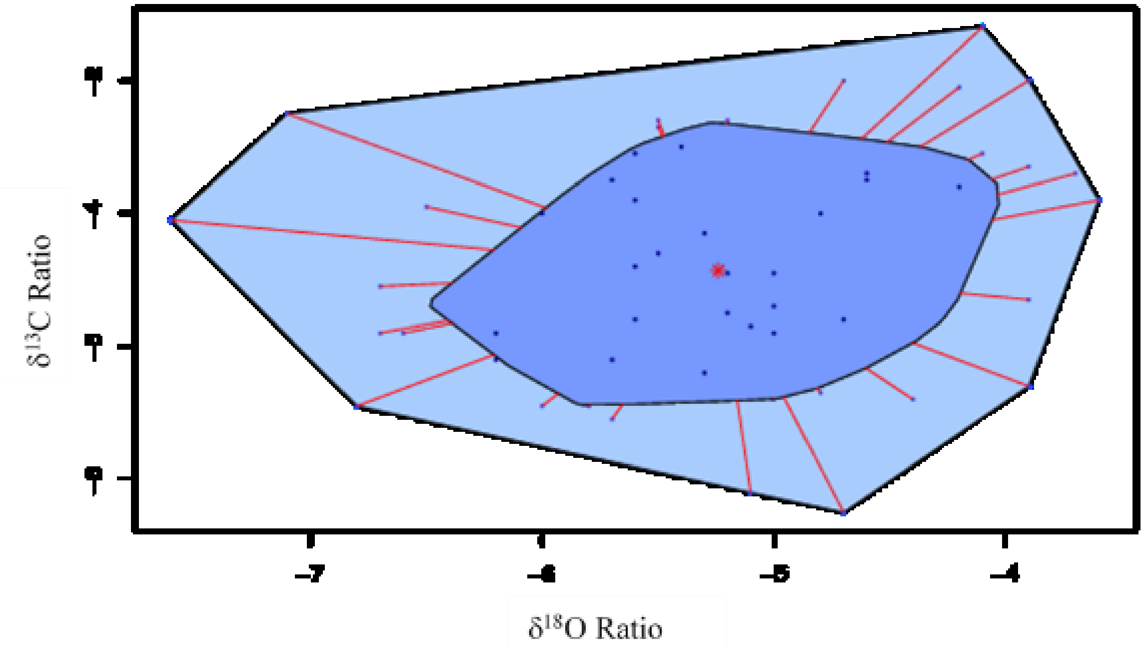

Figure 7.12 Bagplot of complete $\delta^{18}O$ & $\delta^{13}C$ datasets.

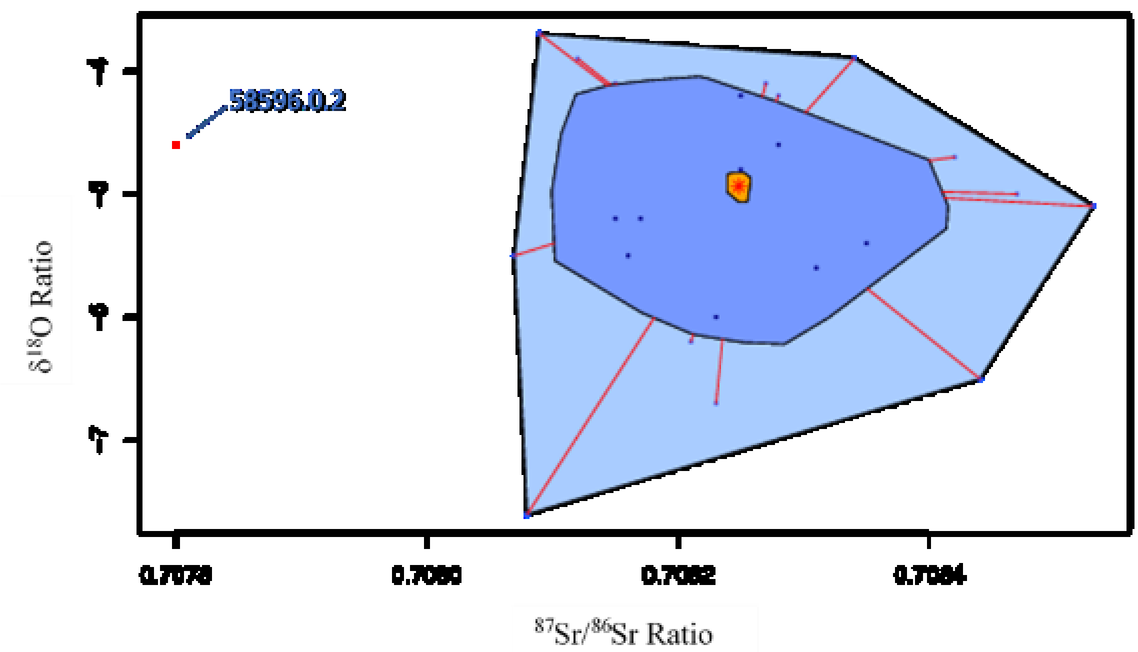

Figure 7.13 Bagplot of Holmul $^{87}Sr/^{86}Sr$ & $\delta^{18}O$ datasets.

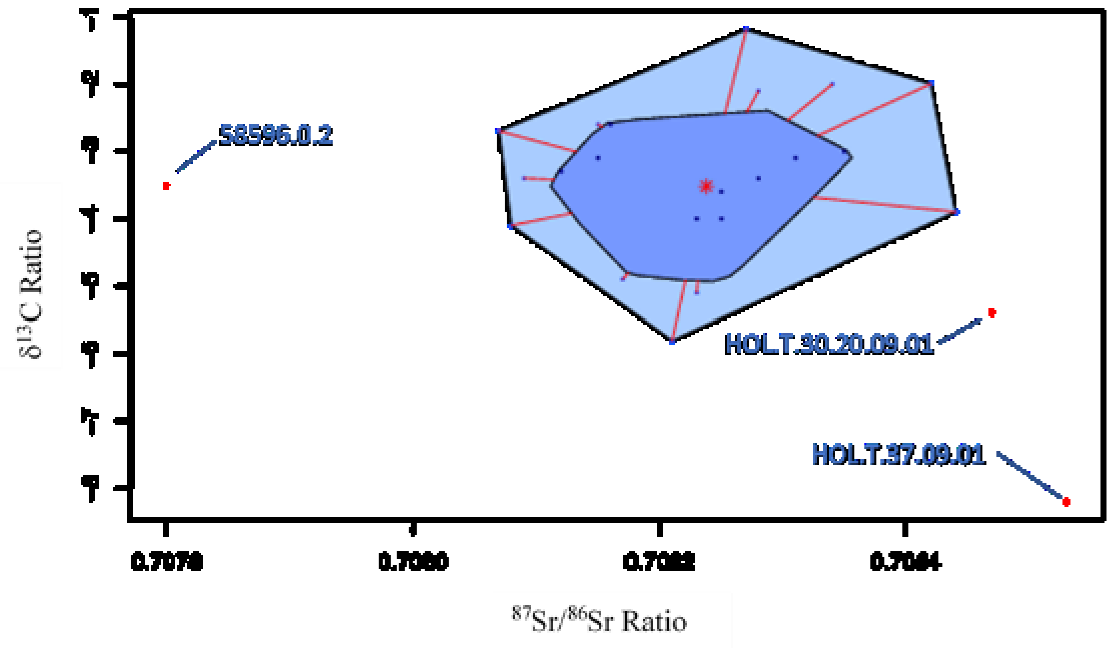

Figure 7.14 Bagplot of Holmul $^{87}Sr/^{86}Sr$ & $\delta^{13}C$ datasets

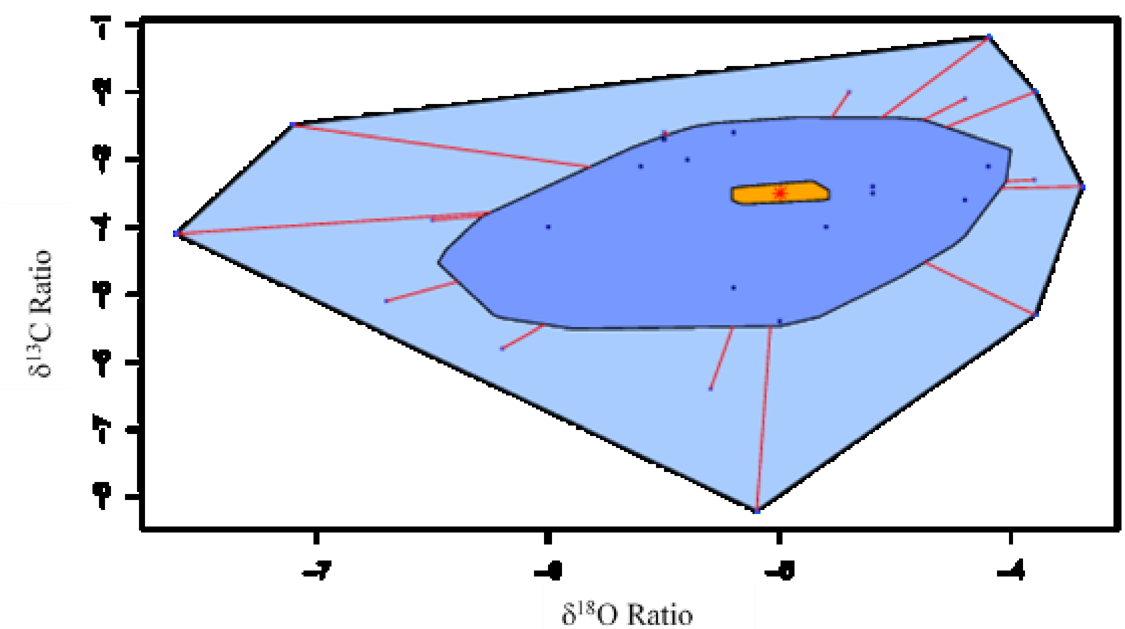

Figure 7.15 Bagplot of Holmul $\delta^{18}O$ & $\delta^{13}C$ datasets.

Chapter Summary

Considering the results of the Holmul site isotopic ratio bagplots (Table 7.18), possible non-local individuals include 58596.0.2, HOL.T.37.09.01, and HOL.T.30.20.09.01. These are considered only possible because when considered as one complete Holmul region dataset (box- or bagplots), no individuals were suggested as outliers, except for SUF.L8.01.09.01, which may be the result of testing error. KOL.T.26.03.09.01 and SUF.T.23.54.09.01 are also tentative non-local individuals, as they were suggested by the box-and-whisker plots for their site-specific samples, but the bagplots were not available to corroborate.

Burial ID	$^{87}Sr/^{86}Sr$	$\delta^{18}O_{ap}$*	$\delta^{13}C_{ap}$
58596.0.2	**0.70780**	-4.6	-3.5
HOL.T.37.09.01	0.70853	-5.1	**-8.2**
HOL.T.30.20.09.01	0.70847	-5.0	-5.4
SUF.L8.01.09.01	***0.70875***	-3.9	-6.6
KOL.T.26.03.09.01	**0.70797**	-5.7	-7.1
SUF.T.23.54.09.01	**0.70809**	-5.6	-4.8

Table 7.18 Possible non-local individuals as a result of the isotope statistical tests (*adjusted values for weaning).
Bold indicates the test indicating outlier. *Italics* suggests a testing error.
Shading identifies the tests that resulted in an outlier when using bagplots.

CHAPTER 8: THE OSTEOBIOGRAPHIES OF THE HOLMUL REGION

This chapter presents the osteobiographies for 52 individuals excavated from the sites of Holmul, La Sufricaya, Cival, K'o, and Hamontun in the Holmul region. The osteobiographies are organized by archaeological site and then by location within the site. A discussion of the individuals follows each site's section of osteobiographies, with the exception of Holmul, where the discussions are located after each particular group within Holmul due to the large number of individuals from that site. Each osteobiography begins with an individual profile table that summarizes the demographic information of the individual, the associated context, and the stable isotope results. An in-depth discussion follows presenting the osteobiographical narrative of the individual, which is then referred to during each site or group discussion.

Holmul

The Osteobiographies of Holmul, Group I, Structure 1, Building D

Group I of Holmul (Figure 8.1) is composed of buildings located on a high, pyramidal base (Structure 1) located just north of the Main Plaza. Six buildings were situated upon this acropolis (Buildings A-F) surrounding a court that was paved and plastered with stucco (Merwin and Vaillant 1932). The south portion of the acropolis contained Buildings A (east) and B (west), which were elongated structures with long, narrow, high-vaulted rooms. Structures C (west) and E (east) were positioned on the north portion of the acropolis on either side of the large temple-pyramid Structure D. Structures C and E were smaller structures with low, broad vaults and benches (Merwin and Vaillant 1932). Building D was aligned with the north face of the Group I platform and "dominated the entire plaza" (Merwin and Vaillant 1932:12). Building F was a "peculiar burial mound" that was situated on the east side of the platform "jammed" just north of Building A (Merwin and Vaillant 1932:7). Buildings A, B and D were constructed first, with C, E, and F after.

This group was first explored and excavated by Merwin between 1910 and 1914 (Merwin and Vaillant 1932:7) and subsequently excavated in 2013 and 2016 by the Holmul Archaeological Project (Estrada-Belli 2013, 2016). Merwin documented the architectural structures of Group I and excavated a burial within Building F (Merwin and Vaillant 1932). This individual (Harvard #58614), an adult flexed on the left, head

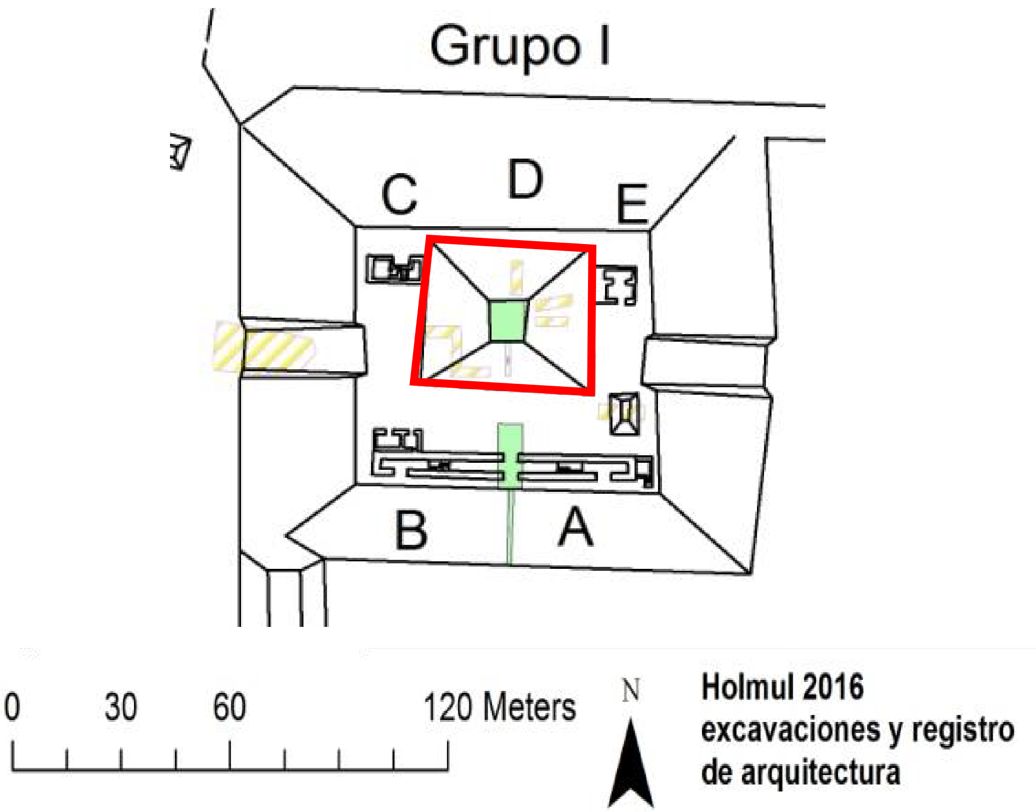

Figure 8.1 Holmul Group I, Building D in red (Adapted from Estrada-Belli 2016:3).

southeast facing southwest, may have been wrapped in textile and was accompanied by five ceramic vessels (Holmul V: AD 650-750). Merwin concluded that the building had not been converted from a domestic space, and instead a foundation platform was constructed, followed by the erection of side walls probably meant to contain the fill (and burial) within the room (Merwin and Vaillant 1932:15).

In 2013, the Holmul Archaeological Project aimed to understand the architectural phases of Building D (Figure 8.2), which Merwin did not excavate and deemed "too ruined for surface observations" (Merwin and Vaillant 1932:13). The 2013 excavations revealed the stucco mask of Chaak, the rain god, that adorned a Late Preclassic substructure of Building D. An Early Classic building was built directly over this Preclassic structure. During these excavations, an Early Classic burial (HOL.T.84.14.09.01) was found under the centerline of the Early Classic stairway.

Excavations of Building D continued in 2016 when excavations and the cleaning of looter's tunnels revealed a structure fully encased by final and unfinished phase of construction (Estrada-Belli 2016). This building was composed of two vaulted rooms with well-preserved stucco walls. The south room (#1) was found sealed but not filled, with placement of complete ceramic vessels, polychrome sherds, and jade artifacts on the floor that had signs of burning. Further, an ash layer was found on the floor. An altar had been constructed against the northern wall. One of the jade artifacts was carved in the image of the three maize god wearing the sun god avian headdress. The jade piece also had an inscription that read "is the necklace of Yuknoon U Ti Chann, divine king of Kaanul," who ruled around AD 619 (Estrada-Belli 2016:16–17). The second chamber

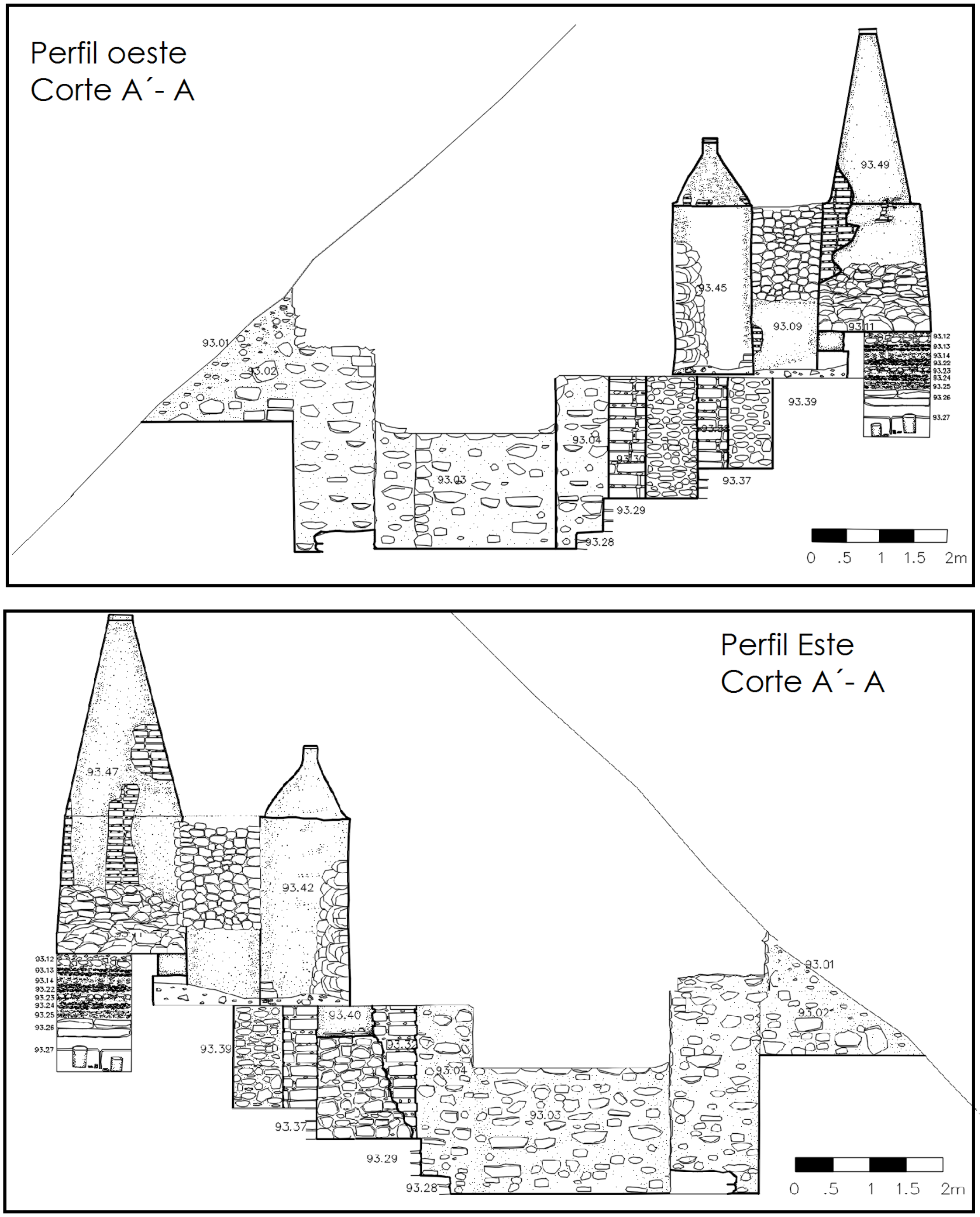

Figure 8.2 East and west profiles of HOL.T.93 of Group I Building D (Estrada-Belli 2016:153).

(Room 2) had a bench that occupied a third of the room, which was partially filled and had signs of burning. Excavations revealed a burial (HOL.T.93.27.09.01) under the bench. This room may have been used as a throne room with the adjacent structures to Building D forming a royal palace on top of Group I until the death of HOL.T.93.27.09.01.

HOL.T.84.14.09.01

Individual/Burial ID #:	**HOL.T.84.14.09.01**
Laboratory ID #:	HO-16-13
Site:	Holmul
Associated Period/Date:	Early Classic (AD 400-500 from ceramics)
Year Excavated:	2013 (Shelter)
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul y Cival. Informe Preliminar de la Temporada 2013*
Dentition Sampled:	Premolar
Burial Location and Construction:	Holmul, Group I, Structure 1, Building D, Palace?, simple crypt
Burial Type, Manner, and Positioning:	Interment, primary, single, re-entered, Extended N-S, head in N facing W
Associated Artifacts:	3 ceramic vessels, 1 jade bead
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult
Biological Sex Estimation:	Indeterminate
Observations:	Dental inlays (one pyrite found), mandibular alveolar reabsorption
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70825, $\delta^{18}O$: -4.5 (-4.8*), $\delta^{13}C$: -4.0 **local** *adjusted for weaning

Table 8.1 Individual profile of HOL.T.84.14.09.01

The 2013 excavations in Group I were centered on Building D with the intention of understanding the construction phases of this northern pyramid structure (Estrada-Belli 2013). A tunnel (HOL.T.84) followed the south wall of the structure to the east. Context

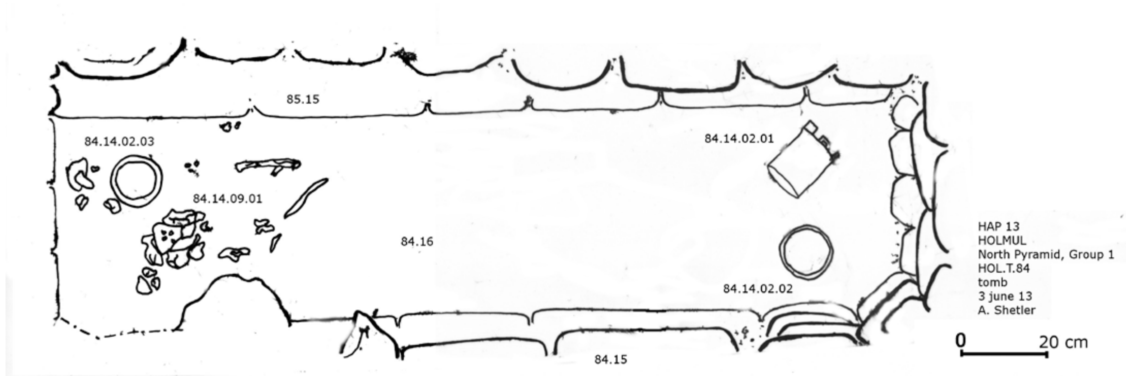

Figure 8.3 Plan drawing of HOL.84.14.09.01 by A. Shelter.

HOL.T.84.13 was described as a group of slabs covering an area of 2.1m by 0.5m, which was later concluded to be the slab covering of the grave. The slabs had collapsed on the skeleton (HOL.T.84.14.09.01) in the northern half of the grave, while in the southern half, they were intact as an unstable roof. Context HOL.T.84.15 corresponds to the limestone block walls of the burial, which are 0.48m-0.56m high and 0.18 m- 0.30 m wide. Context HOL.T.84.16 was the "rustic floor" of the grave, varying in thickness between 5 and 8 cm.

HOL.T.84.14.09.01 (Figure 8.3) was a primary, single interment in a ceremonial or religious building (temple-pyramid). The positioning of the body is unclear due to the possible re-entry of the tomb in antiquity (and possible removal of bones), although the excavators described it as extended north-south, with the head in the north and facing west. Because of the presence of capstones resting on stone sidewalls, the grave construction is categorized as a simple crypt. The burial was accompanied by three ceramic vessels and one jade bead. A tripod vessel (HOL.T.84.14.02.01), painted dark brown/black, was found in southwest corner of the grave. Another similarly painted tripod vessel (HOL.T.84.14.02.02) was found fragmented in the northwest quadrant of the grave near the skull. This vessel had an incised decoration and an "accordion" shape with two deep grooves below the main section of the body. The third vessel (HOL.T.84.14.02.03) was found alongside the body in the southeast corner of the grave. A jade bead (HOL.T.84.14.06.01) was found near the skull, perhaps having been placed in the mouth of the individual.

This skeleton was extremely fragmented, partially due to taphonomic occurrences, but also the result of possible re-entry of the crypt during antiquity. The cranium was very fragmentary with 16 small to medium cranial fragments, likely from the parietal bones (meningeal grooves present). Four temporal bone fragments were recovered, including pieces of a mastoid process and petrous pyramid. A piece of the squama (including the suprameatal crest and supramastoid crest) of the left temporal bone mends with the aforementioned mastoid process. While they do mend together, the fragment of the temporal bone is still too small to take any mastoid measurements, but in general the mastoid process seems small to medium sized.

Also preserved was a right body fragment of the mandible with alveolar resorption of the molars. The right molars were lost during life and the mandible experienced complete resorption (Figure 8.4), suggesting the individual was an adult at death. The dentition (Figure 8.5) recovered includes two canines (one right and one left, both probably mandibular) with incised pockets for inlays. One of these canines retained the pyrite inlay. Three lower premolars with eroded roots were recovered, two of which also had incised pockets for inlays. The long bone fragments include one rib fragment, nine fragments of a humerus shaft, a shaft fragment of a radius, and a shaft of a metatarsal. A possible fragment of trabecular bone was also recovered, possibly of a femoral head.

Figure 8.4 Mandible of HOL.84.14.09.01, note alveolar resorption.

Figure 8.5 Modified dentition of HOL.84.14.09.01.

Based on the extremely fragmented condition of HOL.T.84.14.09.01, it is not possible to estimate biological sex or age-at-death. It is likely that the individual was an adult due to the alveolar resorption in the right portion of the mandible. Besides the alveolar resorption, there is no observable pathology on the cranial fragments, teeth, or the postcranial skeletal fragments. The mandibular canines and premolars were modified in the form of stone inlays.

The enamel of the premolar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70825, while the $\delta^{18}O$ was -4.5 (adjusted to -4.8 for weaning) and $\delta^{13}C$ was -4.0. The stable isotope analysis did not suggest that HOL.T.84.14.09.01 was a statistical outlier, and most likely was a local individual from Holmul or the Holmul region.

HOL.T.93.27.09.01

Individual/Burial ID #:	**HOL.T.93.27.09.01**
Laboratory ID #:	HO-16-68
Site:	Holmul
Associated Period/Date:	Classic (AD 600-650)
Year Excavated:	2016
Archaeological Reports:	*Investigaciones Arqueológicas y Conservación de Arquitectura Monumental en la Región de Holmul: Temporada 2016*
Dentition Sampled:	Left first maxillary molar
Burial Location and Construction:	Holmul, Group I, Structure I, Building D, Room 2, under bench, Palace?, Simple crypt
Burial Type, Manner, and Positioning:	Primary, single?
Associated Artifacts:	5 polychrome ceramic vessels, 2 jade ear flares, 2 small jade pendants, 5 snail shells, 1 spondylus shell
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Dental calculus
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70831, $\delta^{18}O$: -4.9 (-5.6*), $\delta^{13}C$: -3.1 **local** *adjusted for weaning

Table 8.2 Individual profile of HOL.T.93.27.09.01

In 2016, excavations in Structure 1 of Group I were intended to find staircases and other architectural components of the primary pyramid of Group I (Estrada-Belli

2016). In order to understand the relationship of Building D to Structure 1, a tunnel excavation was placed in the lower central section of its southern slope. First, excavations revealed Room 1 (HOL.T.93.06), which was rich in artifacts, including polychrome ceramic vessels and jade artifacts. Excavations continued into Room 2, where the burial HOL.T.93.27.09.01 was found under the bench in the room (Figure 8.6). This room was used as a throne room, possibly until the death of this individual. There were many associated artifacts with this burial, although the human remains were extremely fragmentary, so much so that most of the mortuary analysis, such as the body positioning and head orientation, is impossible to decipher.

In the 2016 report (Estrada-Belli 2016), the grave was described as having slab walls 0.55m to 0.65m high with large stones resting on the walls as capstones. The excavators suggest the burial was of a single individual and in primary context, although

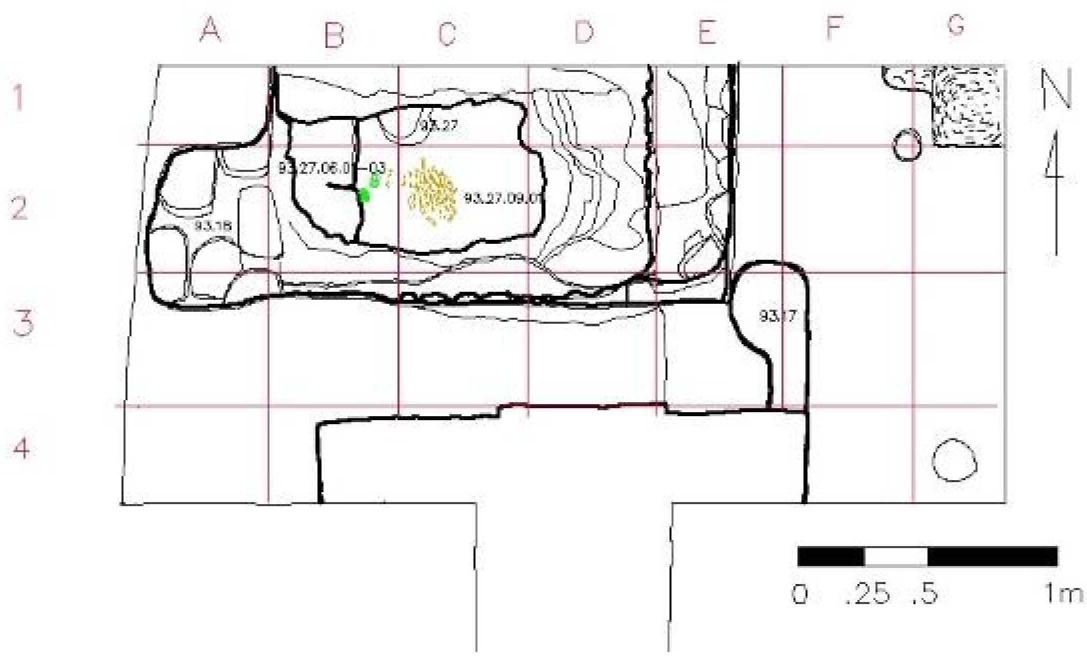

Figure 8.6 Plan drawing of HOL.T.93.27.09.01 by B. Garcia Vazquez (Estrada-Belli 2016:181).

it is difficult to conclude (Figure 8.6). This simple crypt was found under a bench within a pyramid structure (ceremonial or religious building). The associated artifacts included two circular jade ear flares and two small jade pendants (HOL.T.93.27.06.01-.04), five ceramic vessels (HOL.T.93.27.02.01-.05), five snails (HOL.T.92.27.10.01-.05) of which four were found within a ceramic vessel, and a Spondylus shell (HOL.T.93.27.10.06 found near the jade ear flares. The ceramic vessels included: (a) two fragmented, but complete, tripod polychrome dishes decorated on both the interior and exterior surfaces; (b) one flat plate; and (c) two incised, cylindrical vessels.

The osteological analysis has yet to be performed, although from the documentation available, it appears that the preservation of the skeleton is extremely poor, with only a few teeth, fragments of spongy bone, and some long bone shaft fragments recognized by excavators. The dentition provided for stable isotope analysis, the left first maxillary molar, had dental calculus on the buccal and lingual surface (Figure 8.7).

The enamel of the left first maxillary molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70831, while the $\delta^{18}O$ was -4.9 (adjusted to -5.6 for weaning) and $\delta^{13}C$ was -3.1. The stable isotope analysis did not suggest that HOL.T.93.27.09.01 was a statistical outlier, and most likely was a local individual from Holmul or the Holmul region.

Figure 8.7 Left first maxillary molar of HOL.T.93.27.09.01.

*Considering the Burials of Holmul, Group I, Structure 1, Building D*As demonstrated through the Building D (Figure 8.8) excavations of Structure 1 of Group I, this structure had a long history, stretching from at least the Late Preclassic (ca. 400 BC-AD 100) to the Late Classic (cs. AD 600-800). Three burials have been found in Group I, including the Late Classic burial of Building F (Figure 8.8). During the Early Classic, an elite individual (HOL.T.84.14.09.1) was interred in this palace at the Holmul site core. This adult was placed in an intrusive crypt grave between AD 400-500, based on the ceramic types. The associated artifacts of this burial include three tripod vessels of Teotihuacano style, suggesting that during the Early Classic, there were ties, either political or economic, to Teotihuacan and Tikal (Estrada-Belli et al. 2009). The stable isotope analysis suggests that this individual was local to Holmul or the Holmul region, not born in Teotihuacan or Tikal. The collapse of the slabs in the northern section, and the missing lower limbs, suggest that the grave was re-entered and parts of the skeleton were removed. An offering of an *incensario* (HOL.T.84.02.01-.02), located approximately 1m above the burial, typologically dates to the Late Classic, suggesting that the deposition of the offering may have coincided with the re-entry of the burial. Also during the Late Classic, the final phase of construction of Building D included two rooms, in the second of which was found an elite crypt burial (HOL.T.93.27.09.01). The stable isotope analysis of this individual suggests that they were also local, born in the Holmul region.

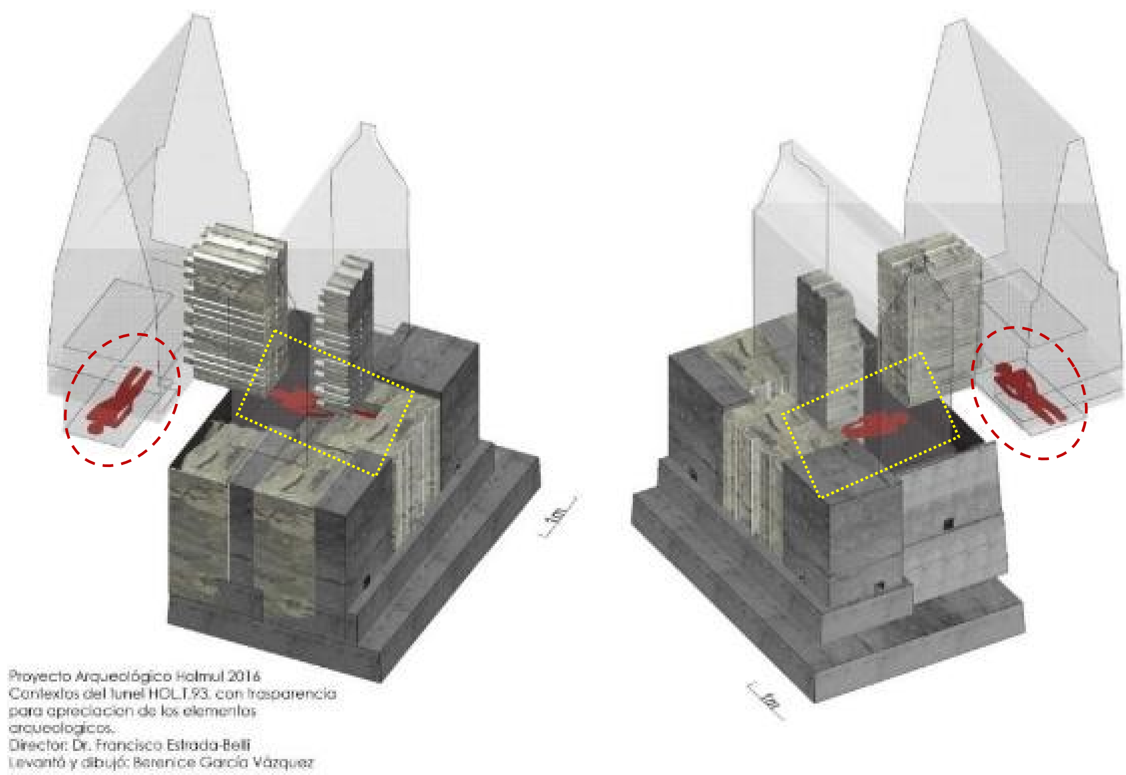

Figure 8.8 Reconstruction of Holmul Group I Building D with burials HOL.T.84.14.09.01 (dotted yellow line) and HOL.T.93.27.09.01 (dashed red line) by B. Garcia Vazquez (Estrada-Belli 2016:189).

The burial of HOL.T.93.09.01 was placed in Room 2, followed by the sealing of the doorway connecting the rooms. Then, in Room 1, the jade object "belonging" to Yuknoon U Ti Chaan, the king of the Kaan dynasty, was deposited, suggesting a relationship between the rulers of Holmul and of Kaan and dating the burial (HOL.T.93.27.09.01) to a time following the rule of Yuknoon U Ti Chaan, which has been dated to around AD 619. Estrada-Belli (personal communication, 2017) posits that the individual buried in Room 2 was Kinich Tajal Tuun, the son of ruler Tzahb Chan Yopaat possibly buried in Group II Building A (HOL.20.21.09.01).

Holmul, Group I, Structure 1, Building D

HAP ID	HOL.T.84.14.09.01	HOL.T.93.27.09.01
Sample ID	HO-16-13	HO-16-68
Also Known As		K'inich Tajal Tuun?
Period	Early Classic (AD 400-500)	Early Classic/Late Classic (AD 600-650)
Age-at-Death	Adult	Indeterminate
Biological Sex	Indeterminate	Indeterminate
Dental Pathology	Pyrite inlay, inlay pockets, Mandibular alveolar resorption	Dental calculus
Burial Type	Grave interment	Grave interment
Burial Manner	Primary, single, re-entered	Primary, single?
Body Positioning	Extended, N-S, facing W	?
Burial Location	Palace?	Palace?
Grave Construction	Crypt, simple	Crypt, simple, under bench
Associated Artifacts	3 ceramic vessels, 1 jade bead	5 polychrome ceramic vessels, 2 jade ear flares, 2 small jade pendants, 5 snail shells, 1 spondylus shell
Tooth Sampled	PM	LM^1
$^{87}Sr/^{86}Sr$	0.70825	0.70831
$\delta^{18}O_{ap}$	-4.5 (-4.8*)	-4.9 (-5.6*)
$\delta^{13}C_{ap}$	-4.0	-3.1
Local or Non-Local	Local	Local

Table 8.3 Summary of the burials of Holmul Group I, Str. 1, Building D.

The Osteobiographies of Holmul, Group II, Building A

Holmul's Group II lays approximately 365 meters to the northwest of Group I upon a low platform, which serves as an acropolis with seven main structures. Merwin paid particular attention to Group II, documenting Buildings A-G (Merwin and Vaillant 1932). Building A, an L-shaped structure upon a wide platform, occupied the majority of the southern portion of the acropolis. Building C abutted Building A to the southwest and may have served a domestic purpose (Merwin and Vaillant 1932). Building D was a similar building located in the southwest corner of the acropolis, with G located to its north. Building E was a building of three rooms oriented east-west in the northwest corner. Building B, a pyramidal building was located to the east of Building E, with Building F even further to the east. Building F was described by Merwin as a small house that was modified into a platform (Merwin and Vaillant 1932:17).

Merwin documented the condition of Building A and the architecture of its final phase (Merwin and Vaillant 1932). He described the L-shaped structure, composed of three rooms and placed upon a wide platform that had large masks on its east and southern façades. In 2012, the Holmul Archaeological Project excavated under Buildings A and C with the aim to investigate the architecture and monumental sculpture of the Late Preclassic period (400 BC-AD 100). The excavations revealed that the group was originally organized as a Preclassic triadic group. Under the Late Classic construction of Building A, a temple-pyramid was positioned facing west with a stairway onto the platform.

From the excavations in 2012, 2014, and 2016, three phases of Building A were delineated (Figures 8.9 and 8.10): (1) the last phase dating to AD 650-700 that includes a south-facing entrance; (2) the penultimate phase or the “Frieze Phase” ca. AD 593 of the ceremonial vaulted structure adorned with the Frieze; and (3) the antepenultimate phase or the “Palace Phase” when Building A was a vaulted structure with throne dating ca. AD 558 (Estrada-Belli 2015). Earlier phases are not yet explored. Four burials were excavated from Building A: (1) HOL.L.20.21.09.01, (2) HOL.L.20.15.09.01, (3) HOL.T.78.42.09.01, and (4) HOL.T.98.04.09.01.

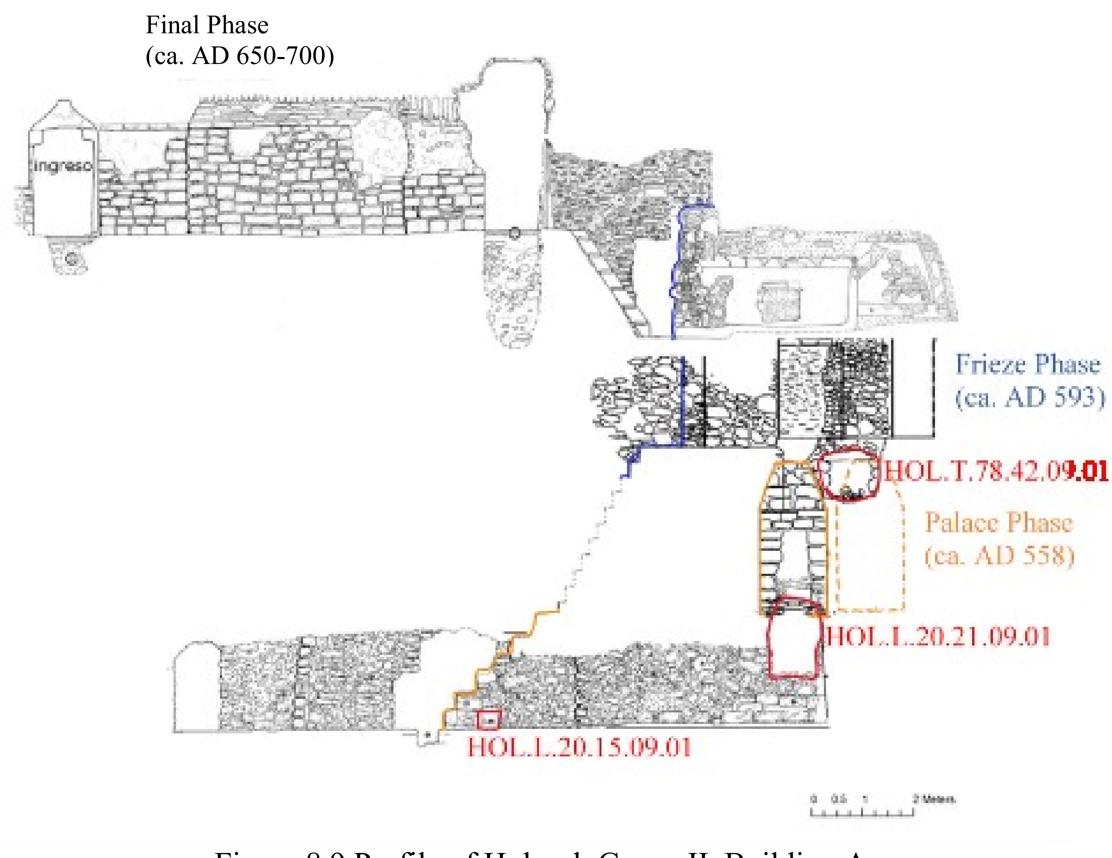

Figure 8.9 Profile of Holmul, Group II, Building A
Palace Phase (ca. AD 558) in orange, Frieze Phase (ca. AD 593) in blue, burial locations in red (Adapted from Estrada-Belli 2015:9).

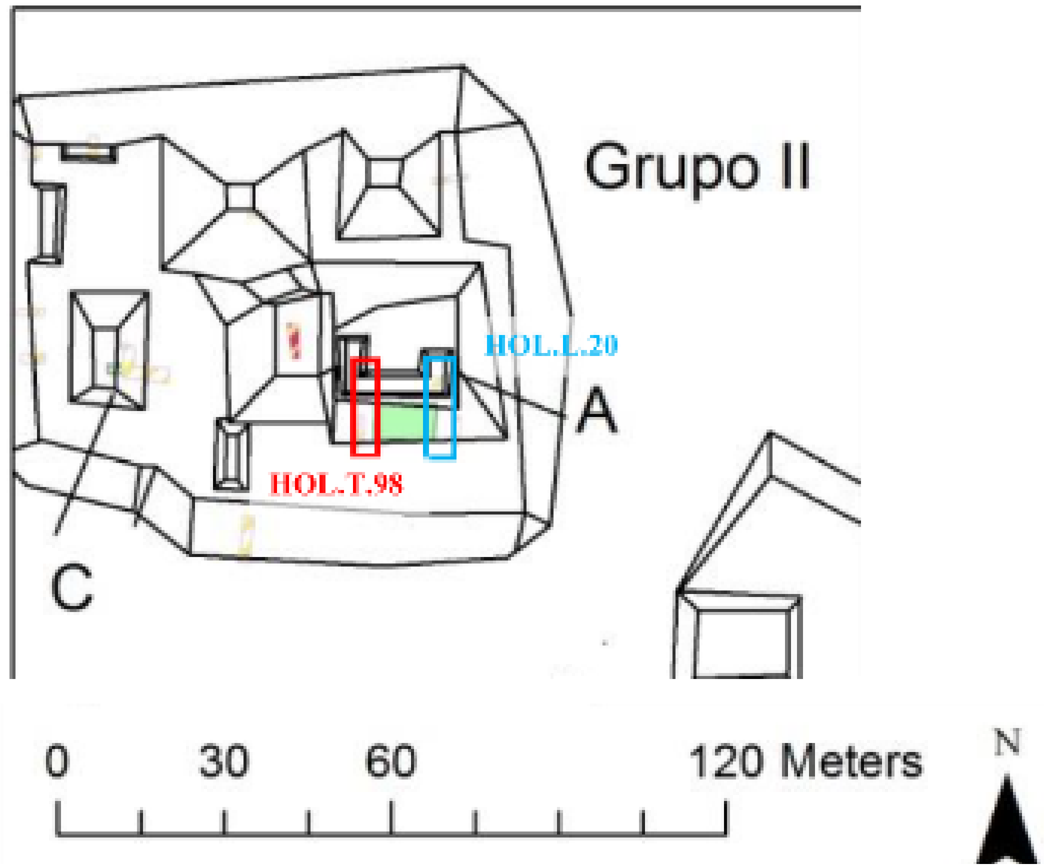

Figure 8.10 Map of Holmul, Group II, Building A
Relative locations of HOL.T.98 (red) and HOL.L.20 (blue)
(Adapted from Estrada-Belli 2016:3).

HOL.L.20.21.09.01

Individual/Burial ID #:	**HOL.L.20.21.09.01**
Laboratory ID #:	HO-16-12, HO-16-10
Site:	Holmul
Associated Period/Date:	Early Classic (AD 500-600 from ceramics)
Year Excavated:	2012 (Diaz Garcia)
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul y Dos Aguadas. Informe Preliminar de la Temporada 2012*; Friedrich 2013
Dentition Sampled:	Left maxillary first (HO-16-12) and third molars (HO-16-10)
Burial Location and Construction:	Religious/Ceremonial (Temple-Pyramid), Building A Group II, platform, tomb unspecified (cut into floor, but then vaulted)
Burial Type, Manner, and Positioning:	Single, primary interment, extended supine, oriented S-N, head in S
Associated Artifacts:	28 vessels, 1 spondylus shell and a perishable mask with jade ear flares
Preservation:	Partial (25-75%)
Age-at-Death Estimation:	Adult 40s-50s (pubic symphysis, auricular surface)
Biological Sex Estimation:	Male? (GSNs and supraorbital margins)
Observations:	Jade dental inlays, dental calculus, possible Schmorl's nodes
Stable Isotope Results:	HO-16-12: $^{87}Sr/^{86}Sr$: 0.70827, $\delta^{18}O$: -3.4 (-4.1*), $\delta^{13}C$: -1.2 HO-16-10: $^{87}Sr/^{86}Sr$: 0.70842, $\delta^{18}O$: -4.7, $\delta^{13}C$: -2.0 **local** *adjusted for weaning

Table 8.4 Individual profile of HOL.L.20.21.09.01

In 2012, HOL.L.20.21.09.01 was excavated following the cleaning of the looter's trench HOL.L.20 that had intruded on Building A of Group II (Estrada-Belli 2012). Building A is located on the east side of Group II, along with Building F. After the cleaning of the 15.40 m long looter's trench, excavations were conducted to understand the late Preclassic pyramid architecture and the role of the building. The burial was found in a cut into the floor of a room in the antepenultimate phase of Building A, where they then constructed a vault using medium limestone slabs. The cut floor had a maximum thickness of 6cm. The tomb construction, as well as the many associated artifacts suggest the high social standing of this individual.

HOL.L.20.21.09.01 was a primary, single interment in an unspecified type of tomb construction (Figure 8.11). This burial cut was topped with vault stones, classifying it as a tomb. The body was positioned in an extended supine position, oriented south-north with the head in the south. The many associated artifacts include 28 ceramic vessels (HOL.L.20.21.02.01 to .28) that can be separated into ten plates and 18 bowls. Nine of the plates were lip to lip, with seven on the left side of the individual, two on the right,

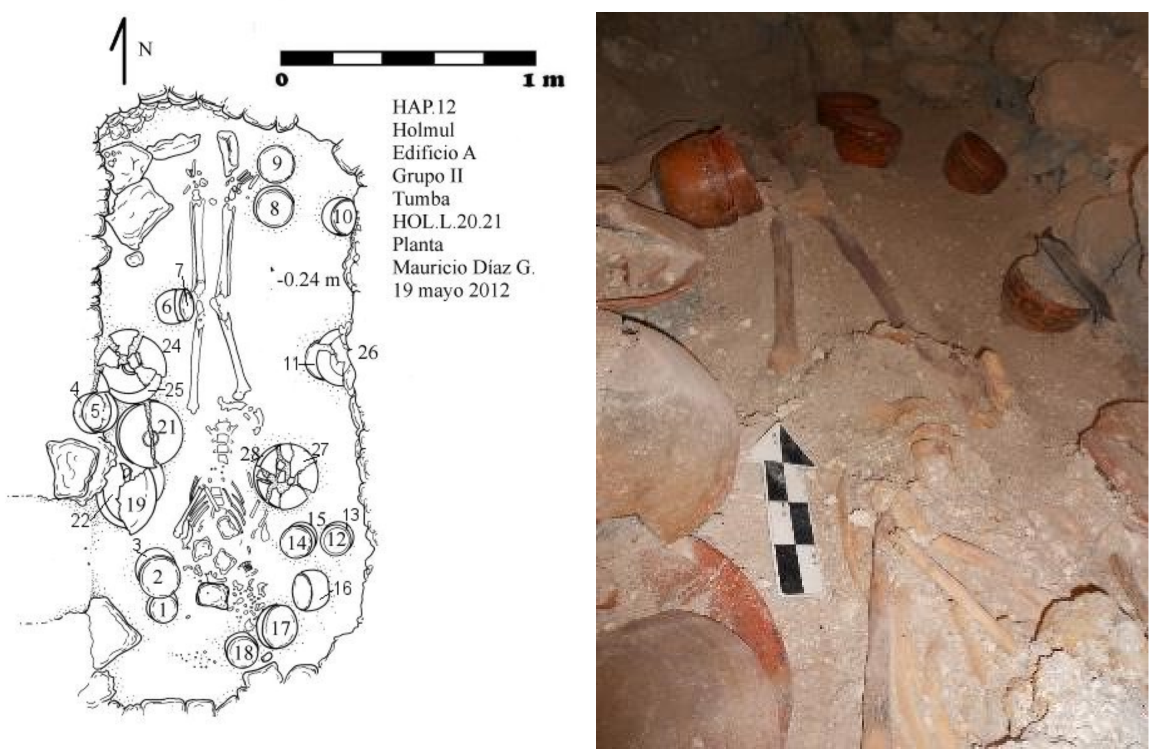

Figure 8.11 Plan drawing (left) of HOL.L.20.21.09.01 by M. Diaz Garcia; In situ photo (right) (Estrada-Belli 2012:193-194).

and one inverted on a bowl on the right. The bowls were all orange with a red border and black lip, painted with bands and designs in brown, red, and black. The ceramic suggests a date of AD 600. Three stones were found in the chest area of the individual, one (HOL.L.20.21.07.01) was embedded with organic material and thin layers of stucco painted greenish blue (HOL.L.20.21.14.24). The archaeological report suggests that the organic material was from a wooden mask, which had two small jade ear flares. Near the skull, a fragment of spondylus shell (HOL.L.20.21.10.01) was found.

HOL.L.20.21.09.01 was partially preserved, primarily due to postmortem damage. The cranium was very fragmented due to structural collapse of the tomb. The axial skeleton was also very fragmented with only a few vertebral bodies and the axis recovered. The appendicular body was relatively well preserved, as fragments of the os coxae were recovered, as well as fragments of all of the limbs. The long bones of the lower limb were, while broken postmortem in pieces could be mostly reconstructed. Bones from both feet were recovered, but hand bones were not.

The fragments of the ossa coxae allowed for an estimate of age at death and biological sex (Figure 8.12). Both ilia were fragmentary, although both greater sciatic notches were preserved, each scoring a 5, indicating very narrow (male). This estimate was also supported by blunt (scored 5) supraorbital margins on frontal bone fragments. Some long bone measurements were attempted, although the fragmentary nature of the long bones rendered any results inconclusive. The right pubic symphysis was complete allowing for age at death estimation of late 40s, using both the Todd (1921) and Suchey-

Brooks (Brooks and Suchey 1990) systems. The examination of the right auricular surface allowed for an estimate of 50 to 59 years of age at death.

The extensive postmortem destruction of the remains hindered the paleopathological evaluation. There is some bony addition on the arch of the axis, and some possible Schmorl's nodes (intrusion of the disc) of the preserved vertebral bodies (Figure 8.13), which is typical of many individuals in their 40s (Ortner 2003). The dentition was very fragile, with the roots being particularly brittle. The labial dentition contained jade inlays (Figure 8.13), and possibly some filing. In addition, there was some dental calculus on the molar recovered.

Two teeth were sampled for isotope analysis. The enamel of the left first and third maxillary molars were tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. For the first molar, the $^{87}Sr/^{86}Sr$ result was 0.70827, while the $\delta^{18}O$ was -3.4 (adjusted to -4.1) and $\delta^{13}C$ was -1.2. For the third molar, the $^{87}Sr/^{86}Sr$ result was 0.70842, while the $\delta^{18}O$ was -4.7 and $\delta^{13}C$ was -2.0. In 2013, Friedrich (2013) also tested a tooth, the right second mandibular molar, from this individual for $\delta^{18}O$ (-1.5) and $^{87}Sr/^{86}Sr$ (0.7082). The stable isotope analysis did not suggest that either dental sample was a statistical outlier, and thus likely HOL.L.20.21.09.01 was a local individual from Holmul or the Holmul region, although variation in $^{87}Sr/^{86}Sr$ ratio from first to third molar suggests possible movement around the region during childhood.

Figure 8.12 Left greater sciatic notch (above), right auricular surface (below left) and pubic symphysis (below right) of HOL.L.20.21.09.01.

Figure 8.13 Dental inlays (above) (Friedrich 2013: Fig 8) and vertebrae (below) of HOL.L.20.21.09.01.

HOL.L.20.15.09.01

Individual/Burial ID #:	**HOL.L.20.15.09.01**
Laboratory ID #:	HO-16-11
Site:	Holmul
Associated Period/Date:	Early Classic (AD 500-600 from ceramic)
Year Excavated:	2012 (Diaz Garcia)
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul y Dos Aguadas. Informe Preliminar de la Temporada 2012*; Friedrich 2013
Dentition Sampled:	Right first mandibular molar
Burial Location and Construction:	Religious/Ceremonial (Temple-Pyramid), Building A Group II, under stairs, simple, pit/(unnamed)
Burial Type, Manner, and Positioning:	Primary, single interment, flexed on left, S-N, head in S facing W
Associated Artifacts:	Ceramic vessel, bone needle, flint projectile tip
Preservation:	Complete (75-100%)
Age-at-Death Estimation:	Adult 30s to 40s (pubic symphyses, auricular surface)
Biological Sex Estimation:	Female (cranium, os coxae, long bone calculations)
Observations:	Fronto-occipital shaping, dental inlays (jade and pyrite), dental caries, osteophyte addition to cervical and lumbar vertebral bodies
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70823, $\delta^{18}O$: -6.0 (-6.7*), $\delta^{13}C$: -5.1 **local** *adjusted for weaning

Table 8.5 Individual profile of HOL.L.20.15.09.01

Similarly to HOL.L.20.21.09.01, HOL.L.20.15.09.01 was excavated following the cleaning of the looter's trench HOL.L.20 that had intruded on Building A of Group II (Estrada-Belli 2012). Excavations revealed a staircase (HOL.L.20.14) in poor conservation, with small amounts of stucco remaining. HOL.L.20.15.09.01 was found buried under this staircase (Figure 8.14; Figure 8.15).

HOL.L.20.16.09.01 is classified as a single, primary interment in a ceremonial or religious building (temple-pyramid). The grave was constructed as a simple pit or unnamed type, using the blocks of the stairs to line the western edge of the burial. The body was placed in a flexed position on the left, oriented south-north with the head to the south and facing west. The associated artifacts include one ceramic bowl (HOL.L.20.15.02.01) with a brown border and red details, which was placed to the west

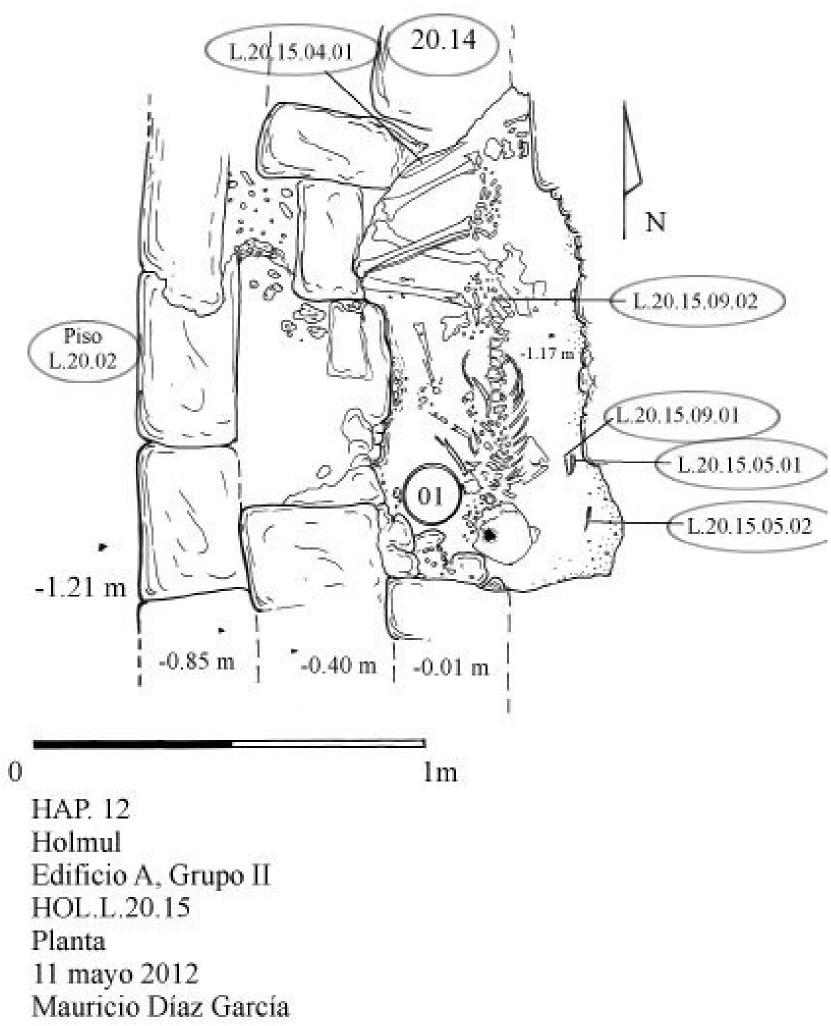

Figure 8.14 Plan drawing of HOL.L.20.15.09.01 by M. Diaz Garcia (Estrada-Belli 2012:198).

of the skull. A bone needle (HOL.L.20.15.09.01) and a flint projectile tip (HOL.L.20.15.04.01) were found associated with the burial.

HOL.L.20.15.09.01 was recovered in relatively complete preservation. The cranium was nearly complete, missing only the right temporal. Rodents may have nested in the neurocranium, resulting in minor postmortem damage. The mandible was mostly complete, except the right ramus and condyle. Three teeth were still in situ in the mandible: the right premolars and the right first molar. Two canines were recovered, both with inlays- one jade, one pyrite. Three incisors and one canine were found with holes for inlays, but without the stone. Other recovered teeth included five premolars and a molar with great postmortem damage. All of the vertebrae were represented, in varying states of preservation. The sacrum was fragmented, as were the ribs with 26 fragments recovered. The left scapula, including the glenoid fossa, was partially preserved, along with both

Figure 8.15 In situ photo of HOL.L.20.15.09.01 (Estrada-Belli 2012: 188).

Figure 8.16 Right pubis of HOL.L.20.15.09.01.

clavicles. A large portion of the left ilium was preserved with the auricular surface and a portion of the greater sciatic notch. Of the right os coxae, only the pubis and pubic symphysis were preserved (Figure 8.16). The lower limbs were fragmented, but present and allowing for some articulation of the fragments. The upper limbs were not as well preserved, although the left humerus is mostly complete, just missing the distal end. Both feet and hand bones are well represented.

The well-preserved cranium and partially preserved right os coxae allowed for an estimation of age at death and biological sex. The right pubic symphysis was examined and estimated to score a 6 (30-35 years) using the Todd (1921) system and a 4 (mean of 38.2) using the Suchey-Brooks system (Brooks and Suchey 1990). The right auricular surface of the ilium scored a 5 (40-44) using the system by Lovejoy and colleagues (1985). The cranial sutures were also scored (Meindl and Lovejoy 1985) resulting in an age range of 34-65.

The left nuchal crest, mastoid process, supraorbital margin, and glabella all were scored as 1, suggesting a female estimation of biological sex (Buikstra and Ubelaker 1994). The right ventral arc, subpubic concavity, ischiopubic ramus ridge, greater sciatic notch (Figure 8.17) and preauricular sulcus scored 1, also suggesting female (Phenice

Figure 8.17 Left ilium of HOL.L.20.15.09.01.

Figure 8.18 Cranium of HOL.L.20.15.09.01.

1969). Bone metrics were also used to estimate biological sex, including the right clavicle, left femoral head diameter, and left calcaneus, which all corroborated the estimation of female.

The body of HOL.L.20.15.09.01 was intentionally modified, with fronto-occipital cranial shaping (Figure 8.18) and dental inlays, both jade and pyrite, of the labial dentition (Figure 8.19). Besides dental caries on a molar, the only pathological changes observed were osteophyte addition to vertebral bodies, most severely in the cervical and lumbar regions.

The enamel of the right mandibular first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70823, while the $\delta^{18}O$ was -6.0 (adjusted for weaning to -6.7) and $\delta^{13}C$ was -5.1. Friedrich (2013) also tested a tooth, the left first maxillary molar, from this individual for $\delta^{18}O$ (-3.4066) and $^{87}Sr/^{86}Sr$ (0.7081). The stable isotope analysis did not suggest that HOL.L.20.15.09.01 was a statistical outlier, and most likely was a local individual from Holmul or the Holmul region.

Figure 8.19 Dental modification of HOL.L.20.15.09.01.

HOL.T.78.42.09.01

Individual/Burial ID #:	**HOL.T.78.42.09.01**
Laboratory ID #:	HO-16-14
Site:	Holmul
Associated Period/Date:	Early Classic (AD 531-565, C14)
Year Excavated:	2014 (Nievens and Estrada-Belli)
Archaeological Reports:	-
Dentition Sampled:	Left maxillary canine
Burial Location and Construction:	Holmul, Group II Building A, Room 2, Ceremonial/Religious, capped cist
Burial Type, Manner, and Positioning:	Single, primary interment, flexed on left, N-S, head N facing E
Associated Artifacts:	2 jade ear flares
Preservation:	Complete (75-100%)
Age-at-Death Estimation:	Adult 40s-50s
Biological Sex Estimation:	Female
Observations:	Dental modification (incision on labia surface), mandibular alveolar reabsorption, osteophyte addition to vertebral bodies, woven bone lesions
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70815, $\delta^{18}O$: -3.4 (-4.1*), $\delta^{13}C$: -3.1 **local** *adjusted for weaning

Table 8.6 Individual profile of HOL.T.78.42.09.01

In 2014, the excavations at Group II aimed to explore the two rooms of the frieze phase of Building A. Two vaulted rooms were excavated- Room 1 (HOL.T.78.36) to the west and Room 2 (HOL.T.78.37) to the east. Excavations revealed a cut (HOL.T.78.41) against the back wall of Room 2. Excavations continued approximately 50 cm into the cut revealing two large capstones (HOL.T.78.43) that covered a burial (HOL.T.78.42).

The primary, single interment of HOL.T.78.42.09.01 was found buried in a flexed position, on the individual's left, oriented north-south, with the head in the north facing east (Figure 8.21). The presence of capstones placed on the unlined or partially lined grave suggests the construction is that of a capped cist. This burial was cut into the floor of a ceremonial or religious building (the frieze phase of Building A). The individual was buried with two jade ear flares (Figure 8.20).

Figure 8.20 Jade earflares of
HOL.T.78.42.09.01 (Image Courtesy of HAP).

Figure 8.21 Insitu photo of HOL.T.78.42.09.01 (Image Courtesy of HAP).

The skull of HOL.T.78.42.09.01 is mostly complete (Figure 8.22), with minor postmortem damage to the splanchnocranium (facial skeleton). The mandible is complete with slight postmortem damage to the condyles and the right coronoid process. One tooth was recovered, a left maxillary canine, in good condition, although the root is very fragile. There is an antemortem incision (dental modification) across the labial surface.

Figure 8.22 Cranium of HOL.T.78.42.09.01.

The axial skeleton is also mostly complete (Figure 8.23), with 25 vertebrae: all seven cervical vertebrae, 12 thoracic vertebrae, and six lumbar vertebrae. This individual had an extra lumbar vertebra. The 4th and 5th lumbar vertebrae were fused together antemortem, which may have made it serve the function of a singular 5th vertebra. The sacrum is complete, with five segments fused together along with the first segment of the coccyx. Two more segments of the coccyx were separate but present. The manubrium and sternal body are very fragmented, in three fragments: jugular notch, larger fragment of the manubrium, and the left side of the sternal body with costal notches and the suggestion of a large sternal foramen. There are 11 left ribs and ten right ribs represented by rib heads, including a fragmented right 1st and 2nd ribs and a fragmented left 1st rib. There are 14 additional left rib shaft fragments, and seven right rib shaft fragments.

Figure 8.23 Articulated skeleton of HOL.T.78.42.09.01.

The appendicular body is also mostly complete, with all elements at least partially present. The ossa coxae (Figure 8.24) are mostly complete, with only the left missing the pubis. Both auricular surfaces and both acetabular surfaces are complete, and the right pubic symphysis only has some postmortem damage to the inferior portion of the surface. The left humerus has a complete head, major postmortem damage/break to the proximal shaft, and a complete distal epiphysis. The right humerus is complete, with some minor postmortem damage to the distal shaft, one postmortem break midshaft, and complete proximal and distal epiphyses. The left radius is complete, with some minor postmortem damage to the shaft in two small places and some minor postmortem damage to the distal end. The right radius shaft was broken postmortem into thirds with some postmortem damage to the distal end. The left ulna has one postmortem break midshaft, the distal epiphysis is not present, and there is some postmortem damage to the olecranon process (a fragment was with the humerus, still in the olecranon fossa). The right ulna has a complete proximal metaphysis and epiphysis, with one postmortem break midshaft and a missing distal epiphysis.

Figure 8.24 Pelvic region of HOL.T.78.42.09.01.

The left femur has postmortem breaks at both metaphyses, with postmortem damage to the medial epicondyle, major postmortem damage to the proximal metaphysis and neck, very fragmented trochanters, and minor postmortem damage to the femoral head. The right femur is mostly complete with minor postmortem damage to the greater trochanter, femoral head, and the anterior surface of the distal metaphysis. The left tibia has postmortem breaks at both metaphyses, but has a complete tibial plateau and distal epiphysis. The right tibia is complete with some minor postmortem damage to the anterior proximal shaft surface, but has a complete distal epiphysis and tibial plateau. The left fibula has one postmortem break midshaft, minor postmortem damage to the distal epiphysis, and a missing proximal epiphysis. The right fibula has a complete shaft with one postmortem break mid shaft, missing proximal epiphysis, and a separate fragment of the distal epiphysis.

The left hand was complete except for two missing proximal phalanges, three intermediate phalanges, and three distal phalanges. The right hand was also mostly complete except for a missing pisiform, for two missing proximal phalanges, three intermediate phalanges, and three distal phalanges. There was one sesamoid bone that was not able to be sided. The left foot was complete, although there was postmortem damage to the lateral side of the calcaneous, to the cuboid, and the first metatarsal. The right foot also had postmortem damage to the lateral side of the calcaneous, but was missing the 2nd proximal phalanx and the 2nd, 4th and 5th intermediate phalanges.

The biological sex of this individual was estimated to have been female, both morphologically and metrically. The left os coxae has a greater sciatic notch that is fairly wide and a preauricular sulcus that is wide and deep. The right os coxae has a slightly visible ventral arc and a fairly wide greater sciatic notch. These morphological traits of the pelvis, using the Phenice (1969) and Buikstra and Ubelaker (1994) methods, suggest that the estimated biological sex was probably female (Figure 8.24). The skull has an ambiguous nuchal crest, small mastoid processes, ambiguous supraorbital margins, slightly pronounced supracilliary arches/glabellar region, and a very slight mental eminence. The morphological characteristics of the skull suggest an ambiguous estimation of biological sex. The metric analysis of the skeletal remains suggests an estimation of biological sex of female. The right clavicle, both humeri, both radii, the right ulna, both femoral heads, both tibiae, and both tali provided estimations of a biological sex of female from the metric calculations.

The auricular surfaces of the ossa coxae have no macroporosity, loss of transverse organization, possible retroauricular activity, depth at the apex, dense not granular surfaces, and the edges are defined with slight lipping and irregularity (Figure 8.25). Using the Lovejoy and colleagues (1985) method for scoring the auricular surface, these characteristics score a 5 to 6, which corresponds to the age range of 40 to 49 years of age at death. Only the left pubic symphysis was partially preserved, but there was enough left in order to estimate age at death. The symphyseal face is slightly concave or depressed with few and slight irregular ridges and the dorsal margin is very irregular. Using the

Figure 8.25. Left auricular surface of HOL.T.78.42.09.01.

Todd (1920) method, these traits score a 9 to 10, which estimates the age at death of 45 years or more. Using the Suchey-Brooks (1990) method, these traits score a 6, which estimates the age at death range as 42 to 87 years with a mean of 60 years of age at death. Most of the cranial vault and lateral-anterior sutures are closed, and using the Meindl and Lovejoy (1985) method, the suture closure composite scores estimate age at death of between 35 and 65 years of age at death. Considering all of these methods, an estimated range for age of death is between 40 and 65 years, with it being more likely that the individual was around age 50 at death.

The skeletal remains showed many instances of pathological bone addition and reduction. The mandible and maxilla demonstrate that the individual had lost all but one tooth (left maxillary canine) antemortem and that the alveolar surfaces had reabsorbed completely (Figure 8.26). Many of the vertebrae have macro- and microporosities on the superior and inferior body surfaces, as well as osteophytic activity on the body margins.

Figure 8.26 Mandible of HOL.T.78.42.09.01.

Many of the vertebrae also had small antemortem holes or lesions through the superior or inferior surfaces of the body, perhaps indicating some sort of infection. Many of the thoracic vertebrae have compression of the bodies on the right side. The 5th and 6th thoracic vertebrae have antemortem fractures of the vertebral bodies, evidenced on the inferior surface of the bodies, with indication of healing. The 4th and 5th lumbar vertebrae are fused together at the body (Figure 8.27). The right tibia has some active woven bone addition midshaft on the medial side and some on lateral side of the proximal shaft, just under the tibial plateau (Figure 8.28). The left 2nd and 3rd metacarpals also have instances of woven bone, as does the left and right proximal 2nd and 3rd proximal phalanges and the left and right intermediate phalanges. There is also woven bone present on many of the metatarsals and foot phalanges. The woven bone also indicates an active infection at the time of death.

The enamel of the left maxillary canine was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70815, while the $\delta^{18}O$ was -3.4 (-4.1 when adjusted for weaning) and $\delta^{13}C$ was -3.1. The stable isotope analysis did not suggest that HOL.T.78.42.09.01 was a statistical outlier, and most likely was a local individual from Holmul or the Holmul region.

Figure 8.28 Pathology of the right tibia of HOL.T.78.42.09.01.

Figure 8.27 Vertebrae of HOL.T.78.42.09.01.

HOL.T.98.04.09.01

Individual/Burial ID #:	**HOL.T.98.04.09.01**
Laboratory ID #:	HO-16-70
Site:	Holmul
Associated Period/Date:	Late Classic AD 700-750
Year Excavated:	2016 (Silvestre)
Archaeological Reports:	*Investigaciones Arqueológicas y Conservación de Arquitectura Monumental en la Región de Holmul: Temporada 2016*
Dentition Sampled:	Left Mandibular First Molar
Burial Location and Construction:	Group II, Building A, stone-lined tomb
Burial Type, Manner, and Positioning:	Single, primary interment, extended supine N-S, head to N
Associated Artifacts:	5 ceramic vessels (including polychrome), carved jade pendant, incised bone, worked shell, animal teeth (jaguar?), round jade bead, jade zoomorphic bead, 5 obsidian blades
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Infans I? (3 years?)
Biological Sex Estimation:	Indeterminate
Observations:	Indeterminate
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70807, $\delta^{18}O$: -4.8 (-5.5*) $\delta^{13}C$: -2.7 **local** *adjusted for weaning

Table 8.7 Individual profile of HOL.T.98.04.09.01

In 2016, an excavation square unit (HOL.T.98) was placed on the northwest side of Building A of Group II in order to investigate further the construction phases of the pyramid. This unit was excavated to a depth of 3m and then continued in a tunnel to the south at the same level. The burial chamber was found approximately 3 meters into the tunnel. This vaulted chamber was approximately 3m in length by 1.2m wide and 1.6m high oriented north-south.

The primary, single interment of the individual (HOL.T.98.04.09.01) was found in an extended supine position oriented north-south with the head to the north (Figure

8.29). Building A of Group II was a temple-pyramid during the Late Classic, classifying the burial location as ceremonial or religious. The vaulted construction, with possible

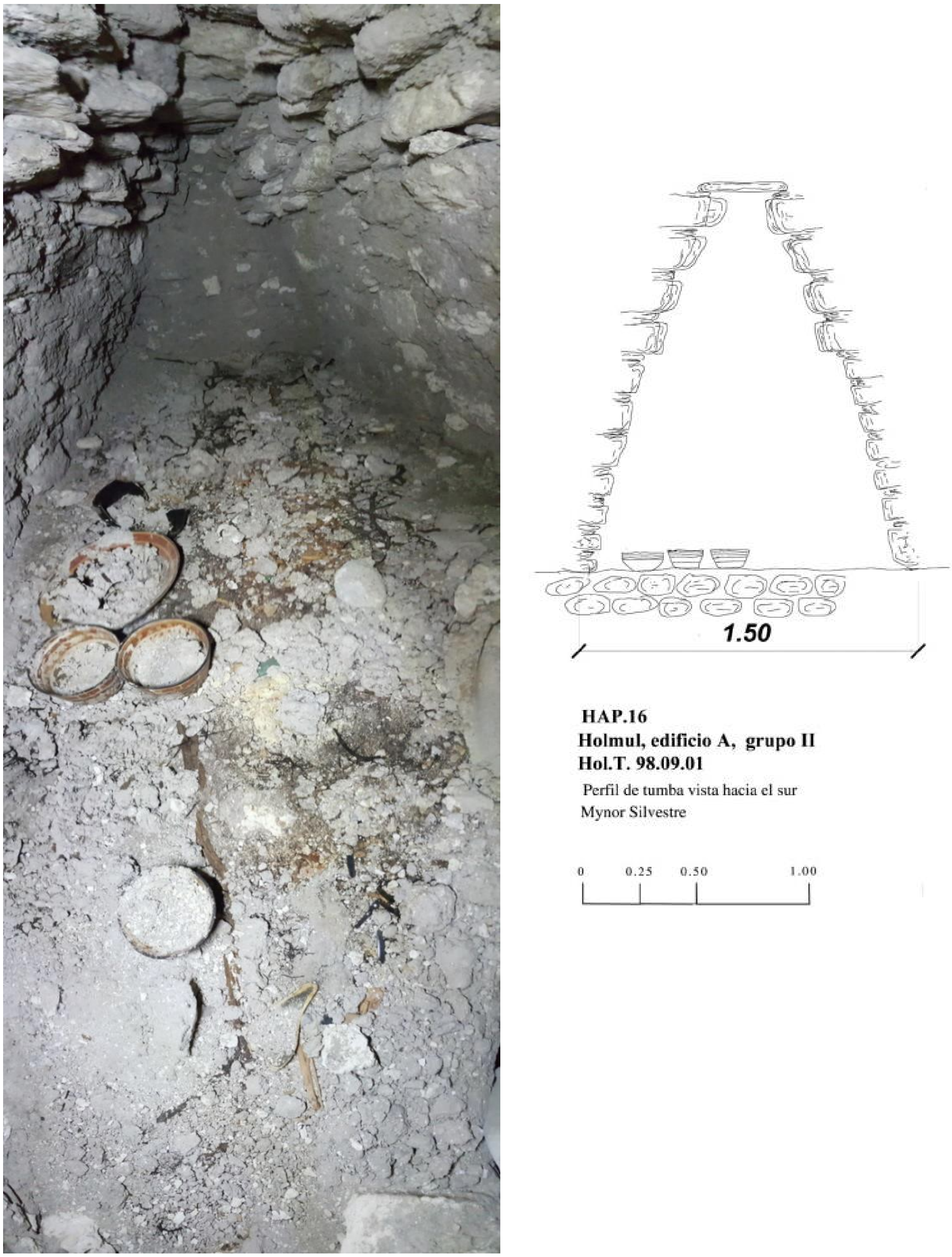

Figure 8.29 Insitu photo of HOL.T.98.04.09.01 (right), profile drawing of tomb (left) (Estrada-Belli 2016:6,57).

plaster remaining on the stone walls is classified as a stone-lined tomb. Associated artifacts include: 5 ceramic vessels, including a polychrome vessel with pseudo-glyphs (Figure 8.30); a carved jade pendant with the profile of a ruler wearing a headdress; an incised bone fragment with illegible hieroglyphic inscription; a shell or worked snail; five obsidian blades; two worked shell pieces; one worked shell shaped as a star; animal teeth (jaguar fangs?); a round jade bead; and a jade bead shaped as a stylized bird head.

The osteological analysis has yet to be performed, although from the report, it appears that the preservation of the skeleton is extremely poor condition with very fine fragments of cranial bones, some hand bones, fragments of lower left limbs, a shaft of a tibia, some metatarsals and foot phalanges. The dentition provided for stable isotope analysis, a left mandibular first molar, was not completely formed, with the crown nearing completion or completed and no root growth. This dental development allows for an age-at-death estimation of 2-10 years (Thoma and Goldman 1960) or around 3 years

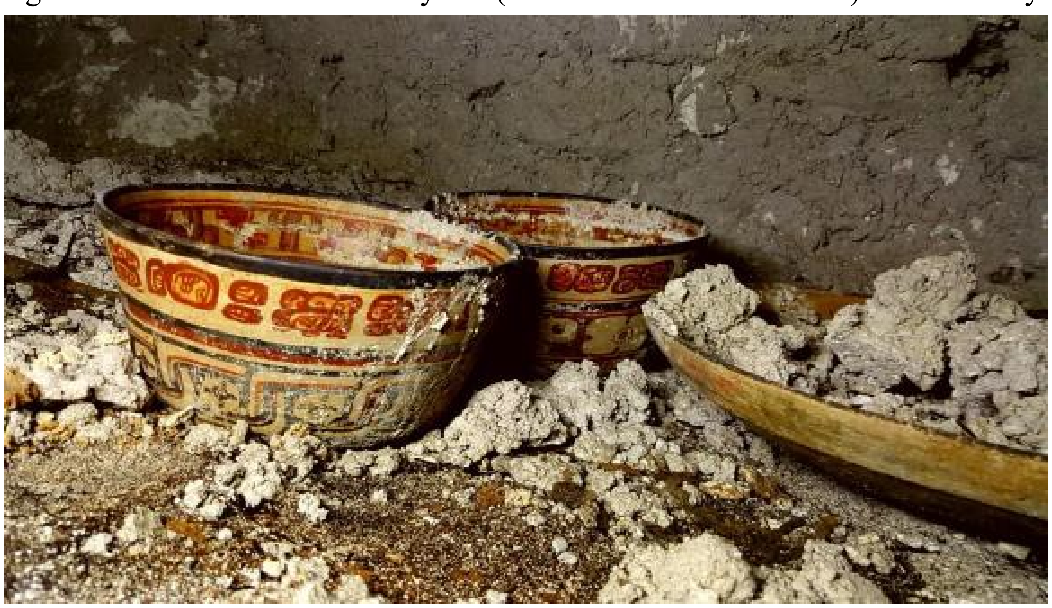

Figure 8.30 Ceramic vessel found with HOL.T.98.04.09.01 (Estrada-Belli 2016: 6).

(Smith 1991). It is possible that this tooth belonged to a second individual interred with the primary individual.

The enamel of the left mandibular first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70807, while the $\delta^{18}O$ was -4.8 (-5.5 when adjusted for weaning) and $\delta^{13}C$ was -2.7. Statistically, HOL.T.98.04.09.01 was not an outlier, and was most likely a local to Holmul or the region.

*Considering the Burials of Holmul, Group II, Building A*During the 2012 season, two burials were excavated from Building A. The first (HOL.L.20.15.09.01) was found under the stairway of the Throne Phase, while the second (HOL.L.20.21.09.01) was within an intrusive tomb constructed through the floor of the vaulted room of the Throne Phase. A painted inscription of the interior wall next to the throne contains the date 7 Cib 14 Ch'en (9.6.4.9.16; September 13, AD 558), dating both burials post AD 558 and most likely towards the end of the Throne Phase or at the beginning of the Frieze Phase.

In 2014, the burial HOL.T.78.42.09.01 was found in a cut into the floor of Room 2 of the Frieze Phase vaulted building. Radiocarbon (Estrada-Belli 2015) from Room 1 of the Frieze Phase Building A produced a date of 1470±30, which when calibrated corresponds to AD 567 to 630 (1-sigma 68% probability and 2-sigma AD 545-645 with 98% probability). This corresponds to the age of Ajnumsaj, the Naranjo ruler, that was mentioned in the dedicatory text of the frieze, suggesting the date of AD 593. The burial of HOL.T.78.42.09.01 was also radiocarbon dated (Estrada-Belli 2015) to 1540±30, which is, when calibrated, AD 531-565 (1-sigma 68% probability and AD 426-588 with 2-sigma 98% probability). The radiocarbon results suggest HOL.T.78.42.09.01 was buried sometime following the completion of the vaulted rooms, but perhaps before the dedicatory text of the Frieze was completed. All three burials can be dated to between AD 550 and 600.

As HOL.L.20.21.09.01 was buried in connection with Building A being transformed from a palace structure to a ceremonial structure, it is probable that HOL.L.20.21.09.01 was the ruler who used the palace and was commemorated by the frieze-adorned temple structure. The principal figure of the frieze is the ruler Tzahb Chan Yopaat, suggesting that the tomb of HOL.L.20.21.09.01 is in fact that of a royal tomb of Tzahb Chan Yopaat. The osteological evaluation estimates that the individual buried was a male who died at an age between late-30s and mid-50s. The mortuary analysis concurs with a royal burial, as the construction of the grave was that of a tomb, the most elaborate construction found in the Holmul center. Further, the burial was accompanied by 28 ceramic vessels, two quatrefoil jade ear flares, and the remains of a wooden mask, all suggesting a royal personage.

Two teeth were selected from HOL.L.20.21.09.01 for stable isotope analysis, a first molar and a third molar, to reveal any changes in the $^{87}Sr/^{86}Sr$ ratios, which would suggest a change in location between early childhood to late childhood. Statistically, however, the strontium stable isotope ratios from both the first molar (early childhood) and the third molar (late childhood) were not outliers, suggesting that this individual was in the Holmul region throughout his childhood.

HOL.L.20.15.09.01 was interred during the same construction phase as the possible Tzahb Chan Yopaat. It is probable that this burial, while not as elaborately constructed, was that of an elite female, possibly a member of Tzahb Chan Yopaat's royal family. HOL.L.20.15.09.01 was interred in a flexed position on her left in an intrusive simple pit grave, while the royal personage was extended in a constructed, yet intrusive, tomb. Further, this individual is estimated to have been a female in her 30s or 40s at the time of death, possibly also an elite, as she had jade and pyrite dental inlays and was accompanied by a polychrome bowl, a bone needle, and a flint projectile tip. The stable isotope analyses suggest that she was local to Holmul or the Holmul region. Interestingly, burials under staircases are usually interpreted as a dedicatory cache during the construction of building (Kunen et al. 2002), although in this case it could be a terminal act to accompany the death and burial of Tzahb Chan Yopaat. It is also common to find burials in the courtyard in line with the staircase (Kunen et al. 2002). It is as possible that she was buried on in association with Tzahb Chan Yopaat as a member of the royal family.

HOL.T.78.42.09.01 was another elite female buried in Building A around the same time, although definitely after the burial of Tzahb Chan Yopaat and possibly also HOL.L.20.15.09.01. This burial occurred after or during the conversion of palace structure into a ceremonial structure for Tzahb Chan Yopaat. HOL.T.48.42.09.01 was also positioned flexed on her left in an intrusive grave, although as it was inside of a building and more elaborately constructed as a capped cist. She was in her 40s or 50s at the time of death and was buried only accompanied by a set of jade earflares. The stable isotope analysis suggests that she also was local to Holmul or the Holmul region. Further, this female also might have been a member of the royal family of Tzahb Chan Yopaat.

In 2016, excavations of Building A were placed to the west of previous excavations to investigate further the architectural phases of the building. During tunnel excavations, HOL.T.98.04.09.01 was found in a vaulted burial chamber. Based on stratigraphy and the phases of construction, this interment dates later than the Frieze Phase, perhaps ca. AD 700 to 750 (Estrada-Belli, personal communication). The burial construction, positioning, and associated artifacts suggest the designation of an elite individual's grave. The grave was a stone-lined tomb opulently filled with five polychrome vessels, a carved jade pendant, incised bone, worked shell, animal (jaguar?) teeth, a jade zoomorphic bead, and five obsidian blades. Unfortunately, the skeletal remains of this individual were very fragile, and the osteological evaluation is forthcoming. However, the left mandibular first molar exported for stable isotope analysis had a nearly completed crown, yet not fully developed, which suggests that the individual was not yet an adult, and may have been as young as two or three years of age-at-death. It is also possible that the tooth selected was from a second individual, a child, in the tomb, perhaps serving as a burial offering.

The four individuals buried in Building A were elite individuals buried in a palace that was modified to become a ceremonial structure. It is probable that the individual in the elaborate tomb, HOL.L.20.21.09.01, was in fact the ruler mentioned on the frieze, Tzahb Chan Yopaat, who was born elsewhere in the southern lowlands and traveled to Holmul during late childhood. The two local females were interred at the same time or shortly thereafter, suggesting a familial connection. Later, an individual, possibly a young individual (Infans I), was interred in a well-constructed grave with lavish associated artifacts, perhaps accompanying an adult. It is possible that this adult individual was a descendent of Tzahb Chan Yopaat and his family.

Holmul, Group II, Building A

HAP ID	HOL.L.20.21.09.01	HOL.L.20.15.09.01	HOL.T.78.42.09.01	HOL.T.98.04.09.01
Sample ID	HO-16-12; HO-16-10	HO-16-11	HO-16-14	HO-16-70
Possible Name	Tzahb Chan Yopaat?			
Period	Early Classic (AD 550-600)	Early Classic (AD 550-600)	Early Classic (AD 550-600)	Late Classic (AD 650-750)
Age-at-Death	Adult (35-55yrs)	Adult (30s-40s)	Adult (late 40s)	Infans I? (3years?)
Biological Sex	Male?	Female	Female	Indeterminate
Dental Pathology	Jade inlays	Dental caries, jade and pyrite inlays	Incision on labial surface of tooth, alveolar resorption	Unknown
Pathology	possible Schmorl's nodes	Fronto-occipital shaping, osteophyte addition to cervical and lumbar vertebral bodies	osteophyte addition to vertebral bodies, woven bone lesions	Unknown
Burial Type	Grave interment	Grave interment	Grave interment	Grave interment
Burial Manner	Primary, single	Primary, single	Primary, single	Primary, single?
Body Positioning	Extended, supine, S-N	Flexed, left side, S-N, facing W	Flexed, left side, N-S, facing E	Extended?, supine? N-S
Burial Location	Religious/ Ceremonial (Temple-Pyramid)	Religious/ Ceremonial (Temple-Pyramid),	Religious/ Ceremonial (Temple-Pyramid)	Religious/ Ceremonial (Temple-Pyramid)
Grave Construction	Tomb, unspecified	Simple, pit or unnamed, under stairs	Cist, capped	Tomb, stone-lined
Associated Artifacts	28 vessels, 1 spondylus shell and a perishable mask with jade ear flares	Ceramic vessel, bone needle, flint projectile tip	2 jade ear flares	5 ceramic vessels carved jade pendant, incised bone, and much more
Tooth Sampled	LM^1; LM^3	RM_1	LC^1	LM_1
$^{87}Sr/^{86}Sr$	0.70827; 0.70842	0.70823	0.70815	0.70807

$\delta^{18}O_{ap}$	-3.4 (-4.1*); -4.7	-6.0 (-6.7)	-3.4 (-4.1*)	-4.8 (-5.5*)
$\delta^{13}C_{ap}$	-1.2; -2.0	-5.1	-3.1	-2.7
Local or Non-Local	Local	Local	Local	Local

Table 8.8 Summary of the burials of Holmul Group II, Building A

The Osteobiographies of Holmul, Group II, Building B

Merwin excavated the mortuary contexts of Building B during the field seasons of 1910 and 1911, providing extensive architectural and ceramic sequences, although lacking in-depth mortuary analysis, other than that the building's purpose was as a burial structure (Merwin and Vaillant 1932). The burials excavated by Merwin were included in the mortuary analyses of Welsh (1988) and Gerry (1993). Welsh (1988) argued that, since the building was constructed of high vaults and contained caches and burials, Building B should be considered a temple, and he included the burials of Building B in his temple burial sample. Gerry (1993:92) posited that it may have been an elite residence before being converted into an elaborate tomb structure in the Early Classic.

According to Merwin and Vaillant (1932), Building B has four major architectural phases (Figure 8.31), as revealed by the burial sequence that follows. During the first phase, Skeleton 21 was placed in a vaulted room (#9), which was subsequently covered by a floor and a structure was erected upon it. This structure was then sealed to construct the vaulted Room 8 to hold Skeletons 17, 18, 19, and 20. Following the filling and sealing of Room 8, a temple was erected with Rooms 1, 2, and 3. During the second construction period, Room 4 was added to the temple and Room 7 was built to house Skeleton 16. During the third phase, Skeleton 15 was deposited in Room 4, which was subsequently filled and sealed along with Room 3. The original floor of Room 1 of

Building B was augmented to be flush with the floor of Room 2, to allow for a larger area for burial deposition. Skeleton 1 was placed during the third period of interments, following (#1) Skeletons 13 and 14 and (#2) Skeleton 5. Skeleton 1 was placed during the same interment period (#3) as Skeletons 2 and 6, followed by (#4) Skeleton 10 and (#5) Skeleton 9 (Figure 8.33). Following the burial of Skeleton 9, the rooms were filled and the temple was sealed. During the fourth period of construction, Building B was covered by rubble to form a mound and Room 10 was constructed to house Skeleton 22.

In 2003, the Holmul Archaeological Project investigated the construction fill and Merwin's archaeological back-fill of Building B's Room 1. Excavations in the southwest area of Room 1 revealed a burial (HOL.HT.41.11.09.01; "Burial 10") not excavated by Merwin in 1910 and 1911. This simple crypt (classified as a cist by the excavators) was lined with roughly cut blocks and covered by capstones. The interred individual was positioned extended supine east to west with a jade bead and mammiform tetrapod, dating the burial to the Late Preclassic or Early Classic periods. Radiocarbon dating of a rib fragment confirmed the date of 1840±40 BP, calibrated to AD 120-230 (1-sigma) and AD 80-250 (2-sigma) (Estrada-Belli 2005). It is likely that HOL.HT.41.11.09.01 was the first grave of the sequence, just before Skeleton 21 of Room 9.

In 2004, 2005, and 2007, excavations continued to reveal the construction phases previous to those presented by Merwin (Figure 8.32). The earliest phase of construction was that of six plastered rooms filled with Late Preclassic material. The south façade of the platform supporting this earliest building held a monumental stucco mask with the image of an earth-monster or *witz*. Estrada-Belli (Estrada-Belli 2011) interprets this iconography as indicating a symbolic mountain or place of death, ascribing the purpose of ancestor veneration to the Preclassic structure. The ceramic material under this phase one building dates the construction to between 1000 and 400 BC, extending the occupation of Holmul into the Middle Preclassic. The ceramic analysis of all recovered materials from Building B was discussed by Callaghan (2013). Radiocarbon dating from the mask stucco presented the dates of 2300±40 and 2270±40 BP, calibrated to 400-340 BC, which confirms that this mask is one of the oldest found in the Maya region.

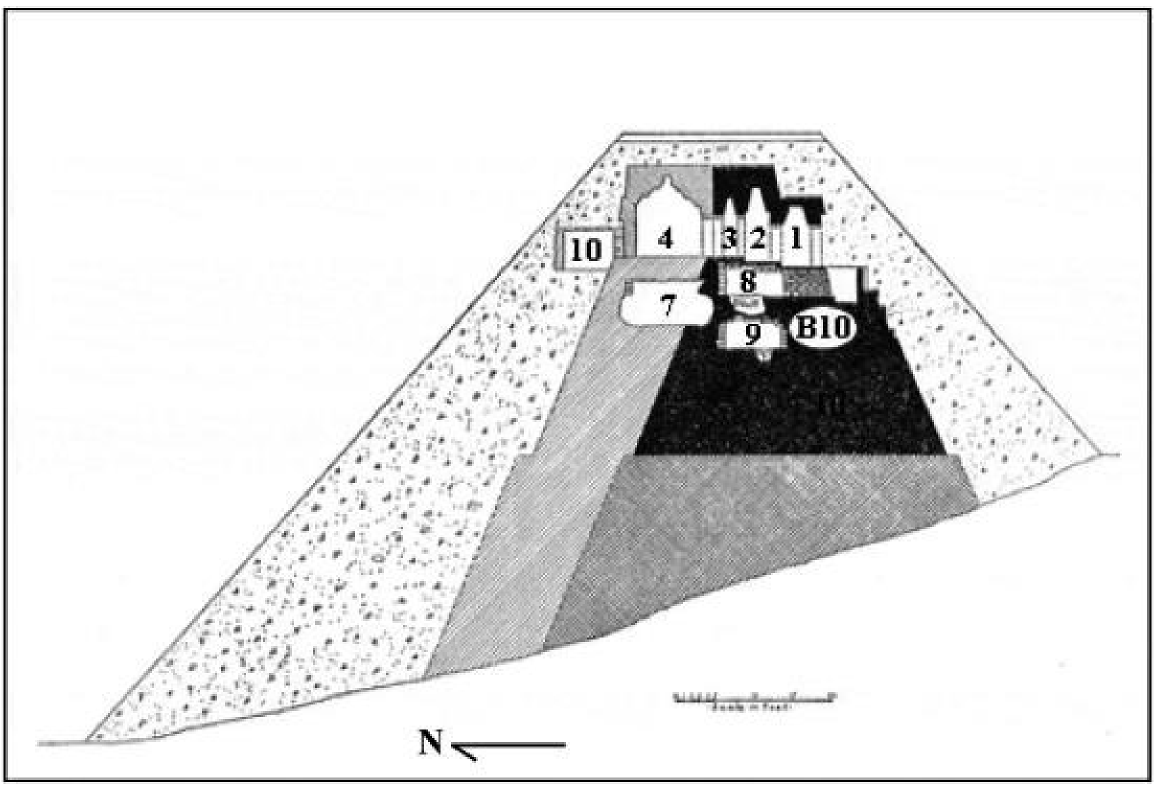

Figure 8.31 West profile of Building B, Group II, showing rooms excavated in 1909–1911. Holmul Project Burial 10 has been added ("B10"). Modified from Merwin and Vaillant (1932) by Callaghan (2013: Figure 6).

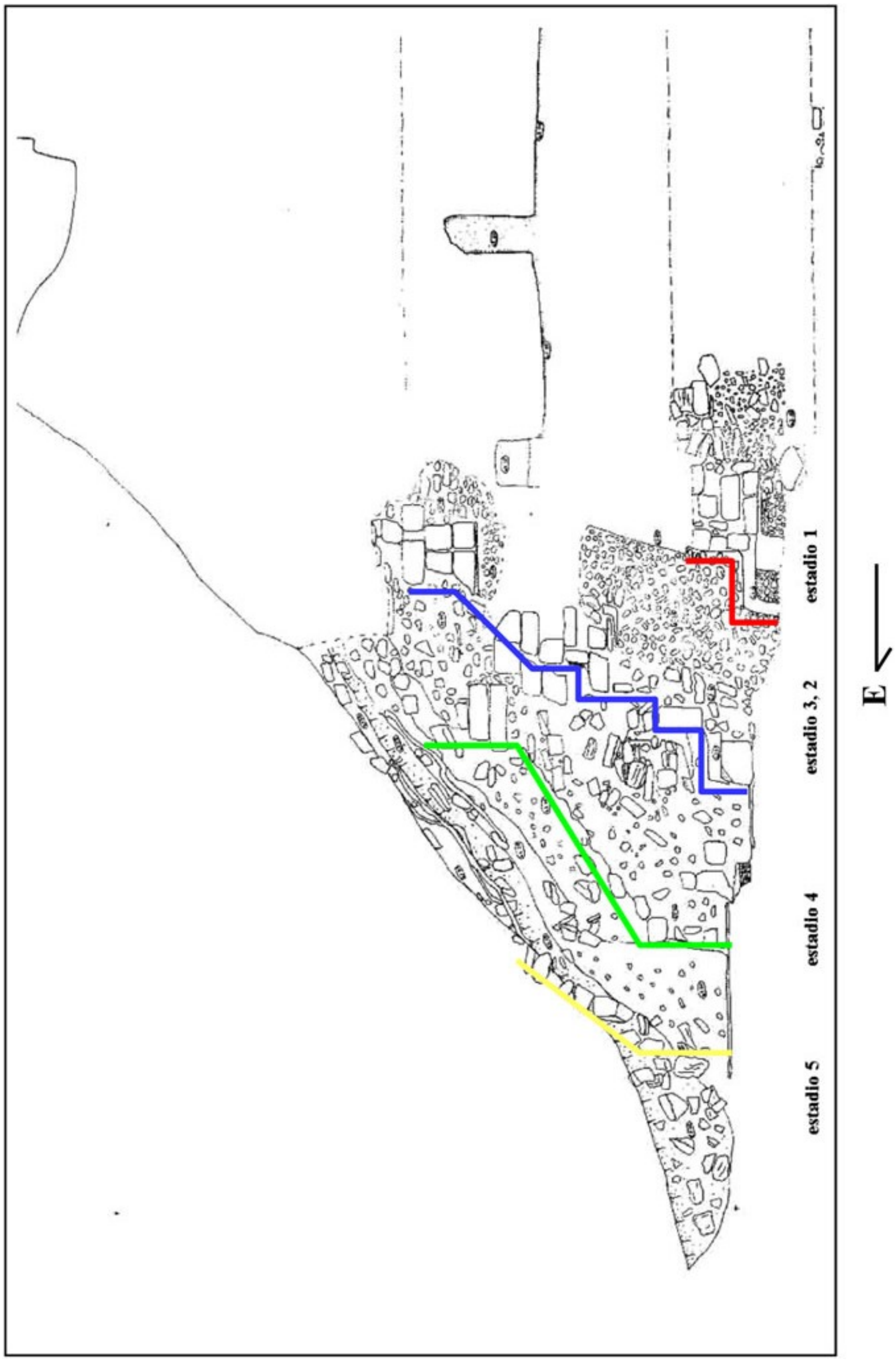

Figure 8.32 North profile of Building B, Group II, showing three Late Preclassic construction phases adapted by Callaghan (2013: Figure 7) from a drawing by N. Nievens (Estrada-Belli 2005:4).

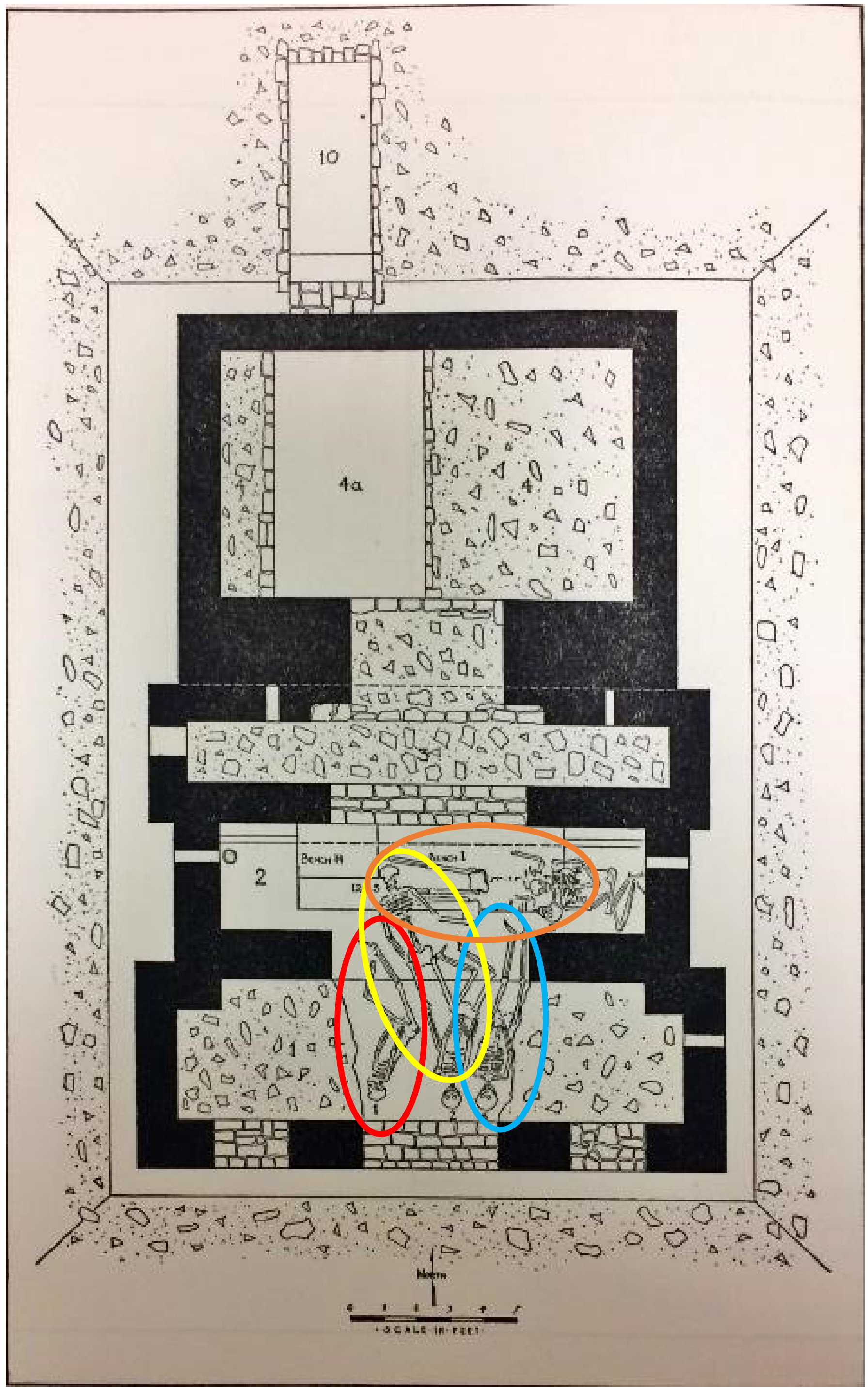

Figure 8.33 Plan drawing of the burials of Group II Building B, 58596.0.2/Skeleton 1 encircled in red, 58599/Skeleton 6 encircled in blue, 58605/Skeleton "12 or 5" encircled in yellow, with Skeletons 13 and 14 encircled in orange (Merwin and Vaillant 1932:22).

11-6-20/58596.0.2

Individual/Burial ID #:	**11-6-20/58596.0.2; Skeleton 1**
Laboratory ID #:	HO-16-15
Site:	Holmul
Associated Period/Date:	Early Classic AD 200-600 (Welsh 1988)
Year Excavated:	1910-1911
Archaeological Reports:	Merwin and Vaillant 1932:29-30; Welsh 1988; Gerry 1993
Dentition Sampled:	Left first maxillary molar
Burial Location and Construction:	Group II Building B, Room 1, Ceremonial/Religious, simple blocked up room
Burial Type, Manner, and Positioning:	Primary, multiple, flexed on left side, S-N head to S facing W
Associated Artifacts:	19 ceramic pots, including 1 polychrome; 1 jade ear flare; 1 jade ornament; 2 shells; 1 shell ornament; 1 stingray barb, 1 clay disc, 1 bone ring, 1 painted slate, green paint fragment
Preservation:	Fragmentary (0-15%)
Age-at-Death Estimation:	Adult (?)
Biological Sex Estimation:	Indeterminate
Observations:	Osteophytic lipping on distal 1st foot phalanges
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70780, $\delta^{18}O$: -3.9 (-4.6*) $\delta^{13}C$: -3.5 **not local** *adjusted for weaning

Table 8.9 Individual profile of 11-6-20/58596.0.2

Merwin and Vaillant (1932) describe Skeleton 1 as being buried upon its left side. The associated plan drawing allows for the inference that this flexed individual was a part of a multiple individual interment in its primary context oriented south-north and facing to the west. Because this building was constructed for burials, it is considered a simple blocked up room grave type in a ceremonial or religious building. The plentiful associated artifacts include 19 ceramic vessels of varying types, jade objects, shell artifacts, a stingray spine, a bone ring, a clay disc, and a painted slate.

Individual 58596.0.2, whose remains are housed at the Peabody, is in fragmentary condition. The cranium is represented by a few small fragments, two maxillary incisors, three premolars, the left first and second mandibular molars, the right mandibular second molar, and a fragmented mandibular molar crown. Five small fragments of vertebral arches and one rib fragment compose the axial skeleton. Two patellar fragments and many long bone fragments represent the appendicular body. Some of the long bone fragments include that of a right distal tibia, right distal fibula, left distal fibula, and a radial head. Many feet and hand bones were preserved, with some duplicates, indicating an additional individual, probably a reflection of the excavation and collection techniques during the early twentieth century.

An estimation of age-at-death and biological sex is not possible from the remains preserved, although Merwin and Vaillant (1932:29) describe the individual as a "young adult." The only observation of paleopathological changes is that of some osteophytic addition or lipping on the distal first foot phalanges, although it is not clear from which individual these bones belong.

The enamel of the left first maxillary molar (Figure 8.34) was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70780, while the $\delta^{18}O$ was -3.9 (adjusted to -4.6 for weaning) and $\delta^{13}C$ was -3.5. Gerry (1993) found $\delta^{13}C$ from collagen was -8.7 and from apatite was -3.7. He also tested for $\delta^{15}N$, resulting in an 8.7. This individual was the only Holmul statistical outlier, suggested by the $^{87}Sr/^{86}Sr$ box-and-whisker plot and the bagplots of $^{87}Sr/^{86}Sr$ ratio plotted against both $\delta^{18}O$ and $\delta^{13}C$ ratios. Thus, it is possible that 58596.0.2 was not local to Holmul, but still most likely from the southern lowlands, with possible geographic origins including Piedras Negras (0.7080), Calakmul (0.7077), Tonina (0.7079), Palenque (0.7079), and El Mirador (0.7079).

Figure 8.34 Left first maxillary molar of 11-6-20/58596.0.2.

11-6-20/58599.0.02 & 11-6-20/58599.0.1

Individual/Burial ID #:	**11-6-20/58599.0.2/11-6-20/58599.0.1; Skeleton 6 (?)**
Laboratory ID #:	HO-16-16 (0.2) and HO-16-17 (0.1)
Site:	Holmul
Associated Period/Date:	Early Classic AD 200-600 (Welsh 1988)
Year Excavated:	1910-1911
Archaeological Reports:	Merwin and Vaillant 1932:22,30,33; Welsh 1988; Gerry 1993
Dentition Sampled:	Right first mandibular molar (0.2), left first maxillary molar (0.1)
Burial Location and Construction:	Group II, Building B, Room 1, Ceremonial/Religious, simple blocked up room
Burial Type, Manner, and Positioning:	Primary, multiple, extended supine S-N
Associated Artifacts:	17 ceramic pots (1 with skull in bowl), 5 jade ear flares, 2 jade beads, 7 jade fragments, 9 shells, 11 shell ornaments, 3 painted shell fragments, 1 obsidian knife, 5 bone beads, 2 antlers, 1 inscribed antler, 1 engraved skull, 4 mica pieces, inscribed pyrite, inscribed tooth, worked bone, red-green paint fragment
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	"A": Infans II (12 years±36 months); "B": Adult (Merwin and Vaillant 1932)
Biological Sex Estimation:	Indeterminate
Observations:	"B": occlusal wear, osteophytic lipping
Stable Isotope Results:	HO-16-16: $^{87}Sr/^{86}Sr$: 0.70834, **local** $\delta^{18}O$: -3.2 (-3.9*), $\delta^{13}C$: -2.0 HO-16-17: $^{87}Sr/^{86}Sr$: 0.70828, **local** $\delta^{18}O$: -3.9 (-4.6*), $\delta^{13}C$: -3.4 *adjusted for weaning

Table 8.10 Individual profile for 11-6-20/58599.0.02 & 11-6-20/58599.0.1

"Skeleton 6" is described by Merwin and Vaillant (1932:30) as simply "an adult in a very poor state of preservation" buried during the third interment period of Rooms 1 and 2 along with Skeletons 1 and 2.

From the plan drawing of the burials in Room 1, "Skeleton 6" was buried in the extended supine position (south-north) with the head to the south. As with the other individuals in Room 1, this is a primary burial with multiple individuals, located in a simple blocked up room in a ceremonial or religious building. The associated artifacts include 17 ceramic pots with the skull being held between two of the bowls, five jade ear flares, two jade beads, seven jade fragments, nine shells, 11 shell ornaments, three painted shell fragments, one obsidian knife, five bone beads, two antlers, one inscribed antler, one engraved skull, four mica pieces, an inscribed piece of pyrite, an inscribed tooth, one piece of worked bone, and a fragment of red-green paint.

During the osteological evaluation in the Peabody Museum at Harvard, two individuals were found in the box for "Skeleton 6." The dentition (Figures 8.36 and 8.37) was separated into Individual A (58599.0.2) and Individual B (58599.0.1), while the rest of the skeletal fragments were grouped together. The teeth present for Individual A (58599.0.2) include both central maxillary incisors, the right lateral maxillary incisor, a fragment of an additional incisor, the maxillary right canine, three maxillary premolars, one mandibular premolar, the right first, second, and third maxillary molars, the left third maxillary molar, both mandibular first molars, a second mandibular molar, and both third mandibular molars. The third molars appear be still developing, as the enamel has not completely formed. The teeth present for Individual B (58599.0.1) include three mandibular incisors with minor occlusal wear, a maxillary canine (with occlusal wear), three premolars with broken roots, the left first and second maxillary molars, and the right first and second mandibular molars.

The skeletal fragments present include 15 cranial fragments, a sacral fragment, 14 rib fragments, two rib fragments with the sternal ends (which appear quite mature), nine vertebral arch fragments, six vertebral body fragments (with a cervical body with osteophytic lipping), a fragment of the right glenoid fossa (with lipping around the edge), and two lateral shaft fragments (obviously from two different individuals). The long bone fragments include a distal left radius, a fragment of a radial head, an ulnar shaft fragment, and a humeral head fragment. Three proximal and three intermediate hand phalanges were preserved, along with a fragment of a metacarpal head.

From the inventorying of the box labeled "Skeleton 6," it becomes obvious that during excavation or rehousing an additional individual was added. From the teeth labeled "A" (58599.0.2), the individual's permanent dentition had not yet fully developed, allowing for an estimation of age-at-death of 12 years ± 36months (Ubelaker 1999). The occlusal wear on the dentition of Individual "B" and the osteophytic lipping on some of the skeletal elements suggest that the second individual ("B") was an adult.

The enamel of the right first mandibular molar of 58599.0.2 and of the left first maxillary molar was tested of 58599.0.1 for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result for 58599.0.2 was 0.70834, while the $\delta^{18}O$ was -3.2 (adjusted to -3.9) and $\delta^{13}C$ was -2.0. The $^{87}Sr/^{86}Sr$ result for 58599.0.1 was 0.70828, while the $\delta^{18}O$ was -3.9 (adjusted to -4.6) and $\delta^{13}C$ was -3.4. Gerry (1993) tested "58599" and found $\delta^{13}C$ from collagen was -9.3 and from apatite was -4. He also tested for $\delta^{15}N$, resulting in a 9.3. Statistically, both individuals were not considered outliers and were most likely from Holmul or the Holmul region.

Figure 8.36 Mandibular dentition of 58599.0.02.

Figure 8.35 Maxillary dentition of 58599.0.1.

11-6-20/58600.0.2

Individual/Burial ID #:	**11-6-20/58600.0.2; "Skeleton 15"**
Laboratory ID #:	HO-16-18
Site:	Holmul
Associated Period/Date:	Early Classic AD 200-600 (Welsh 1988)
Year Excavated:	1910-1911
Archaeological Reports:	Merwin and Vaillant 1932:36; Welsh 1988; Gerry 1993
Dentition Sampled:	Left first maxillary molar
Burial Location and Construction:	Group II, Building B, Room 4, Ceremonial/Religious, simple blocked up room
Burial Type, Manner, and Positioning:	Single individual in a secondary context
Associated Artifacts:	1 conch shell, 1 grooved stone, 1 worked stone, 4 worked bones, 1 piece of obsidian, 1 piece of jade, 1 shell ornament, charred wood
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult?
Biological Sex Estimation:	Indeterminate
Observations:	Occlusal wear, osteophytic addition/lipping
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70816, $\delta^{18}O$: -4.8 (-5.5*) $\delta^{13}C$: -2.6 **local** *adjusted for weaning

Table 8.11 Individual profile of 11-5-20/58600.0.2

Room 4 was a northern addition to Building B during the second period of architectural construction. A doorway was constructed through the northern wall of Room 3 to allow access to Room 4. During the third period of construction, the east portion of the room was filled creating a smaller room known as Room 4a. Skeleton 15 was found in the south end of Room 4a. Merwin and Vaillant (1932:36) describe the interment as "only a few bones, as there was no evidence that a burial in the flesh had subsequently been disturbed," labeled as secondary burial by Welsh (1988:270).

Because Merwin and Vaillant (1932) did not publish a plan drawing of the excavation of Skeleton 15 and Welsh (1988) interpreted it as a secondary burial, the mortuary data available is primarily the burial construction (simple blocked up room in a ceremonial or religious structure) and the associated artifacts. Merwin and Vaillant (1932:36) describe the artifacts as being placed on the floor of Room 4 in no particular arrangement. These artifacts included one large conch shell, one grooved stone, one worked stone, four worked bones, one piece of obsidian, one piece of jade, one shell ornament, and charred wood.

The remains of 58600 are very fragmented. The dentition present include a first mandibular incisor with occlusal wear, a maxillary canine with occlusal wear, three maxillary premolars, both first maxillary molars, both first mandibular molars, and the left second and third molars (Figure 8.37). One cervical vertebra was present and in good condition, but had severe addition/lipping on superior edges of the body and the inferior body surface is very irregular. A scapular fragment contained a portion of the glenoid surface. The distal end of the left fibular was the only long bone fragment present. Two hand phalanges and many foot bones were preserved, which is strange for a burial labeled a secondary burial. An estimate of age-at-death and biological sex is not possible, although the paleopathological changes on the cervical vertebra and presence of third molars suggests an adult.

The enamel of the left first maxillary molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70816, while the $\delta^{18}O$ was -4.8 (adjusted to -5.5) and $\delta^{13}C$ was -2.6. Gerry (1993) found $\delta^{13}C$ from apatite was -3.3. He also tested for $\delta^{15}N$, resulting in a 10.4. Statistically, 58600.0.2 was not an outlier, and most likely from Holmul or the Holmul region.

Figure 8.37 Maxillary dentition of 58600.0.2.

11-6-20/58601.0.1

Individual/Burial ID #:	**11-6-20/58601.0.1; "Skeleton 17"**
Laboratory ID #:	HO-16-19
Site:	Holmul
Associated Period/Date:	Late Preclassic/Early Classic 0-200AD (Welsh 1988)
Year Excavated:	1910-1911
Archaeological Reports:	Merwin and Vaillant 1932:37-38; Welsh 1988; Gerry 1993
Dentition Sampled:	Left first mandibular molar
Burial Location and Construction:	Group II, Building B, Room 8 (SE Corner), crypt unspecified
Burial Type, Manner, and Positioning:	Secondary or bundle (?), multiple
Associated Artifacts:	1 small, flat-bottomed red bowl resting on femur and tibia
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult?
Biological Sex Estimation:	Male?
Observations:	Minor occlusal wear to mandibular molars
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70823, $\delta^{18}O$: -5.3 (-6.0*) $\delta^{13}C$: -4.0 **local** *adjusted for weaning

Table 8.12 Individual profile of 11-6-20/58601.0.1

Found when excavating under Room 2, the earlier Room 8 was found (Figure 8.38), which was a plastered room scattered with the remains of Skeletons 17, 18, and 19. Skeleton 17 is described as a "bunched" or bundled (?) burial in the southeast corner of the room, with a ceramic bowl resting on the femur and tibia (Merwin and Vaillant 1932:38), approximately five feet four inches from the north wall and one foot ten inches from the east wall.

This interment of an individual along with multiple other individuals is described as a bundle burial in the excavation report. Welsh (1988:270) describes the burial as being within a crypt of an unspecified type in this a ceremonial and religious building. There are multiple ceramic vessels found in Room 8, although the only in direct association with Skeleton 17 is that of Pot 1, a small, flat-bottomed red bowl found resting on a tibia and femur. The bowl contained a carpal and two phalanges.

The skeletal remains of 58601.0.1 are fragmentary. The dentition recovered includes one mandibular incisor, one canine, two mandibular premolars, the first and second right mandibular molars, and the left first mandibular molar. The aforementioned first and second right mandibular molars have slight occlusal wear and are still situated within a fragment of the mandible (Figure 8.39). There is postmortem damage to all of the loose dentition. Three cranial fragments are present. Of the axial skeleton, five vertebral arches and two body fragments were preserved. The shaft of the left clavicle is present, along with five fragments of an ilium, with portions of the greater sciatic notch. Both pubic bones are fragmentary, although the ischiopubic rami is flat, broad and blunt, with no sharp medial aspect, possibly suggesting an estimation of biological sex as male.

Long bone fragments present include that of a femoral head, many femoral shaft fragments, that of the distal radius, a radial head fragment, and the proximal end of an ulna. Fragments of both calcanei and tali are present, along with the left first metatarsal and the right fifth metatarsal.

The enamel of the left first mandibular molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70823, while the $\delta^{18}O$ was -5.3 (adjusted to -6.0) and $\delta^{13}C$ was -4.0. Gerry (1993) found $\delta^{13}C$ from apatite was -4.8. Statistically, 58601.0.1 was not an outlier and most likely was from Holmul or the Holmul region.

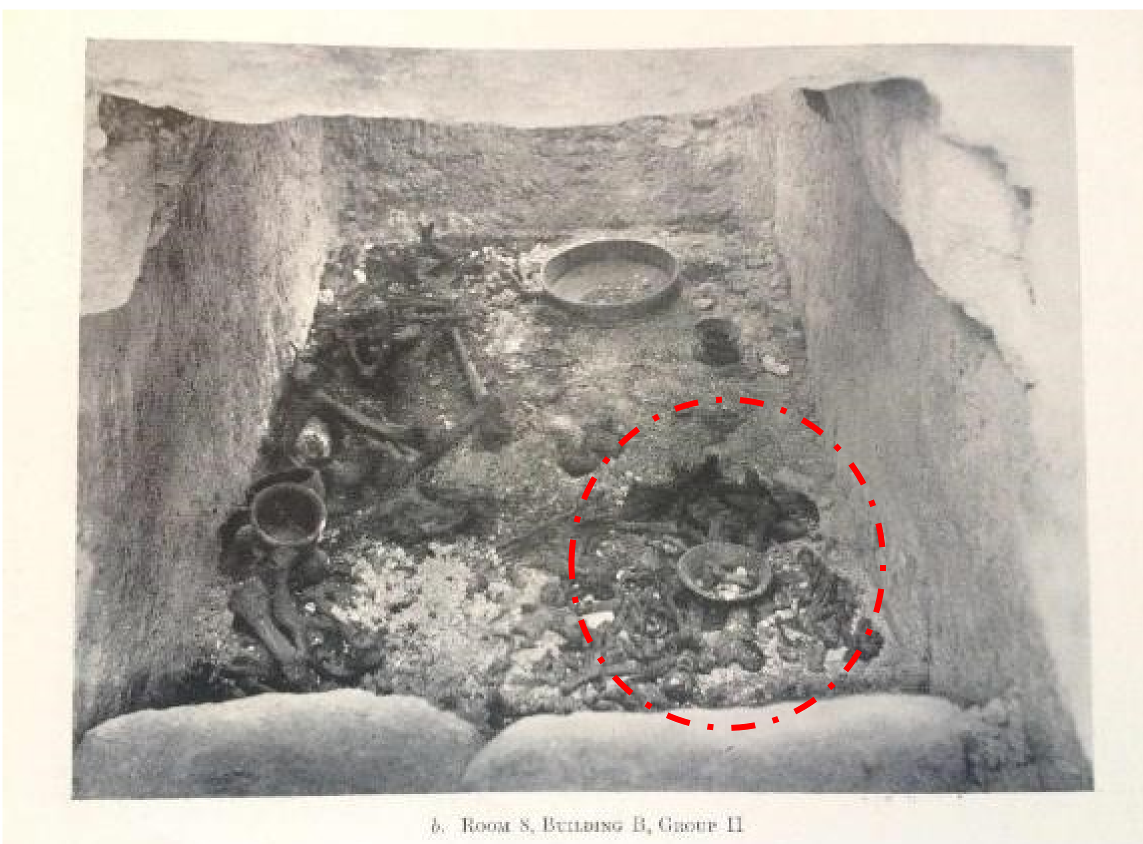

Figure 8.38 Photo of the burials in Room 8 with 58601 circled in red (approximately) (Merwin and Valliant 1932:Plate 14b).

Figure 8.39 Right mandibular fragment of 58601.

11-6-20/58605.0.1

Individual/Burial ID #:	**11-6-20/58605.0.1; "Burial 12 or 5"**
Laboratory ID #:	HO-16-20
Site:	Holmul
Associated Period/Date:	Early Classic AD200-600 (Welsh 1988)
Year Excavated:	1910-1911
Archaeological Reports:	Merwin and Vaillant 1932:22,29-33; Welsh 1988; Gerry 1993
Dentition Sampled:	Left first maxillary molar (from "A")
Burial Location and Construction:	Group II, Building B, Room 2, Ceremonial/Religious, simple blocked up room
Burial Type, Manner, and Positioning:	Primary, multiple interment, extended, prone (?), N-S, head in N
Associated Artifacts:	4 bowls (1 contained a skull, 1 contained a jade bead, obsidian knife, tooth, and shell; 1 polychrome bowl with polychrome lid; 7 beads, 3 shells, 107 shell beads, 2 shell rings, 6 shell fragments; 1 inscribed stingray spine, 6 bone objects, 7 teeth, 19 deer phalanges, 1 mandible, 129 mineral pieces, 2 pyrite beads, 1 carved antler, and green paint fragment
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult?
Biological Sex Estimation:	Indeterminate
Observations:	Occlusal wear, alveolar absorption
Stable Isotope Results:	^{87}Sr/^{86}Sr: 0.70815, δ^{18}O: -4.5 (-5.2*) δ^{13}C: -2.6 **local** *adjusted for weaning

Table 8.13 Individual profile of 11-6-20/58605.0.1

The box labeled 58605 by the Peabody is referred to in their catalogue as "Burial 12 or 5." Merwin and Vaillant (1932) refer to Skeletons 5 and 12 separately, except in their plan drawing of the burials of Room 1 and 2 of Building B, where the prone individual extended north to south is labeled "12 or 5." In the report, Skeleton 5 is described, while Skeleton 12 is mentioned in passing. In Merwin's field notebook #2, he states that "it may be that skull 12 belongs to skeleton 5." Skeleton 5 is described as being placed in Room 2 following the burial of Skeletons 13 and 14, but before Skeletons 1, 2, and 6. Merwin and Vaillant (1932:30) describe Skeleton 5 as being "very much disarranged, due to the fallen-in masonry."

In the plan drawing of Building B Rooms 1 and 2, Skeleton "12 or 5" is drawn extended through the door opening with the head in Room 1 and legs in Room 1. The skeleton is drawn slightly at an angle, suggesting the orientation of the body, while reported as north-south, may be more northwest-southeast. It is not clear in the drawing nor mentioned in the site report if the skeleton is in a supine or prone position, although Welsh (1988:270) describes it as prone. This burial, located in a ceremonial or religious structure, is categorized as a multiple individual interment in primary context with a simple blocked up room construction. The associated artifacts are numerous including: four bowls, one of which contained a skull and another contained a jade bead, obsidian knife, tooth, and shell; one polychrome bowl with polychrome lid; seven beads; three shells; 107 shell beads; two shell rings; six shell fragments; one inscribed stingray spine; six bone objects; seven teeth; 19 deer phalanges; one mandible; 129 mineral pieces; two pyrite beads; one carved antler; and a green paint fragment.

The box labeled 58605 containing "12 or 5" also was indicated to contain a minimum number of individuals (MNI) of 3. The only remains contained in the box were various small cranial fragments, three fragments of one mandible, a right side of a different mandible with alveolar resorption, and two bags of dentition (labeled "A" and "B"). The bag labeled "A" contained two maxillary incisors occlusally worn, one mandibular incisor, two canines, two maxillary premolars, one mandibular premolar, the left maxillary first molar, the first and second right maxillary molar, both maxillary third molars, the left first and second mandibular molar, and the right first and second molars. The bag labeled “B” contained two lateral incisors, one maxillary premolar, three mandibular premolars, both first maxillary molars, one left first mandibular molar, one left second mandibular molar, two additional left mandibular molars, a right first, second, and third mandibular molar, an additional right mandibular molar, and an additional two third mandibular molars. Individual “B” appears to be more than one individual. The presence of third molars suggests the individual was an adult at the time of death.

The enamel of the left first maxillary molar (Figure 8.40) from bag “A” (Figure 8.40) was tested for $\delta^{18}O$, $\delta\,^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70815, while the $\delta^{18}O$ was -4.5 (adjusted to -5.2) and $\delta\,^{13}C$ was -2.6. This individual was not a statistical outlier and most likely a local person from Holmul or the Holmul region.

Figure 8.40 Left first maxillary molar of 58505 "A".

11-6-20/58607.1.1

Individual/Burial ID #:	**11-6-20/58607.1.1; "Skeleton 14"**
Laboratory ID #:	HO-16-21
Site:	Holmul
Associated Period/Date:	Early Classic AD 200-600 (Welsh 1988)
Year Excavated:	1910-1911
Archaeological Reports:	Merwin and Vaillant 1932; Welsh 1988; Gerry 1993
Dentition Sampled:	Right first maxillary molar
Burial Location and Construction:	Group II, Building B, Room 2, Ceremonial/Religious, simple blocked up room
Burial Type, Manner, and Positioning:	Primary, multiple, extended supine E-W, head to the E
Associated Artifacts:	5 bowls, 2 jars, and 4 bowls with lids; 1 lid over skull; 1 polychrome bowl covered in stucco; 1 jade bead; 2 shells, 67 shell beads, and 1 shell fragment; 2 bones and green paint fragments
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult
Biological Sex Estimation:	Indeterminate
Observations:	Dental calculus
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70835, $\delta^{18}O$: -4.7 (-5.4*) $\delta^{13}C$: -3.0 **local** *adjusted for weaning

Table 8.14 Individual profile of 11-6-20/58607.1.1

Skeletons 13 and 14 were the first individuals placed in Building Room 2, later disturbed by the deposition of Skeleton "12 or 5". Merwin and Vaillant (1932:30) described the remains of Skeletons 13 and 14 as "embedded in the concrete that covered them" or "surrounded by a soft, dark red matter, looking very much like some burnt substance mixed with earth." Welsh (1988:270) refers to Skeletons 13 and 14 as Burial 13a and 13b.

Skeleton 14 was placed, along with Skeleton 13, in a simple grave of the blocked-up room variety in a ceremonial or religious structure (8.41). This primary, multiple burial was accompanied by 12 ceramic vessels, including four bowls with lids, one lid over the skull and a polychrome bowl covered in stucco. Other artifacts included one jade bead, two shells, 67 shell beads, one shell fragment, two bones, and green paint fragments. Both Skeletons 13 and 14 were extended supine with their heads to the east. Skeleton 14 was positioned to the north of skeleton 13.

Figure 8.41 Photo of Skeletons 13 and 14 (58607) in Room 2 of Group II, Building B (Merwin and Valliant 1932).

In the box labeled 58607.1.1 at the Peabody Museum, only dentition was present. The dentition included one central incisor, two lateral incisors, four canines, three maxillary premolars, three mandibular premolars, three left maxillary molars, three right maxillary molars, three left mandibular molars, and three right mandibular molars. Dental calculus was present on most of the teeth, although it appears to have been heavier on the left side. Based on the presence of third molars, the age-at-death can be estimated to be adult. Biological sex estimation is not possible.

Figure 8.42 Right maxillary molars of 58607.

The enamel of the right first maxillary molar (Figure 8.42) was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70835, while the $\delta^{18}O$ result was -4.7 (adjusted to -5.4) and $\delta^{13}C$ was -3.0. This individual was not a statistical outlier and most likely a local person from Holmul or the Holmul region.

*Considering the Burials of Holmul, Group II, Building B*The individuals buried in Group II, Building B are discussed below in order of deposition. The earliest burial excavated from Building B was that of "Burial 10" by the Holmul Archaeological Project. This individual of unknown age or biological sex was interred in a simple crypt, with one ceramic vessel and jade bead, extended supine on an east-west orientation with head to the east. This first burial, to the best of our knowledge, dates to approximately AD 150, corroborating the structure's Preclassic function as a site of burial and ancestor veneration. The similarities in style of the ceramics from "Burial 10" and in Rooms 8 and 9 suggest that the individuals were interred around the same time following AD 150 (Callaghan 2013). Following analysis at the Peabody museum, the remains of Skeleton 21 in Room 9 were extremely fragmented and, according to Merwin (Merwin and Vaillant 1932:39), were not accompanied by any grave goods.

Skeletons 17, 18, 19, and 20 were excavated from the south end of Room 8, located underneath Rooms 1, 2, and 3 of Building B. The remains of Skeletons 17, 18, and 19 were found "scattered" and "some… were broken," "bunched," and "few… were still articulated" (Merwin and Vaillant 1932:37–38). Associated with these remains were five Sierra Red ceramic vessels that suggest the period of the Late Preclassic (Callaghan 2013). Skeleton 20 was interred in the vault of Room 8, cut into the floor in northeastern portion of the room. This burial was also disarticulated and "bunched" (Merwin and Vaillant 1932:38). The ceramic vessels with Skeleton 20 represent modes from the Late Preclassic, Terminal Preclassic, and Early Classic periods (Callaghan 2013).

Room 8 experienced alterations during its use as a mortuary context, as portions of the room was sealed with plaster, with the possible rearrangement of the ceramic offerings (Hammond 1984). The "bunched" individuals and the probably re-entering or re-organization of the space suggest that this space was acting as a loci of ancestor veneration during the Late Preclassic period. The intention of ancestor veneration is corroborated with the stable isotope analysis of Skeleton 17, which resulted in signatures that suggest the local origin of this individual. These individuals were most likely local elites, venerated by their descendants during the Late Preclassic, resulting in the bunches of disorganized human remains.

At some point during the Early Classic, Room 8 was filled and sealed, ending its ability to be re-entered for active ancestor veneration. A temple structure was constructed over Rooms 8 and 9, with the delineation of Rooms 1, 2, and 3, as well as the later additions of Rooms 4 and 7. Room 7 follows chronologically with the burial of Skeleton 16, which was extremely fragmented in the center and north end of the room. Five ceramic vessels were found with Skeleton 16, resembling K'ahk 1-2/Tzakol 1-2 ceramic complexes dating to the first two thirds of the Early Classic period (Callaghan 2013). Following the filling of the eastern portion of Room 4, Skeleton 15 was interred in the southeastern area of now Room 4a. The mortuary details are lacking, but since Merwin noted only a few bones, it is probable that this was the secondary burial of Skeleton 15, placed right before the remainder of Room 4 was filled and sealed. Interestingly, foot phalanges were recovered for Skeleton 15, which is highly unusual for a secondary burial. Skeleton 15 was tested for isotopic ratios of strontium, oxygen, and carbon, which suggest that this individual was also local to the region.

In five subsequent phases of interment, Rooms 1 and 2 were converted into burial chambers. First, in Room 2, Skeletons 13 and 14 were interred (Welsh's Burial 13) in the position of extended supine oriented east-west with the head to the east. Some of the ceramic vessels interred with Skeletons 13 and 14 are comparable to assemblages from other lowland Maya sites of the complex K'ahk 2/Tzakol 2, dating approximately to AD 250-400 (Callaghan 2013). This period is prior to the events of AD 378 (the "entrada") that resulted in an influx of Mexicanized elite ideology in the Petén (Stuart 2000). It is possible that Skeletons 13 and 14 were elites engaged in socio-economic connections to surrounding Petén lowland sites. Whatever the connection, the strontium stable isotope analysis for Skeleton 14 suggested that this individual was from Holmul or the Holmul region.

Skeleton "12 or 5" was interred after Skeletons 13 and 14, disturbing their remains, and positioned extended approximately north-south through the doorway between Rooms 1 and 2. The head and torso were placed on the lower extremities of Skeletons 13 and 14, while the legs extended into Room 1, found under the remains of Skeleton 2. However, the osteological evaluation was complicated by the presence of multiple individuals in the boxes labeled "12 or 5," most likely due to the complicated excavations and accession into the Peabody collection. The stable isotope analysis suggests that this was also a local individual to the region.

Luckily, the mortuary analysis provides significant information to the status and role of Skeleton “12 or 5”. The positioning of this individual is unique, as it is the only to be extended north-south and possibly prone (Welsh 1988:270). The ceramic material accompanying this interment can compare to Early Classic Tzakol 2 polychromes (Callaghan 2013). The elaborate associated artifacts include numerous worked non-ceramic artifacts, most notably a stingray spine with the inscription of the title Chak-Tok-Wayab (Estrada-Belli 2005:238–331). This title has been found on objects belonging to elites and royal elites in the eastern Petén lowlands, especially those of Naranjo, and throughout time in the Holmul area, in Early Classic contexts at La Sufricaya and Terminal Classic contexts at Holmul Group III (Estrada-Belli et al. 2009). It is probable that this individual carried the title Chak-Tok-Wayab during this portion of the Early Classic period, suggesting his or her high political position in the region.

The next phase of interments in Rooms 1 and 2 included those of Skeletons 1, 2, and 6. Merwin describes Skeleton 1 as a young adult buried on their left side with head to the south (Merwin and Vaillant 1932:29); the plan drawing supports the description, although it is not a definitive flexed positioning, as only one leg is partially flexed. Skeleton 1 is accompanied by an extensive amount of ceramic vessels, with some dating to the late K’ahk 2/Tzakol 2 or early K’ahk 3/Tzakol 3 ceramic complexes (Callaghan 2013). Other associated artifacts include jade ornaments, shell ornaments, a stingray spine, and a bone ring. Skeletons 2 and 6 were adults extended supine oriented south-north directly to the east of Skeleton 1 (Merwin and Vaillant 1932:30). Skeleton 2 was not accompanied by ceramic artifacts, but other associated artifacts include an obsidian knife, jade beads, a stingray spine, shell ornaments, and worked animal teeth. Skeleton 6 was accompanied by many jade artifacts, shell ornaments, worked bone, and ceramic vessels dating to the late K'ahk 2/Tzakol 2 or early K'ahk 3/Tzakol 3 ceramic complexes (Callaghan 2013).

Callaghan (2013) evaluated a few significant and unusual ceramic vessels from the burials of Skeletons 1 and 6. Vessel 9 from Skeleton 1 was a cylinder with vertical walls and four hollow cylindrical supports. Callaghan (2013) suggests that this vessel may be a local imitation of those from the Tzakol 3 ceramic sphere, as it has the general form of the supported cylindrical vessels of the lowlands and those influences by central Mexico after AD 378, but lacks the specific form and decorative traits typical to Tzakol 3. Vessel 11 of Skeleton 1 is a bowl with incurved walls on a pot stand slipped brownish cream with two bands of red pant at the rim. Callaghan (2013) concludes that while the pot stand is typically of Early Classic ceramics, the entire vessel is rare for the Holmul region and may have been an import. The multitude of monochrome serving vessels with Skeleton 1 lack comparative contexts to more specifically date the ceramics. Vessel 3 of Skeleton 6 is similar to Vessel 9 described above, suggesting another local version of the Tzakol 3 ceramic sphere.

The osteological evaluation of the skeletons from Room 1 complicates the understanding of these individuals. The box containing 58596.0.2 or Skeleton 1 contained human remains of more than one individual, and not identifiable as the "young adult" Merwin excavated. The box containing 58597 or Skeleton 2 also contained multiple individuals. The box containing 58599 or Skeleton 6 contained two individuals: (A) an

Infans II/juvenile of 12 years±36 months and (B) an adult. It is probable that the individuals from Room 1 are comingled in these boxes. The individual in the box 58599 that was a juvenile (A) might actually be the "young adult" of Skeleton 1 that Merwin describes.

Of these three boxes of human remains from Room 1, stable isotope analysis was performed on dentition from three separate individuals, suggesting that each individual from Room 1 was sampled. One of the adults sampled (58596.0.2; HO-16-15) yielded a non-local $^{87}Sr/^{86}Sr$ ratio. The strontium (0.70780) does fall within the range for the southern lowlands, however, is not local to Holmul. This non-local signature may provide insight into the presence of the unusual ceramics found in Room 1. The individuals buried in Room 1, one of whom was non-local, were elite individuals placed and sealed in the front room of a temple structure at Holmul on a site of previous ancestor veneration. These elites were interred during the Early Classic period around the time of the "entrada" of central Mexican ideology. The presence of an individual possibly from elsewhere in the southern lowlands interred at Holmul speaks to the political positioning of Holmul in the Early Classic and following the "entrada."

After the interments in Room 1, Skeletons 9 and 10 were placed in the east end of Room 2. Skeleton 9 was in a flexed position on their right oriented west-east with the head to the west. Skeleton 10 was in poor condition when excavated, possibly due to the placement of Skeleton 9 and the collapsing architecture (Merwin and Vaillant 1932:30). Two ceramic vessels associated with these individuals are classified as Japon Resist (variety unspecified), which is very rare in the Maya lowlands but still dates to the late

K’ahk 2/Tzakol 2 or early K’ahk 3/Tzakol 3 ceramic complexes (Callaghan 2013), or Early Classic. The temple was sealed following the interment of Skeleton 9.

During the next period of construction, Building B was covered by rubble to form a mound and Room 10 was constructed to house Skeleton 22. Merwin (Merwin and Vaillant 1932:40) described the remains of Skeleton 22 as “all broken and in small fragments, scattered throughout.” The current location of these skeletal remains is unknown, although the four accompanying ceramic vessels were analyzed by Callaghan (2013) and are consistent with K'ahk 1–2/Tzakol 1–2 complexes. The discordance between the architectural chronology and these early ceramics, leads Callaghan (2013) to suggest their role as heirlooms in this last burial context.

There is a mortuary practice change indicated by the extended burials of Rooms 1 and 2. The late Preclassic burials were bunched or bundled, disorganized, secondary, and/or actively engaged with by their descendants. These Early Classic burials were interred in extended supine positions and not actively disturbed. It appears that the mortuary function of Building B changed from crypts for active ancestor veneration practices to individuals buried in blocked up rooms of a vaulted temple structure. This contrast suggests a shift in accessibility of the elites following their death, possibly suggesting that the Early Classic elites were important individuals, perhaps even members of the royal family.

Holmul, Group II, Building B

HAP ID	58596.0.2	58599.0.02; 58599.0.1	58600.0.2	58601.0.01	58605.01	58607.1.1
Sample ID	HO-16-15	HO-16-16; HO-16-17	HO-16-18	HO-16-19	HO-16-20	HO-16-21
aka	**Skel 1**	**Skel 6?** "A"; "B"	**Skel 15**	**Skel 17**	"Burial 12 or 5"	**Skel 14 (Burial 13 a or b)**
Period	**Early Classic AD 200-600**	**Early Classic AD 200-600**	**Early Classic AD 200-600**	**Early Classic AD 0-200**	Early Classic **AD 200-600**	**Early Classic AD 200-600**
Age-at-Death	Adult (***young adult***)	Adult	Adult	Adult	Adult	Adult
Biological Sex	**?**	Indeterminate	Indeterminate	M?	Indeterminate	**?**
Dental Pathology		***five teeth with pyrite inlays*** (could be A or B); occlusal wear	occlusal wear	occlusal wear	occlusal wear, mandible alveolar absorption	dental calculus
Pathology	osteophytic lipping on distal foot phalanges	osteophytic lipping	osteophytic lipping			
Burial Type	Grave interment	Grave interment	Grave interment	Grave interment	Grave interment	Grave interment
Burial Manner	Primary, multiple	Primary, multiple	***Secondary***, single	Secondary? bundle?, multiple	Primary, multiple	Primary, multiple
Body Positioning	***Flexed on left side, S-N, facing W***	***Extended supine, S-N***	-	-	***Extended, prone***(?)***, N-S***	**Extended, supine, E-S**
Burial Location	Religious/ Ceremonial	Religious/ Ceremonial	Religious/ Ceremonial	Religious/ Ceremonial	Religious/ Ceremonial	Religious/ Ceremonial

Grave Construction	**Simple, blocked-up room**	**Simple, blocked-up room**	**Simple, blocked-up room**	**Crypt, unspecified**	**Simple, blocked-up room**	**Simple, blocked-up room**
Tooth Sampled	LM^1	RM_1; LM^1	LM^1	RM_1	LM^1	RM^1
$^{87}Sr/^{86}Sr$	0.70780	0.70834; 0.70828	0.70816	0.70823	0.70815	0.70835
$\delta^{18}O_{ap}$	-4.9 (-5.6*)	-3.2 (-3.9*); -3.9 (-4.6*)	-4.8 (-5.5*)	-5.3 (-6.0*)	-4.5 (-5.2*)	-4.7 (-5.4*)
$\delta^{13}C_{ap}$	-3.5	-2.0; -3.4	-2.6	-4.0	-2.6	-3.0
Local or Non-Local	Non-Local	Local; Local	Local	Local	Local	Local

Table 8.15 Summary of the burials of Holmul Group III, Court B
Sources: **Welsh 1988; *Merwin and Vaillant 1932***

The Osteobiographies of Holmul, Group III

Group III of Holmul borders the southwest edge of the Main Plaza, which is to the south of Group I. Two raised platforms constitute Group III, each acting as courts or palace complexes (Figure 8.43). Court A, to the southeast of Court B, has a dominating temple pyramid on its west edge with additional rectangular structures lining the remainder of the platform margins. Very limited excavations have been undertaken in Court A. Court B (Figure 8.44) was composed by roomed structures surrounding various courtyard plazas. Merwin excavated in Court B during 1910 and 1911. The Holmul Archaeological Project continued excavations from 2001 to 2005. Court B was the subject of the dissertation by Ryan Mongelluzzo (2011).

The entrance for Court B was located on its eastern side, the western edge of the Main Plaza. This eastern entrance led into the Central Palace Courtyard of Court B. On the northern side of the Central Palace Courtyard is Structure 74 and entrances to the Northeast Courtyard and the Northwest Courtyard. The Northeast Courtyard was surrounded by Structures 58 (to the east), 59 (to the north), 62 (to the northwest), and 63 (to the south). Room 5 of Structure 62 and Rooms 6 and 8 of Structure 63 were always accessible from the Northeast Courtyard, while at some point a thick wall was constructed obliterating the courtyard entrances for Rooms 2, 3, and 4 of Structure 58 and Rooms 1 and 7 of Structure 59. These rooms continued to have entrances on pathways around the outer edges of the structures. Room 8 contained a bench upon which a burial (58619.0.1) was placed. Room 1 also contained a bench and a burial (HOL.T.50.27.09.01) in the northwest corner of the room.

An exit from the Northeast Courtyard led into the North Hallway, also known as Room 23, directly to the north of Structure 74. Structures 61 (Rooms 11, 13, and 15) and 64 (Room 9, 17, and 19) were to the north of this hallway, with Structure 64 accessible from the hallway and Structure 61 accessible from the outer pathway. Room 23 contained a burial (HOL.T.58.16.09.01). The Northwest Courtyard, also designated Room 29, could be accessed by continuing west through Room 23 (and Room 22). The Northwest Courtyard also had an entrance, on its southeast corner, from the northwest corner of the Central Palace Courtyard.

On the southern edge of the Northwest Courtyard was an entrance into Room B1 of Structure 43, also known as Building B of Group III by Merwin (Merwin and Vaillant 1932) or the Throne Rooms of Holmul by Mongelluzzo (2011). Room B2, with its benches, is accessible by a staircase on the western side of the Central Palace Courtyard, with Room B3 located behind Room B2 to the west serving as an antechamber during some construction phases. During excavations in 1910 and 1911, Merwin (Merwin and Vaillant 1932:49) found two fragments of human bone in Room B2. Room B4, with its entrance to the south into the Western Courtyard, contained a bench with an intrusive burial (HOL.T.06.09.01). The western portion of Court B, with the Western Courtyard and Structures 65, 67, and 68, has limited accessibility from the Central Palace Courtyard from a narrow, vaulted corridor in its southwest corner. Mongelluzzo (2011:152) posits that the Western Courtyard and its surrounding buildings may have served as the private, domestic residence of the ruler, in contrast to the throne rooms directly accessible from the Central Palace Courtyard.

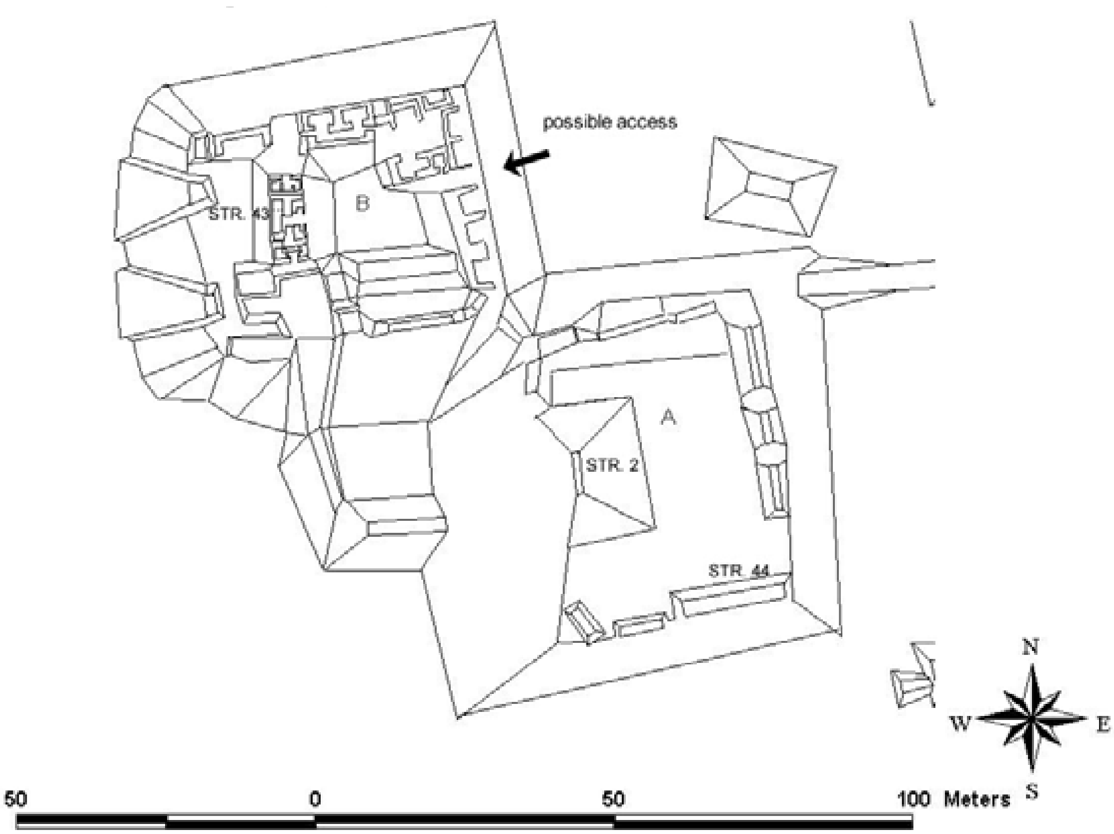

Figure 8.43 Plan view of Group III Courts A and B, showing access from the Main Plaza of Holmul (Estrada-Belli 2001:22).

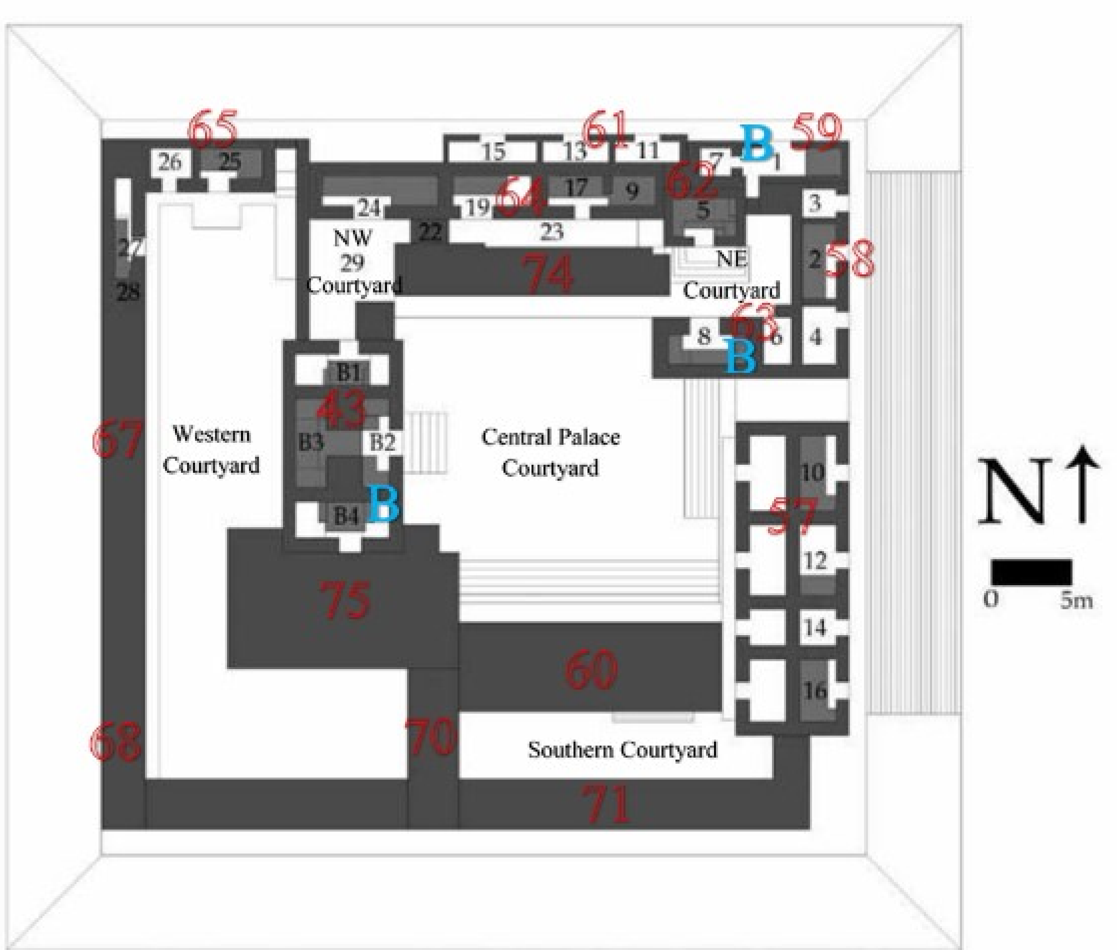

Figure 8.44 Holmul, Group III, Court B. room numbering in Black, structure numbering in Red, Blue B indicates location of burials sampled for isotopic analysis (adapted from Mongelluzzo 2011: 349).

HOL.T.06.09.01

Individual/Burial ID #:	**HOL.T.06.09.01; HAP Burial 1**
Laboratory ID #:	HO-16-1
Site:	Holmul
Associated Period/Date:	Late Classic
Year Excavated:	2001 (Mongelluzzo)
Archaeological Reports:	*Archaeological Investigations at Holmul, Guatemala: Preliminary Report of the 2001 Season*
Dentition Sampled:	Left maxillary second molar
Burial Location and Construction:	Group III; Court B; Structure 43; Room B4, palace, cut into bench 4
Burial Type, Manner, and Positioning:	Flexed on left, W-E, head NW facing E
Associated Artifacts:	Textile impression in plaster slump near skull
Preservation:	Complete (75-100%), some postmortem damage
Age-at-Death Estimation:	Infans II (4-8yrs, based primarily on dental development, but also long bone fusion)
Biological Sex Estimation:	Indeterminate
Observations:	LEH
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70812, $\delta^{18}O$: -3.5 (-3.9*), $\delta^{13}C$: -3.3 **local** *adjusted for weaning

Table 8.16 Individual profile of HOL.T.06.09.01.01

As reported in the *Archaeological Investigations at Holmul, Guatemala: Preliminary Report of the 2001 Season* (Estrada-Belli 2001), HOL.T.06.09.01 ("Burial 1") of the Holmul Archaeological Project was excavated, supervised by Ryan Mongelluzzo. This burial was recovered during excavations in Group III, Court B at the site of Holmul (Figure 8.43). Court B is a rectangular, elevated platform that supports vaulted, multi-room buildings, which may represent an elite palace (Figure 8.44). One of the vaulted buildings, Structure 43, measured 15x6 meters and was elevated 3 meters above the courtyard level. Structure 43 (Figure 8.45) was composed of two central rooms

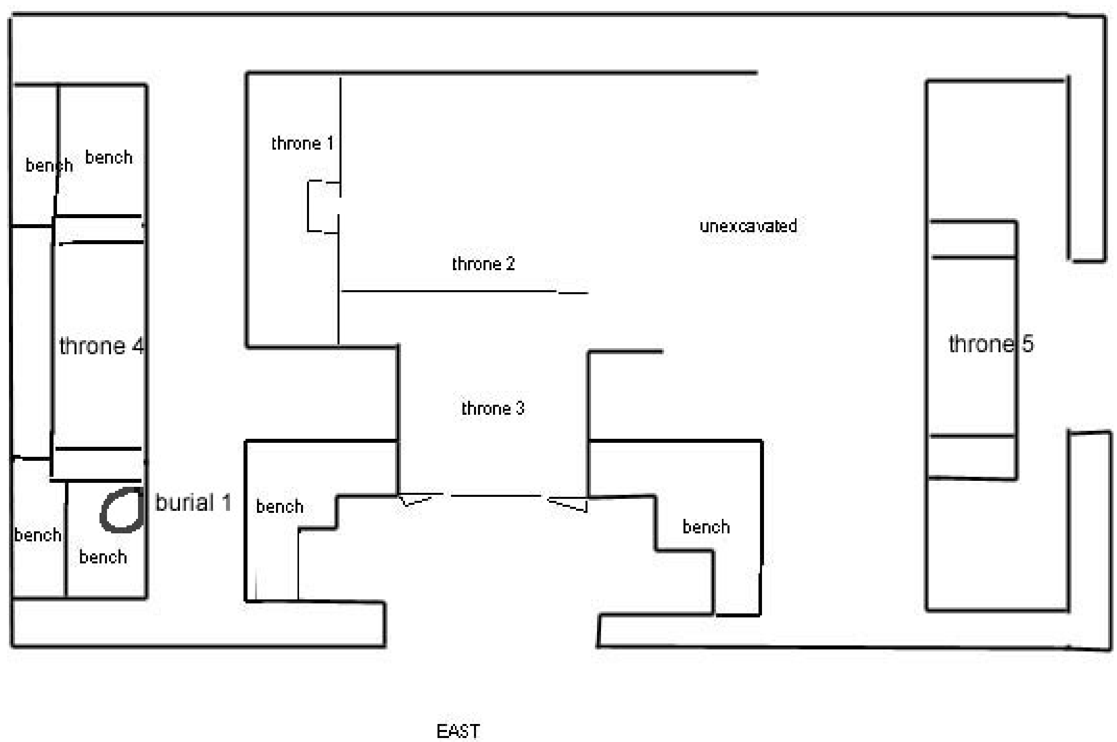

Figure 8.45 Sketch of Structure 43 with excavated rooms and benches (Estrada-Belli 2001:22).

oriented north-south and, later, the addition of two smaller side rooms, one north and one south, each with a door to the north and south side of the building, respectively.

The south side room (B4) was constructed by blocking a window over Bench 1 of the western central room. Following several remodels, two side benches were constructed on either side of Bench 4 in the south room (Figure 8.46). HOL.T.06.09.01 was found in a round feature cut into the surface of the eastern side bench. No artifacts were found in association with the burial, although a "slump of plaster" was recovered near the skull (Estrada-Belli 2001:7). Textile impressions were found (and cast) on the plaster surface

Figure 8.46 View of Throne 4 in south room (B4 of Structure 43 (Estrada-Belli 2001:25).

in contact with the splanchnocranium (face of the skull), suggesting the use of a “textile-lined wooden mask placed in front of the face” (Estrada-Belli 2001:7–8).

As mentioned in the field report, HOL.T.06.09.01 was found in a simple, pit grave interment cut into a bench in a possible palace building. The individual was placed in a flexed position in this single individual, primary burial. HOL.T.06.09.01 was placed flexed on their left side, oriented east-west, with the head placed northwest and facing east (Figure 8.47). While no associated artifacts were found with this interment, possible

Figure 8.47 Photo of HOL.T.06.09.01 (Estrada Belli 2001:26).

plaster impressions suggest that a textile, or wooden, textile-covered mask, was placed on or near the face.

HOL.T.06.09.01 was found nearly complete with some postmortem damage to the acidic conditions and fragility of the developing bones. The cranium was nearly complete, while not intact, which may be due to the age of the individual. The splanchnocranium experienced the most damage of the skull, which may be the result of an object placed on the face during burial or the general fragility of the facial bones. Some teeth remained in situ in the maxilla and mandible, while others were recovered separately. The axial skeleton was also nearly complete with the preservation of 20 vertebrae, although most were in fragments or had postmortem damage to their processes. The sacrum was preserved in 5 unfused segments, with posterior postmortem damage (Figure 8.48). The right first rib was preserved, while the remaining ribs were fragmentary (many, many fragments), due to postmortem damage and excavation. The appendicular body was also nearly complete, with the most postmortem damage to the scapulae. The ossa coxae were complete, although not yet fused into one, with separate ilia, pubes, and ischia (Figure 8.48). Every long bone was recovered, although most missing their (unfused) epiphyses and the shafts broken postmortem. Many elements of the extremities were recovered, although fragmented postmortem and missing unfused epiphyses.

Figure 8.48 Unfused elements of HOL.T.06.09.01, sacrum (left) and os coxae.

Using various dental estimation techniques, fusion (or lack thereof) of epiphyses, and diaphyseal length measurements, HOL.T.06.09.01 was estimated to have been between 4 and 8 years of age at death, probably at the older end of the range. Due to the infans II age-at-death estimation, an estimation of biological sex is not possible. Comparison of dental eruption to Ubelaker's chart (1999) resulted in an estimate of 6±2 years. The left maxillary canine was visible high within the alveolar process with fully formed enamel. An unerupted premolar is lower within the maxillary alveolar process with completed enamel formation and beginning root formation. Further, all of the first molars were erupted and still in situ in the mandible and maxilla. Using Smith's method (1991) for estimating age from permanent lower dentition, the tentative estimate is between 5 and 7 years of age at death. This estimate is tentative due to the obscuration of the first molar roots and their formation progress. The right second mandibular molar was found loose with 75 percent enamel formation corresponding with the age values of 5.8 years for females and 6.1 years for males. Neither a range nor standard deviation accompanied Smith's age values. Using a chart based on Logan and Kronfeld (1933) in Thoma and Goldman's *Oral Pathology* (1960), the estimated age at death is narrow at 7 to 8 years. The right maxillary second molar had complete enamel formation (7-8 years), while the mandibular secondary molars' enamel was not complete (7-8 years).

The many unfused (yet present) epiphyses suggest an age at death range of 5 to 8 years. This estimation is based on the unfused elements of the os coxae, where fusion occurs between 5 and 8 years of age, and the presence of a single compound proximal epiphysis, occurring between 5 and 7 years (Scheuer and Black 2000). From diaphyseal lengths (right radius, left femur, left tibia, and ilium height), the range for age at death is 3.5.-7.5 years (Ubelaker 1999).

Little paleopathology was observed for HOL.06.09.01 probably due to the young estimated age-at-death. Linear enamel hypoplasia is visible on the right first mandibular molar and two incisors; however, there is little occlusal wear and no preserved dental calculus. Further, there is no evidence of antemortem (or perimortem) fractures, healed or not.

The enamel of the right second maxillary molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70812, while the $\delta^{18}O$ was -3.5 (adjusted to -3.9 for weaning effect) and $\delta^{13}C$ was -3.3. Statistically, HOL.06.09.01 was not an outlier, and most likely a local person from Holmul or the Holmul region.

HOL.T.50.27.09.01

Individual/Burial ID #:	**HOL.T.50.27.09.01; Burial 23**
Laboratory ID #:	HO-16-9
Site:	Holmul
Associated Period/Date:	Late/Terminal Classic?
Year Excavated:	2004 (R. Mongelluzzo)
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Informe Preliminar de la Temporada 2004*; Mongelluzzo 2011
Dentition Sampled:	Left maxillary second molar
Burial Location and Construction:	Holmul/Group III/Court B/Structure 59/Merwin Rm 1, palace, simple, pit
Burial Type, Manner, and Positioning:	Single, primary interment, flexed, left side, W-E, head SW facing north
Associated Artifacts:	6 figurines (2 flutes, 4 ocarinas), 30 *Pomacea* shells
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Infans II (8-13 years)
Biological Sex Estimation:	Indeterminate
Observations:	Indeterminate
Stable Isotope Results:	$\delta^{18}O$: -6.8 (-7.1*) $\delta^{13}C$: -2.5 *adjusted for weaning

Table 8.17 Individual Profile of HOL.T.50.27.09.01

HOL.T.50.27.09.01 ("Burial 23") was excavated from within Room 1 of Structure 59 of Group III's Court B (Estrada-Belli 2004b). This room was in the northeastern corner of Court B to the easternmost side where, during the Terminal Classic, the Maya supported the vaults by constructing inside retaining walls. The burial was found in a room in the northwest corner of the structure (Figure 8.49). This room is also referred to as Merwin Room 1.

This single, primary interment was found cut into the latest floor of Merwin Room 1. The body was flexed on the left in the orientation of west-east, with the head in the southwest facing north (Figure 8.50). This simple, pit grave was in a palace structure

Figure 8.49 View of the excavations on the north side of Court B, Group III. (Image Courtesy of HAP).

with associated artifacts. The associated artifacts included 6 figurines (HOL.T.50.25.03.01 to .08), two were also flutes, while the other four were ocarinas (Figure 8.51). There were 30 *Pomacea* shells (HOL.T.50.10.01 to .30) near the head of the individual.

HOL.T.50.27.09.01 was fragmentarily preserved with only a few cranial fragments, vertebrae fragments, long bone shafts, phalanges, and dentition being recovered. Significantly, the dentition that was preserved can allow for an age at death estimation (Figure 8.52). The maxillary first molar's roots were complete, while the maxillary second molar's roots were only a quarter developed, and the maxillary third

Figure 8.50 Photo of HOL.T.50.27.09.01 in situ (Image Courtesy of HAP).

molar's crown had not yet formed enamel. The estimate using Ubelaker's (1999) chart is 10±2 years, and the chart by Thoma and Goldman (1960) estimates 9 to 13 years of age at death due to the completed roots of the first molar and the not yet completed roots of the first premolar. As this is not an adult, an estimate of biological sex is impossible. The poor preservation of the bones hinders any paleopathological evaluation.

The enamel of the left maxillary second molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$.The $\delta^{18}O$ result was -6.8 (adjusted to -7.1 for weaning effect) and $\delta^{13}C$ was -2.5. Unfortunately, the $^{87}Sr/^{86}Sr$ test was unsuccessful and did not result in a ratio for

HOL.T.50.27.09.01. Statistically, this individual may be an outlier suggested by the $\delta^{18}O$ result; future $^{87}Sr/^{86}Sr$ tests may confirm or deny the non-local status of this individual.

Figure 8.51 Photo of figurine from Burial 23 (Image Courtesy of HAP).

Figure 8.52 Molars and premolars of HOL.T.50.27.09.01, illustrating the root development.

11-6-20/58618.0.1

Individual/Burial ID #:	**11-6-20/58618.0.1**
Laboratory ID #:	HOL-16-22
Site:	Holmul
Associated Period/Date:	Late Classic?
Year Excavated:	1910-1911
Archaeological Reports:	Merwin and Valliant 1932:49; Merwin Holmul Field Notebook #3; Mongelluzzo 2011:105
Dentition Sampled:	Right first mandibular molar
Burial Location and Construction:	Group III, Court B, Structure 63, Room 8, on bench, simple in a blocked-up room
Burial Type, Manner, and Positioning:	Primary, single interment (?)
Associated Artifacts:	Ceramic sherds
Preservation:	Partial (25-75%)
Age-at-Death Estimation:	Infans II/Juvenile (12yrs±30mos or11-18 years)
Biological Sex Estimation:	Indeterminate
Observations:	Indeterminate
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70828, $\delta^{18}O$: -3.5 (-4.2*) $\delta^{13}C$: -2.1 **local** *adjusted for weaning

Table 8.18 Individual profile of 11-6-20/58618.0.1

Merwin's Holmul Field Notebook #3 indicates that the burial found in Room 8 of Building A, Group III (Structure 63) was disturbed by the workmen, but he notes that the bones were found on the higher bench at the east end of the room, very close to the south wall and about 1 foot 4 inches from the west edge of the bench. The back of the skull was against the east wall. The other bones were among around 30 ceramic sherds. Merwin and Valliant (1932:48) describe the rooms of Building A as having domiciliary dimensions and equipped with benches. In Mongelluzzo's dissertation (2011), he describes Room 8 as having a C-shaped bench with a crude bench built on top of it, where the human remains were found. He then describes how the door was sealed following the burial.

Due to the disturbances by the workmen during the excavation of Room 8, it becomes difficult to discern the body positioning and orientation, although it is probable that this was a single, primary burial accompanied by ceramics. This burial was located on a bench in a room in a palace structure, with the construction type of a simple grave of the blocked-up room type.

During the evaluation of the skeletal remains at the Peabody Museum, two individuals were within the material labeled 58618. The primary individual (labeled "A") with had some cranial fragments preserved, presumably from the skull referenced by Merwin. The mandible was complete, although in three fragments. The left canine and left first molar were still in situ in the mandible. There were alveolar sockets for a premolar and for a second molar. The right first and second molars could be refitted into the sockets. The right first molar had fully erupted, while the second molar looks to have been partially erupted. Other dentition included all four maxillary incisors and a mandibular incisor, all with broken roots. Four canines were preserved, including the aforementioned left mandibular canine. Two maxillary premolars and three mandibular premolars were present with broken roots. In total, one right first maxillary molar, both first mandibular molars, and both second mandibular molars were present (Figure 8.53).

The vertebrae recovered includes a fragmented second cervical, four additional complete cervical vertebrae, six complete thoracic vertebrae with unfused transverse epiphyses and annular rings, and one lumbar vertebrae lacking a fused annular ring. Fifteen rib fragments were preserved, including a right complete first rib. Fragments of the scapular body were preserved, including complete glenoid fossa, although with unfused elements. Both clavicles were partially preserved, with the right having an unfused medial epiphysis. A small fragment of the left ilium was preserved. Both upper limbs were partially recovered, with a complete right humerus and radius with unfused epiphyses. The right compound distal humeral epiphysis was present but not fused to the shaft. The left radial head was not fused, in addition to the unfused olecranon process of the left and right ulnae. For the lower limbs, only a proximal fibular shaft fragment was recovered with an unfused proximal epiphysis. No hand or foot bones were present.

An estimation of age-at-death is possible from the dentition and stages of epiphyseal fusion. Using the Ubelaker (1999) chart, the estimated age range is 12 years ±30 months due to the partial eruption of the second mandibular molars that are not yet touching occlusally. Because the second mandibular molars were in the process of erupting and the roots not yet completed, the age can be estimated to be 11-15 years (Thoma and Goldman 1960). Because the lateral distal humeral epiphysis had not fused

Figure 8.53 Right first maxillary and mandibular molars of 58618.0.1.

to the shaft, the age can be estimated to have been between 11 and 18 years of age (Scheuer and Black 2000). No paleopathological change was observed, nor mentioned in the reports.

The enamel of the right first mandibular molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70828, while the $\delta^{18}O$ result was -3.5 (adjusted to -4.2) and $\delta^{13}C$ was -2.1. Statistically, 58618.0.1 was not an outlier, and most likely a local person from Holmul or the Holmul region.

Considering the Burials of Holmul, Group III, Court B.

The burials excavated from Group III, Court B have many significant similarities. All of the individuals were between 4 and 14 years of age at death and were likely of local origin. The strontium results will be re-run to confirm the status of HOL.T.50.27.01. The three individuals excavated by the Holmul Archaeological Project were positioned flexed on their left oriented east-west. Little mortuary data is available concerning the burial (58618.0.1) excavated by Merwin, except that the juvenile individual was found "on a bench… with about thirty potsherds" (Merwin and Vaillant 1932:49). It is more probable that this individual was buried flexed than extended due to the location of the burial. All four of the burials were associated with benches or cut into the floor of rooms with benches more similar to sleeping benches than throne benches. Harrison (1970) differentiated thrones from sleeping benches as the former have legs, arms, elaborate decoration, and against one wall, while the later are long and flat, not in front of doorways, and associated with cordholders, the attachments for a curtain. The associated artifacts range from ceramic figurines (HOL.T.50.27.09.01), which are common in burials of children (Welsh 1988:217), to perforated shells (HOL.T.58.16.09.01) to textile impressions in plaster (HOL.T.06.09.01). While not opulent, these are Infans II burials in a Late Classic palace context with some noteworthy accompanying artifacts. These are not extensive tomb burials of adults in ceremonial contexts. Welsh (1988:106) posits that during the Late Classic at Holmul, it is the location of the burial in an elite or ceremonial context that signals status, and not the amount or quality of associated artifacts. It is also possible that the elite or royal adults were interred in the ceremonial contexts, while the children were buried in the elite residence of the palace. Most burials in palaces or residential structures are within or covered by benches. The majority (31/37) of the bench burials examined by Welsh (1988) were in palaces or residential structures. He suggests that this association may have served purposes of ancestor veneration, as the benches could then be considered altars. However, the burials in the Holmul palace were children, possibly acting as dedicatory caches for adult ancestors. Welsh (1988) noted that 13 of the 37 bench burials he examined were children and probably sacrificial or dedicatory in nature, perhaps dedicated to venerated ancestors.

It is possible that the young individuals buried in the palace of Holmul were sacrificial or dedicatory in nature. There is no direct skeletal evidence that these children were sacrificed and then interred in the palace complex. Some contextual evidence for sacrifice includes a combinations of bodies, such as an adult and child, or a primary interred individual accompanied by a sacrificed individual in an urn or as if they were an associated artifact (Welsh 1988:168). Each of the burials in the palace were singular burials and not interred within ceramic vessels. Dedicatory cache burials also tend to contain sacrificed individuals, usually infants or the skulls of young adults and adults in ceramic vessels (Welsh 1988:181–182). In the case of the dedicatory burials C8, C9, and C11 of the San Jose palace, the individuals are flexed children placed on a plaster surface and not in a pit into a surface (Thompson 1939:211). It remains a still unproven hypothesis that the burials in the palace at Holmul were of a sacrificial or dedicatory cache nature.

Holmul, Group III, Court B

HAP/Harvard ID	HOL.T.06.09.01	HOL.T.50.27.09.01	58618.0.1
Sample ID	HO-16-1	HO-16-9	HO-16-22
aka	HAP 1	HAP 23	
Period	Late Classic	Late/Terminal Classic?	Late Classic?
Age-at-Death	Infans II (4-8 yrs)	Infans II (8-13 yrs)	Infans II/Juvenile (12yrs±30mos or 11-18 yrs)
Biological Sex	Indeterminate	Indeterminate	Indeterminate
Burial Type	Grave interment	Grave interment	Grave interment
Burial Manner	Primary, single	Primary, single	Primary, single
Body Positioning	Flexed, left side, W-E, facing E	Flexed, left side, W-E, facing N	unknown
Burial Location	Palace, placed in bench 4, str. 43	Palace, Merwin Rm 1, str. 59	Palace, ***on bench*** (?)
Grave Construction	simple, pit	Simple, pit	**Simple, blocked-up room**
Associated Artifacts	None (possible textile impressions in plaster)	6 figurines (2 flutes, 4 ocarinas), 30 Pomacea shells	***30 ceramic sherds***
Tooth Sampled	RM^2	LM^2	RM_1
$^{87}Sr/^{86}Sr$	0.70812		0.70828
$\delta^{18}O_{ap}$	-3.5 (-3.9*)	-6.8 (-7.1*)	-3.5 (-4.2*)
$\delta^{13}C_{ap}$	-3.3	-2.5	-2.1
Local or Non-Local	Local		Local

Figure 8.54 Summary of the burials of Holmul Group III, Court B

The Osteobiographies of Holmul, Ruin X

Ruin X of Holmul is located between the Main Plaza (south of Group I) and the East Plaza. Merwin excavated Ruin X at Holmul, as documented in his field notebooks. He documented a single room (Room 1) building constructed during the Late Classic on a pyramidal structure. A later structure (Room 2) was constructed to the east. Merwin (Merwin and Vaillant 1932) documented burials in Room 1. The burials were contained in a crudely constructed vault, walled with small unworked slabs and a roof of capstone slabs. Following the interment, the three western doorways were sealed. Welsh (1988:29) classified Ruin X as a household shrine, as it is located to the east of Group I (and Group III), has no evidence of use as a residential structure, and the rooms were sealed off following burial.

In 2007, excavations in the East Plaza, of which Ruin X is the western edge, revealed the presence of an E Group during the Late Preclassic period, followed by an erection of a vaulted building to the east and west during the Late Classic (Estrada-Belli 2007). The 2016 excavations of Ruin X (Figure 8.55) aimed to explore and document the looter's trenches to understand the architectural sequence of this building.

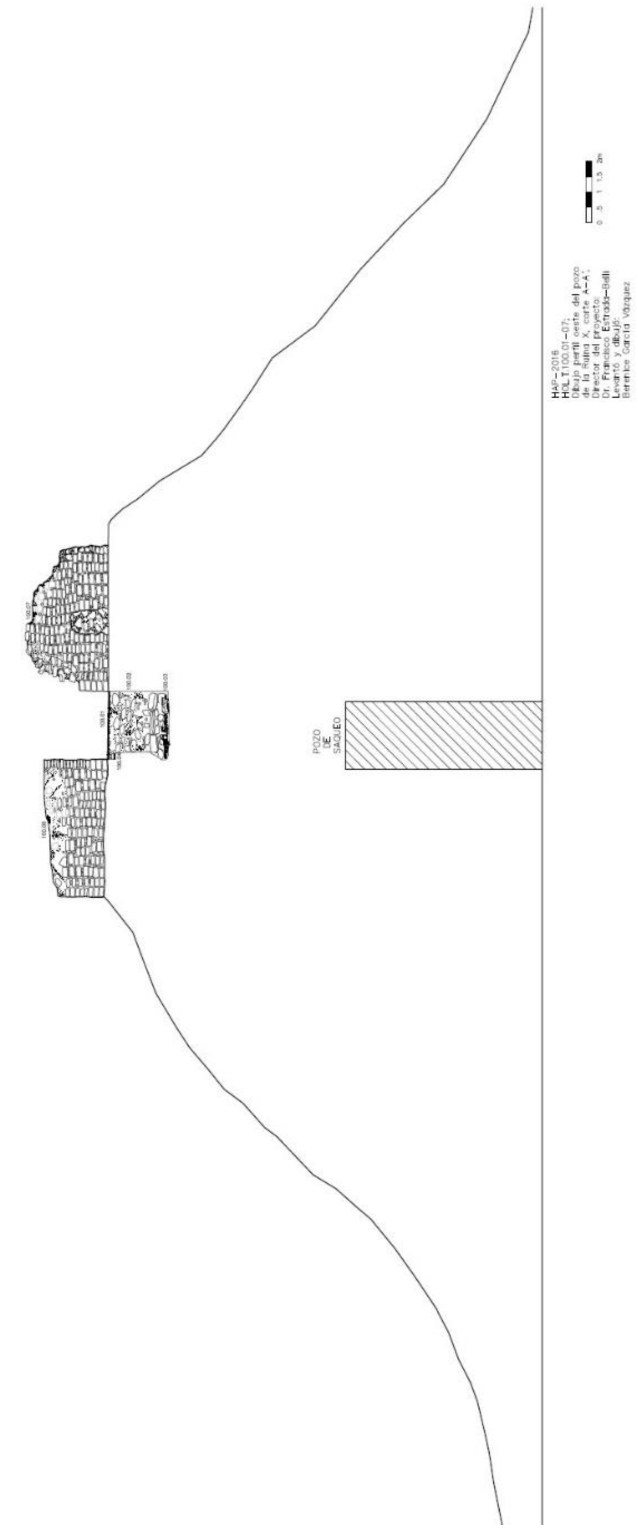

Figure 8.55 Western profile of Ruin X (Estrada-Belli 2016: 7).

11-6-20/58622.0.1

Individual/Burial ID #:	**11-6-20/58622.0.1; Skel 2; X2**
Laboratory ID #:	HO-16-24
Site:	Holmul
Associated Period/Date:	Late Classic (AD 650-750 Welsh 1988)
Year Excavated:	1910-1911
Archaeological Reports:	Merwin Holmul Field Notebook #3; Merwin and Valliant 1932; Welsh 1988
Dentition Sampled:	Right first mandibular molar
Burial Location and Construction:	Ruin X, Religious/Ceremonial, simple crypt
Burial Type, Manner, and Positioning:	Primary, multiple? interment, flexed on left side, S-N, head to S
Associated Artifacts:	Worked bird bone found among upper ribs; flint knife or spear point found near toe bones; textile
Preservation:	Partial (25-75%)
Age-at-Death Estimation:	Infans II/Juvenile (12yrs ± 30mos or11-18yrs)
Biological Sex Estimation:	Indeterminate
Observations:	Indeterminate
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70821, $\delta^{18}O$: -5.5 (-6.2*) $\delta^{13}C$: -5.8 **local** * adjusted for weaning

Table 8.19 Individual profile of 11-6-20/58622.0.1

In 1910-1911, Merwin found three burials in Room 1, which was subsequently sealed off. Skeletons 1 and 2 were found at the west end of room. Skeleton 3 was in a separate vault separated from Skeletons 1 and 2 by stone slabs and concrete. Skeleton 2 (numbers 58622 by the Peabody and X2 by Welsh 1988) was found resting on a thin layer of yellow material, possibly a textile burial garment (Merwin and Vaillant 1932).

Merwin described Skeleton 2 as being buried in a flexed position in a vault of a room in Ruin X (Merwin and Vaillant 1932:52). Skeleton 2 was found just above Skeleton 1 and may represent a multiple person interment. Welsh (1988:271) further described the grave context as a simple crypt in a household shrine and the head orientation as to the south. From an examination of Merwin's field notebooks located at the Peabody, the sketch of Skeleton 2 suggests a flexed position on the individual's left side.

In 2015, the osteological evaluation was conducted of the remains housed at the Peabody Museum. The cranium was not present, only represented by fragments of the mandible. Dentition preserved included both maxillary central incisors and the left lateral incisor, one maxillary canine and one mandibular canine, three mandibular premolars and three maxillary premolars, both first maxillary molars, the right second maxillary molar, both first mandibular molars, both second mandibular molars, a maxillary third molar crown, and a mandibular third molar crown. Of the vertebrae, only two cervical and two lumbar vertebrae were present, although in partial condition. The sacrum was preserved, showing incomplete fusion on the anterior surface.

Of the appendicular body, elements preserved included a lateral fragment of the left clavicle, three ilia fragments with potions of the auricular surfaces, a mostly complete pubis unfortunately missing the pubic symphysis, and a complete left ischium. The long bones preserved and present include many shaft fragments of the upper limbs, one proximal radial head partially fused, a distal fragment of the left humerus with completed fusion of the epiphyses, shaft fragments of the femora, and epiphyses of a humeral head, distal tibia, and distal radius. The hand bones present include the right scaphoid, a lunate fragment, a first metacarpal with the proximal epiphysis partially fused, four phalanges, and two metacarpal distal epiphyses. The foot bones present include the right calcaneus, fragments of both tali, a partial first metatarsal, and a metatarsal shaft fragment.

Using the development of the dentition and epiphyseal fusion (Figure 8.56), the age-at-death of this individual can be estimated. The first molars have completed rooms missing the apex. The mandibular second molars have nearly complete roots and the roots of the maxillary second molar is 75% complete. The third molars have complete crowns, although the mandibular third molar's enamel may not be fully finished forming

Figure 8.56 Partial epiphyseal fusion of 58622.0.1.

(Figure 8.57). Using the Ubelaker chart (1999), the age-at-death was estimated to be 12 years ±30 months.

Using the mandibular molar formation stages of Smith (1991), the estimation is 7.9 to 12.6 years. From the partial fusion of the radial head and the fusion of the distal humerus, the age-at-death can be estimated to between 11 and 18 years (Scheuer and Black 2000). As this individual was not an adult, it is not possible to estimate a biological sex. No paleopathological change was observed, nor mentioned in the reports.

The enamel of the right first mandibular molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70821, while the $\delta^{18}O$ result was -5.5 (adjusted for weaning to -6.2) and $\delta^{13}C$ was -5.8. Statistically, 58622.0.1 was not an outlier, and most likely a local person from Holmul or the Holmul region.

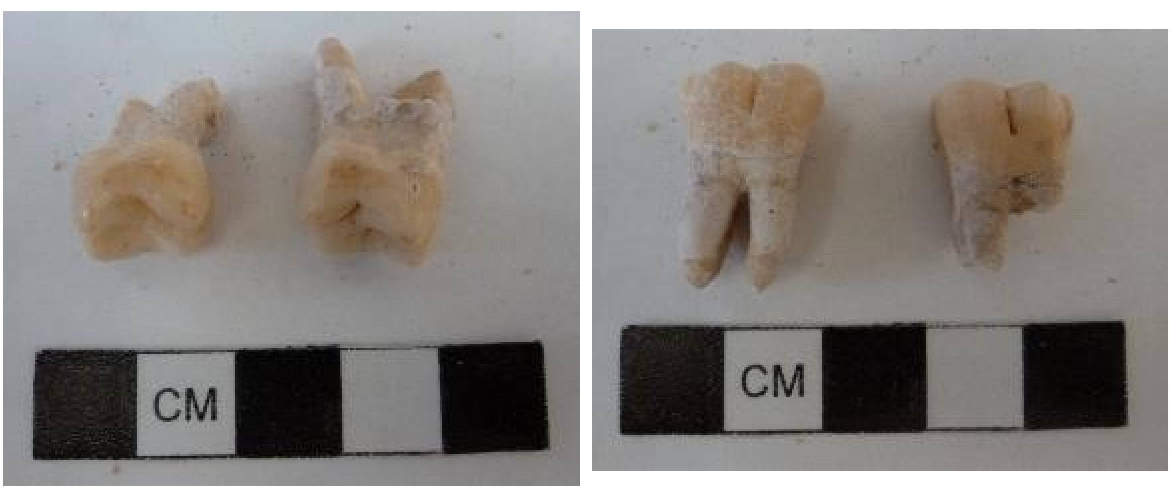

Figure 8.57 Dentition of 58622.0.1.

HOL.T.100.03.09.01

Individual/Burial ID #:	**HOL.T.100.03.09.01**
Laboratory ID #:	HO-16-69
Site:	Holmul
Associated Period/Date:	Early Classic/Late Classic (AD 550-650, ceramics)
Year Excavated:	2016
Archaeological Reports:	*Investigaciones Arqueológicas y Conservación de Arquitectura Monumental en la Región de Holmul: Temporada 2016*
Dentition Sampled:	Left First Maxillary Molar
Burial Location and Construction:	Ruin X, Religious/Ceremonial, capped cist,
Burial Type, Manner, and Positioning:	Primary, single interment, extended N-S, head to N
Associated Artifacts:	8 ceramic vessels (including 2 bowls of Saxche Orange polychrome type- Tepeu 1 and 2), 18 obsidian eccentrics, 2 bivalve shells (1 worked), fragments of red, white, and green stone or coral, white coral
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Dental calculus
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70844, $\delta^{18}O$: -5.8 (-6.5*) $\delta^{13}C$: -3.9 **local** * adjusted for weaning

Table 8.20 Individual profile of HOL.T.100.03.09.01

In the 2016 field season, the HAP placed a square unit on the floor of Room1 to the west of Merwin's 1911 excavations of the burials. The 2.23m (n-s) by 1.8m (e-w) unit was placed in the main western entrance to the room. Approximately 2 meters under the floor, in the western section of the unit, three capstones were found, indicating the top of a grave context.

In this primary, single grave interment, the individual (HOL.T.100.03.09.01) was placed in an extended position oriented north-south with the head to the north (Figure

8.58). The grave construction is that of a capped cist, as it is covered by capstones, but lacks plastered walls. The associated artifacts (Figures 8.59 and 8.60) for this burial include: (a) eight ceramic vessels, including two bowls of Saxche Orange polychrome type (Tepeu 1 and 2), with an pseudoglyph inscription that mimics the primary standard sequence in the style of the royal pottery workshop of Naranjo associated with the ruler Ajnuumsaj Chan K'inich (AD 546-615); (b) 18 obsidian eccentrics; (c) two bivalve shells (one worked); (d) fragments of green stone and red coral; and (e) white coral.

The osteological analysis has yet to be performed, although from the documentation available, it appears that the preservation of the skeleton is extremely poor, with only some fragments of the mandible, two long bone fragments, and phalanges recorded in the 2016 report. The dentition provided for stable isotope analysis (left maxillary first molar) had a large amount of dental calculus on the buccal, distal, and occlusal surfaces.

The enamel of the right second maxillary molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70844, while the $\delta^{18}O$ was -5.8 (adjusted to -6.5) and $\delta^{13}C$ was -3.9. Statistically, HOL.T.100.03.09.01 was not an outlier, and most likely a local person from Holmul or the Holmul region.

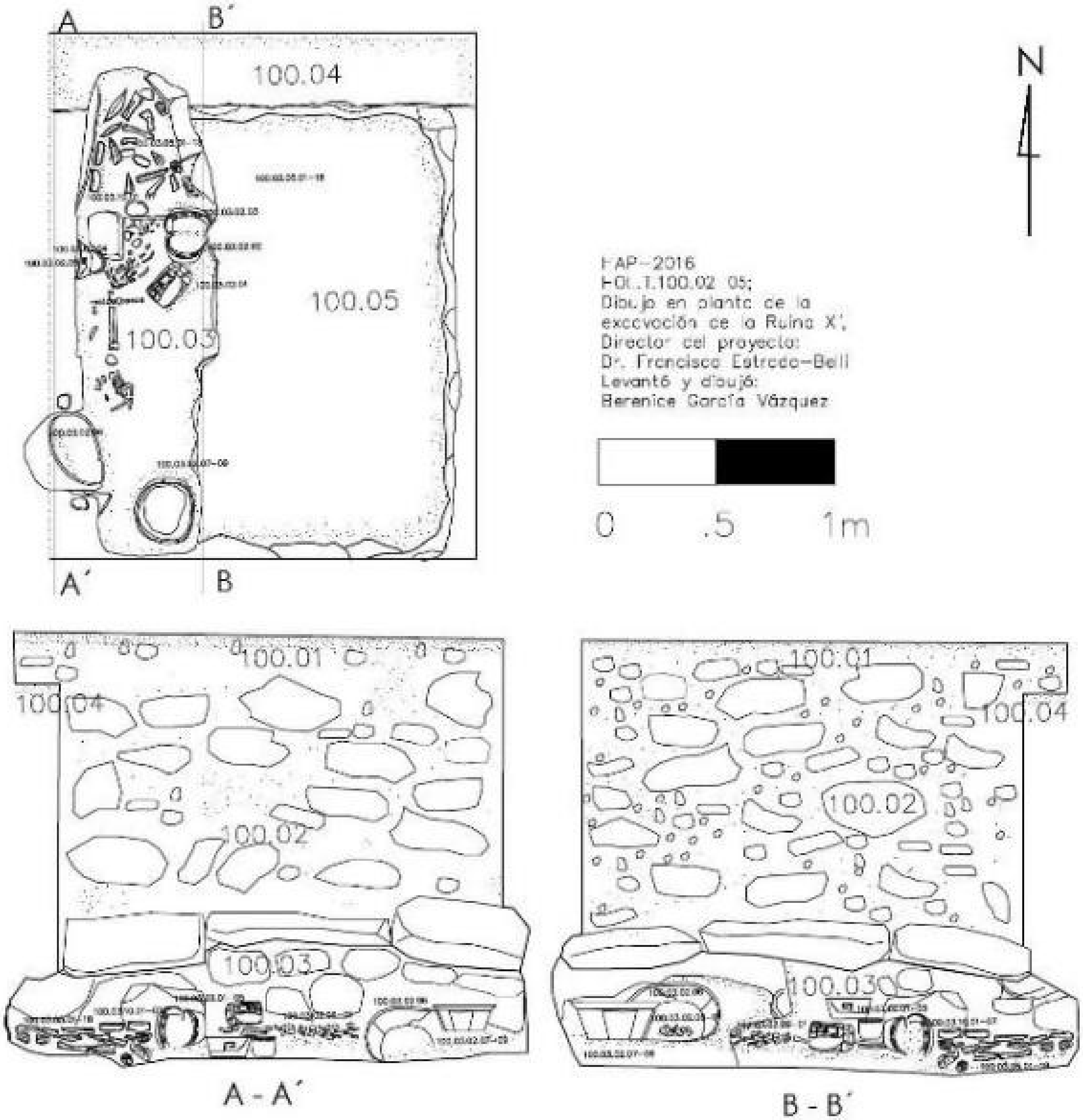

Figure 8.58 Plan and profiles of HOL.T.100.03.09.01 drawn by B. Garcia Vazquez (Estrada-Belli 2016: 137).

Figure 8.59 Associated artifacts of HOL.T.100.03.09.01 (Estrada-Belli 2016:9).

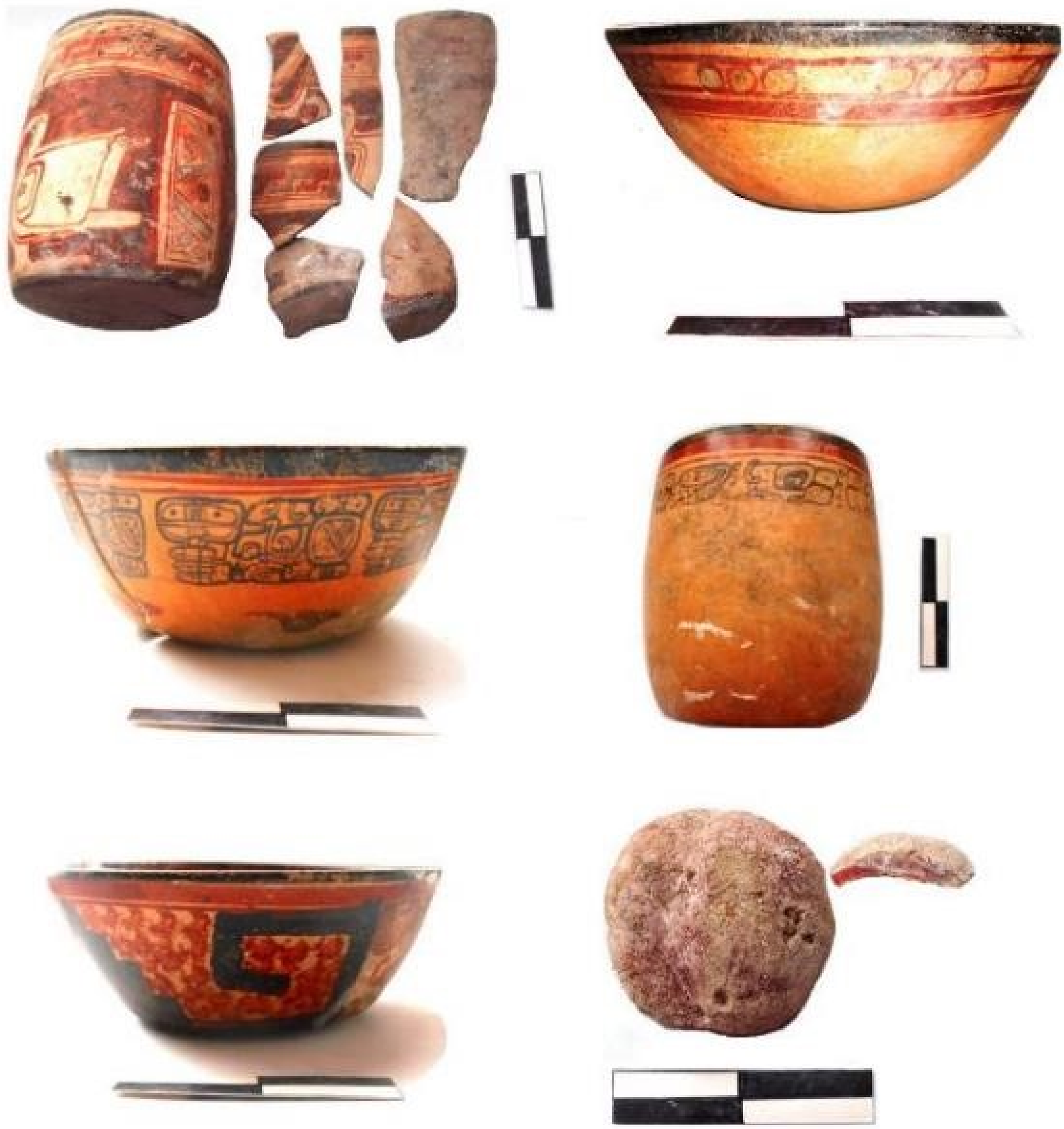

Figure 8.60 Associated ceramic artifacts of HOL.T.100.03.09.01 (Estrada-Belli 2016: 10).

Considering the Burials of Ruin X

The burials excavated by Merwin in the early twentieth century were all located in the center of Room 1 in roughly constructed crypts under the floor. This floor was covered with ash and charred wood, suggesting the practice of burning in the room at some point before all the entrances were sealed. Skeletons 1 and 2 were interred together, with Skeleton 1 being placed in an extended position oriented south-north first, and Skeleton 2, an Infans II/Juvenile, placed on top of the torso of Skeleton 1 in a flexed position with their heads next to each other in the north. Skeleton 1 was an adult accompanied by three ceramic vessels, a spindle whorl, and a fragment of an obsidian knife. The ceramic vessels are classified by Merwin (Merwin and Vaillant 1932:73) to be of the Holmul V type, which Welsh (1988) dates from AD 650 to 750. The associated artifacts with Skeleton 2 consisted only of a worked bird bone and a flint knife or spear point. It is possible that this multiple-individual interment is representative of the adult and child type of sacrificial burial (Welsh 1988:168). Skeleton 3 was an adult interred to the east of Skeletons 1 and 2, separated by limestone slabs that formed a separated burial crypt. The only artifacts associated with Skeleton 3 were a small piece of obsidian and charred wood. This adult was placed in a flexed position on their right oriented with their head to the north.

HOL.T.100.03.09.01, excavated in 2016, was of an earlier construction period compared to Skeletons 1, 2, and 3, as suggested by the architecture and the associated ceramics. Two ceramic bowls associated with HOL.T.100.03.09.01 were of the Saxche Orange Polychrome type of the Tepeu 1 and 2 ceramic horizons of the Late Classic. A pseudoglyph inscription mimicked the style of the Naranjo workshop of the ruler Ajnuumsaj Chan K'inich (AD 546-615), suggesting a burial date towards the end of the sixth century. This date aligns with the burials from Group II, including that of Tzahb Chan Yopaat. The associated artifacts interred with HOL.T.100.03.09.1 include eight ceramic vessels, worked shells, fragments of coral, and 18 obsidian eccentrics. This extensive group of goods presents the high status of the interred adult, perhaps a member of the royal family. This individual was not buried in Group II, however, and instead, buried separately in Ruin X.

The function of Ruin X could provide insight into the identities of the interred, but excavations of the earlier phases are ongoing. Welsh (1988:29) labeled it a household shrine, defined as a religious or ceremonial burial location, where the building was not previously used as a residential structure, but instead individuals were sealed within the building during mortuary practices. Usually household shrines are located on the eastern edge of a residential plaza Welsh (1988:186–190); Ruin X is located to the east of Group III, Holmul's palace or elite residential plaza. Further, Ruin X is situated between the Main Plaza and the East Plaza of Holmul. The 2007 excavations in the East Plaza revealed the remains of a Preclassic E Group, confirming the early ceremonial nature of this area and suggesting that Ruin X was not residential in earlier architectural phases. Thus, the individuals interred in Ruin X were placed in a ceremonial location, with HOL.T.100.03.09.01 being interred similarly to the primary burial of Group II Building A, the possible ruler, Tzahb Chan Yopaat. It is possible that the later burials of Skeleton

1, 2, and 3 in Ruin X were some type of veneration to the earlier, elaborate burial of HOL.T.100.03.09.01, with Skeleton 2 being a possible child sacrifice.

Holmul, Ruin X		
HAP/Harvard ID	58622.0.1	HOL.T.100.03.09.01
Sample ID	HO-16-24	HO-16-69
aka	**Skel 2; X2**	
Period	**Late Classic AD 650-750**	Early Classic/Late Classic (AD 550-650)
Age-at-Death	Infans II/Juvenile (12yrs ± 30mos or 11-18yrs)	Indeterminate
Biological Sex	Indeterminate	Indeterminate
Dental Pathology		dental calculus
Burial Type	Grave interment	Grave interment
Burial Manner	Primary, multiple?	Primary, single
Body Positioning	***Flexed on left side, S-N***	Extended, N-S
Burial Location	Religious/Ceremonial	Religious/Ceremonial
Grave Construction	**Simple crypt; household shrine; *south end of vault***	Cist, capped
Associated Artifacts	***Worked bird bone found among upper ribs; flint knife or spear point found near toe bones; textile***	8 ceramic vessels (including 2 bowls of saxche Orange polychrome type- Tepeu 1 and 2), 18 obsidian eccentrics, 2 bivalve shells (1 worked), fragments of red, white, and green stone or coral, white coral
Tooth Sampled	RM_1	LM^1
$^{87}Sr/^{86}Sr$	0.70821	0.70844
$\delta^{18}O_{ap}$	-5.5 (-6.2*)	-5.8 (-6.5*)
$\delta^{13}C_{ap}$	-5.8	-3.9
Local or Non-Local	Local	Local

Table 8.21 Summary of the burials of Holmul Ruin X

Sources: **Welsh 1988; *Merwin and Vaillant 1932*; Gerry 1993**

The Osteobiographies of Holmul, South Group I

South Group I is a residential group located on a hill-top 1 km to the south of the Main Plaza of Holmul. The group consists of six primary mounds arranged along the edges of a 30m wide plaza. The group was constructed by building upon a basal platform on a low hill of bedrock. Structure 1 lies to north, along with Structure 2. Structures 5 and 6 are on the western edge, with Structure 4 to the south and Structure 3 to the east. Additional low mounds and a chultun were found in the plaza.

In 2002 and 2003, excavations in South Group I focused on Structures 1, 5, and a low mound in the southern portion of the plaza. In Structure 1 (Figure 8.61), three burials were excavated, HOL.T.28.04.09.01, HOL.T.30.20.09.01, and HOL.T.30.33.09.01. An additional burial, HOL. T.37, was excavated from the low mound. In 2004, excavations continued in the southern half of the mound in Structures 101 and 103. The exact location of these mounds is unknown, as a map of the mound is not available. One burial, HOL.T.28.33.09.01, was excavated from Structure 101 and another, HOL.T.47.05.09.01, from Structure 103. The low mound excavated in 2003 was deemed a later, possible Terminal Classic, occupation of South Group I. It is possible that Structures 101 and 103 are the 2004 designations for these additional mounds of South Group I.

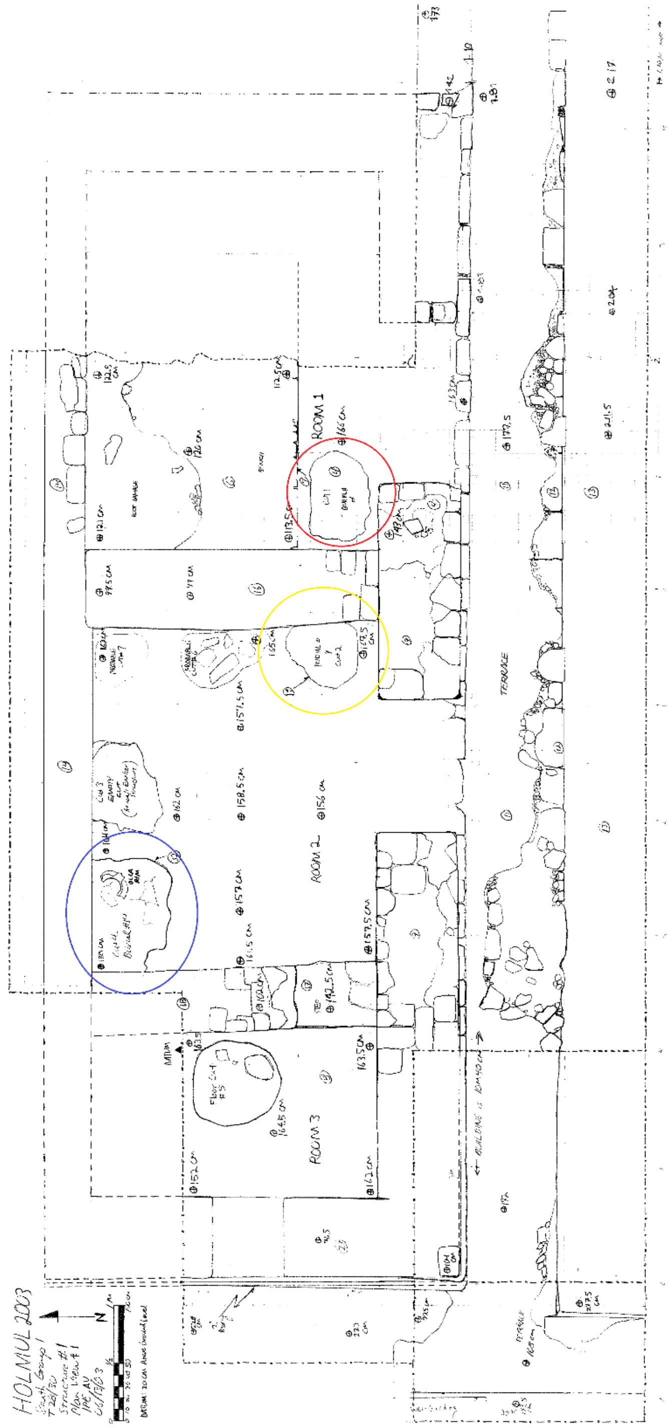

Figure 8.61 Plan view of South Group I, Structure 1 (drawing by J. Ebersole). HOL.T.28.04.09.01 in red circle. HOL.T.30.20.09.01 in yellow circle. HOL.T.30.33.09.01 in blue circle (Image Courtesy of HAP).

HOL.T.28.04.09.01.01

Individual/Burial ID #:	**HOL.T.28.04.08.01; HAP Burial 2/8**
Laboratory ID #:	HO-16-3
Site:	Holmul
Associated Period/Date:	Late Classic
Year Excavated:	2002 (Justin Ebersole)
Archaeological Reports:	*Archaeological Investigations at Holmul, Petén, Guatemala: Preliminary Results of the Third Season, 2002*
Dentition Sampled:	Left first maxillary molar
Burial Location and Construction:	South Group I, Structure 1, Room 1, elite residential, simple pit in floor in front of bench
Burial Type, Manner, and Positioning:	Unknown
Associated Artifacts:	Unknown
Preservation:	Fragmentary (0-25%); complete dentition (75-100%)
Age-at-Death Estimation:	Adult 18+years
Biological Sex Estimation:	Indeterminate
Observations:	LEH, possible lesion on proximal ends of radius and ulna (medial surfaces)
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70808, $\delta^{18}O$: -6.9 (-7.6*) $\delta^{13}C$: -4.1 **local?** *adjusted for weaning

Table 8.22 Individual profile of HOL.T.28.04.09.01.01

In 2002, HOL.T.28.04.08.01 was excavated in South Group I of Holmul (Estrada-Belli 2002:11). Trench 28 was placed in the northernmost structure (Structure 1) of South Group I dating to the Late or Terminal Classic. The clearing of Structure 1 revealed a multi-room vaulted building, possibly residential. A low step led up to a main room (Room 1) with masonry walls and floors. The room has a masonry door jam, opening to the south, and a bench (2.68x2m) in the interior. The burial HOL.T.28.04.08.01 (referred to as Burial 2 in 2002 and Burial 8 in 2003) was described as "a shallow human burial… cut 0.5m deep in the plaza floor in front of the room's threshold. The bone preservation was minimal and only a few fragments were recovered from this context" (Estrada-Belli

2002:11). This description contradicts the profile view and photos, where the burial is located inside the room in a pit in front of the bench.

HOL.T.28.04.08.01 was excavated from an elite vaulted, residential structure, in a simple, pit grave dug into the floor in front of a bench (Figures 8.62 and 8.63). No artifacts were reported associated with this primary, single individual interment. Body positioning and orientation was not recorded in the report.

Figure 8.62 Excavation T.28 in South Group I, Structure 1, showing the small step up to a platform holding a room with door jam and interior bench (Estrada-Belli 2002:44).

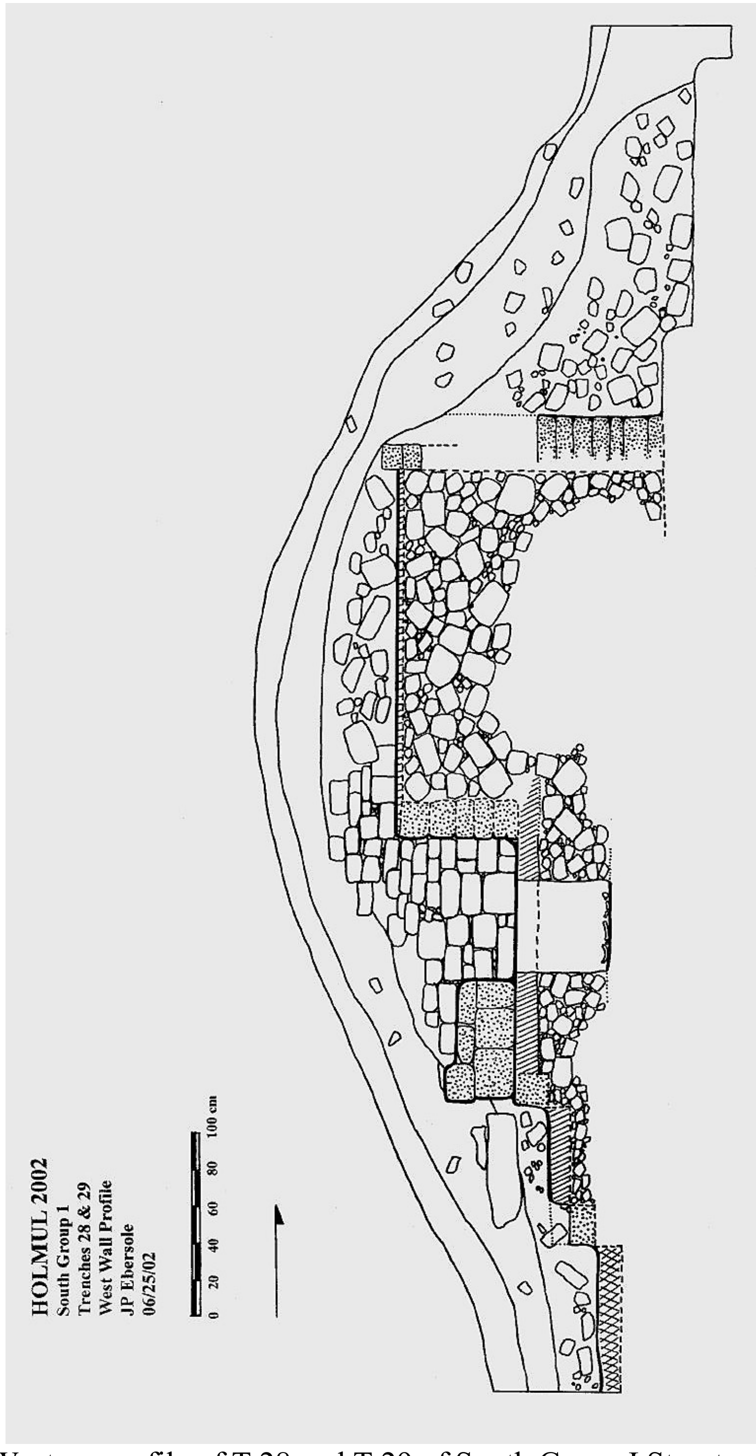

Figure 8.63 Western profile of T.28 and T.29 of South Group I Structure 1, showing the masonry walls, floors, and the burial HOL.T.28.04.08.01 (drawing by J. Ebersole) (Estrada-Belli 2002:45).

HOL.T.28.04.08.01 was found poorly preserved and very few fragments were recovered. The cranium is represented by a small mandible fragment, a small maxilla fragment (with in situ left second premolar), and five calvarium fragments (possibly temporal). The permanent dentition was nearly complete, with seven incisors, four canines, eight premolars, and ten molars. Long bone shaft fragments were recovered, as well as shafts of metacarpals and metatarsals and phalange fragments. The presence of two third molars suggests the individual was at least 18 years of age at death (Thoma and Goldman 1960; Smith 1991). Due to the fragmentary nature of the postcranium (and cranium), an estimation of biological sex is indeterminate.

Both first maxillary incisors present linear enamel hypoplasia (Figure 8.64). Paleopathological changes are visible on the fragments of the proximal shafts of the left

Figure 8.64 Linear Enamel Hypoplasia on the Central Maxillary Incisors of HOL.T.28.04.08.01.

Figure 8.65 Pathological changes on medial surfaces of proximal left radius and ulna.

ulna and radius on their medial surfaces (*.65). The bony addition and possible cloacae suggest an infection in the proximal end of the lower arm, perhaps making the elbow stiff and painful.

The enamel of the left first maxillary molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70808, while the $\delta^{18}O$ was -6.9 (adjusted for weaning to -7.6) and $\delta^{13}C$ was -4.1. Statistically, this individual may be an outlier suggested by the $\delta^{18}O$ ratio result, but the bivariate analysis did not concur. It is more likely that this was a local individual with a significant $\delta^{18}O$ ratio as a result of diet variation or sample processing error.

HOL.T.30.20.09.01

Individual/Burial ID #:	**HOL.T.30.20.09.01; HAP Burial 9**
Laboratory ID #:	HO-16-4
Site:	Holmul
Associated Period/Date:	Late Classic
Year Excavated:	2003 (Justin Ebersole)
Archaeological Reports:	*Archaeological Investigations in the Holmul Region, Petén: Results of the Fourth Season, 2003*
Dentition Sampled:	Maxillary left first molar
Burial Location and Construction:	South Group I, Structure 1, Room 2, elite residential, simple pit grave
Burial Type, Manner, and Positioning:	Primary, Single, Flexed on Left, S-N, head SW facing N
Associated Artifacts:	Bone with drill hole
Preservation:	Partial (25-75%)
Age-at-Death Estimation:	Adult 20-33 years
Biological Sex Estimation:	Female (?)
Observations:	LEH, dental modification, dental calculus, resorbed mandibular sockets, osteophyte addition to vertebral bodies
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70847, $\delta^{18}O$: -4.3 (-5.0*), $\delta^{13}C$: -5.4 **non-local?** *adjusted for weaning

Table 8.23 Individual Profile of HOL.T.30.20.09.01

During the 2003 field season, HOL.T.30.20.09.01 was excavated in Structure 1, Room 2 of the South Group I (Estrada-Belli 2003b). Trench 30 was initiated to the west of Trench 28, exposing Room 2 and 3 of Structure 1, as well as the front terrace, the southwest corner of the building, and the western façade. Room 2, entered from the south, is the central and largest room of the three. The floor of Room 2 was plastered smooth, but not level. When the floor was cleared, five cuts were evident. Cut 2, in the southeastern corner of the room, contained HOL.T.30.20.09.01 ("Burial 9"). The individual was well preserved, despite the postmortem destruction of the cranium and pelvis.

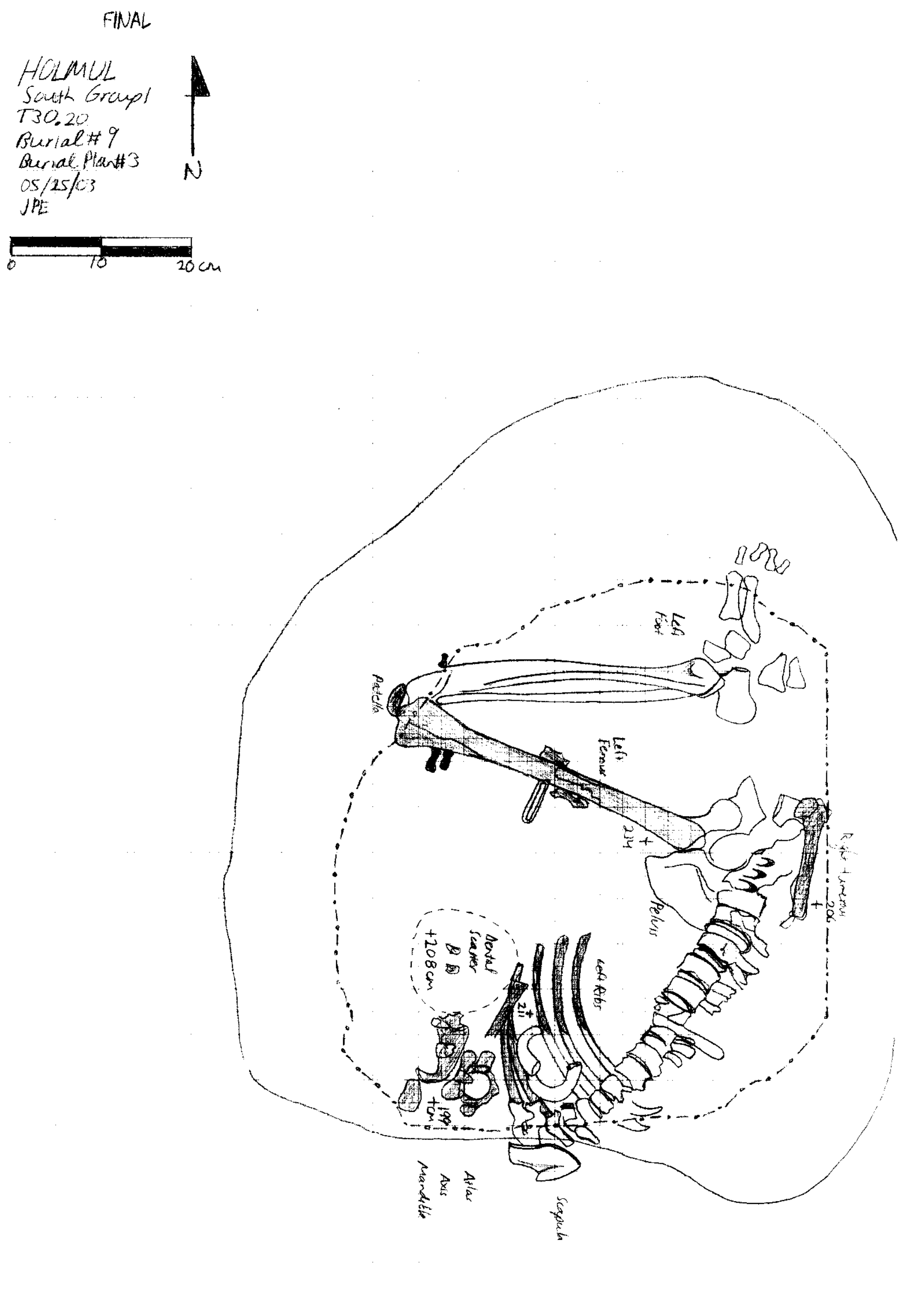

Figure 8.66. Plan view of Burial HOL.T.30.20.09 (drawing by J. Ebersole) (Image Courtesy of HAP).

HOL.T.30.20.09.01, a single, primary interment, was buried in the elite residence of Structure 1, South Group I. The individual was placed in a simple, pit grave in the southeastern corner of the central room. The body was placed in a flexed position (Figure 8.66), on their left side oriented south-north, with the head placed southwest and facing north. A fragment of worked bone was associated with the burial context.

HOL.T.30.20.09.01 is considered partially complete (25-75%), as significant portions (the cranium and pelvis) suffered postmortem damage and were not preserved. The dentition was partially complete with six incisors, four canines, seven premolars, and seven molars recovered. The axial skeleton well preserved, with seven cervical vertebrae, eight thoracic vertebrae, and fragments of all five lumbar vertebrae. The sacrum was nearly complete and the ribs, while fragmented, were well represented. Both clavicles were complete, with the left able to be measured. The left had a fused medial epiphysis, while the right had a partial fusion. Both patellae were complete. The upper limbs were fragmentary, with distal fragments of both humeri and proximal fragments of the right ulna. The lower limbs were partially complete, with nearly complete fibulae, proximal femora fragments (including the right femoral head with minimal postmortem damage), a nearly complete left tibia, and fragmented right tibia. The hand and foot bones, while partially preservered, were plentiful.

Using the partial fusion of the medial epiphysis of the right clavicle and the complete fusion of the left, the individual was between 20 and 33 years of age at death (Webb and Suchey 1985). Fusion lines still visible on the distal fibulae support this young adult estimate. The biological sex can be estimated from the discriminate function

Figure 8.68 Maxillary and mandibular dental modification of HOL.T.30.20.09.

Figure 8.67 Osteophyte addition to
vertebral bodies of HOL.T.30.20.09.

calculation of the left clavicle and the right femoral head diameter. The clavicle calculation resulted in a negative number indicating female, and the femoral head (slightly damaged) measured 40.96 mm also indicating female. The young age of the individual adds some doubt to the estimation of biological sex, as this individual could be a still developing young male, although a fused clavicle is widely considered the end of physiological growth.

The macroscopic evaluation of the dentition of HOL.T.30.20.09.01 illuminated linear enamel hypoplasia, dental modification (Figure 8.68), dental calculus, and resorbed mandibular sockets. Further, there was some osteophyte addition to the fragmented thoracic or lumbar vertebral bodies (Figure 8.67). The maxillary first incisors (Figure 8.68) were modified in mirror images like the type B4 (Romero 1970). The mandibular first incisors were modified, again in mirror image, like the type B3 (Romero 1970). The right second mandibular incisor was modified like type F4 (Romero 1970) and the right first mandibular premolar was modified like type A1(Romero 1970).

The enamel of the left first maxillary molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70847, while the $\delta^{18}O$ was -4.3 (adjusted to -5.0) and $\delta^{13}C$ was -5.4. The strontium value is on the very upper bounds for the Holmul local signature but not a statistical outlier. When $\delta^{13}C$ and $^{87}Sr/^{86}Sr$ were evaluated using the bivariate plot, it suggested that HOL.T.30.20.09 was an outlier and thus a possible non-local individual from elsewhere in the southern lowlands.

HOL.T.37.09.01

Individual/Burial ID #:	**HOL.T.37.09.01; Burial 12**
Laboratory ID #:	HOL-16-5
Site:	Holmul
Associated Period/Date:	Terminal Classic
Year Excavated:	2003 (A. Vasquez)
Archaeological Reports:	*Archaeological Investigations in the Holmul Region, Petén: Results of the Fourth Season, 2003*
Dentition Sampled:	Mandibular left canine
Burial Location and Construction:	South Group I, Trench 31 North Extension, housemound or house group, unclassifiable (simple, simple?)
Burial Type, Manner, and Positioning:	Grave interment, primary, single, unclear positioning on the right side, S-N, head to SE
Associated Artifacts:	None
Preservation:	Fragmentary (0-25%) and eroded
Age-at-Death Estimation:	Adult?
Biological Sex Estimation:	Indeterminate
Observations:	Nearly complete resorption of mandibular alveolar (possibly only LC and LI_2 in situ)
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70853, $\delta^{18}O$: -4.4 (-5.1*) $\delta^{13}C$: -8.2 **non-local?** *adjusted for weaning

Table 8.24 Individual profile of HOL.T.37

HOL.T.37.09.01 (“Burial 12”) was excavated in the 2003 excavations in the South Group I of Holmul. Trench 31 was placed centrally in the southern portion of the plaza, laid out over a low mound. This mound was suspected to be evidence of a Terminal Classic reoccupation of South Group I, due to its odd positioning and surface rubble (Estrada-Belli 2003b). The architecture of this mound was revealed to be noticeably different from Structure 1. The walls were crudely constructed and were not perfectly aligned cardinally. The doorways found were unusually narrow (44cm wide) and the plaster floors with barely 3cm thick. Trench 31 was expanded northward, uncovering more walls and plaster floor surfaces. "Burial 12" was found in this northern extension of Trench 31[2] adjacent to a wall built directly on bedrock (context 16). HOL.T.37.09.01 was found at a depth of 1.25m below datum or 55cm below ground level and roughly 30cm above bedrock.

The excavators noted the HOL.T.37.09.01 was poorly preserved and not within a visible burial cut or pit, yet the positioning of the identifiable bones suggest the body was articulated when buried, and thus a single, primary interment burial (Figure 8.69).

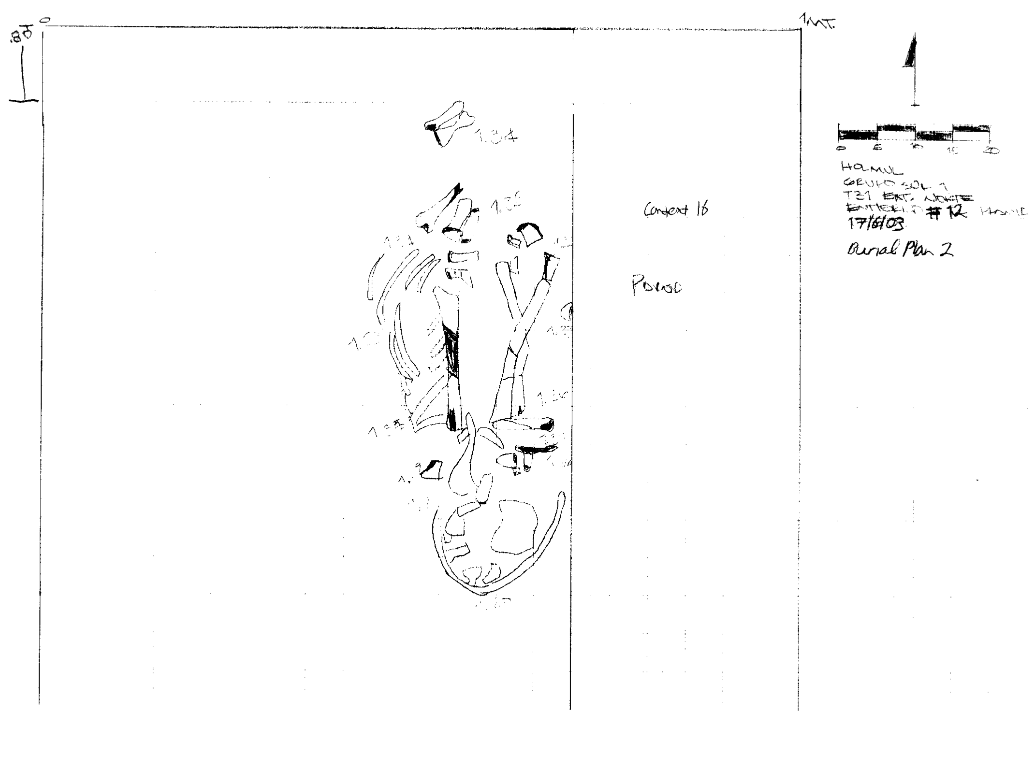

Figure 8.69 Profile drawing of HOL.T.37.09.01 by J. Ebersole
(Image Courtesy of HAP).

[2] "Burial 12" will continue to be labeled throughout this work as HOL.T.37.09.01, although it is most likely that a mislabeling of the remains resulted in "HOL.T.37" instead of "HOL.T.31", as it was excavated from Trench 31.

HOL.T.37.09.01 was buried adjacent to a “well constructed wall” (Estrada-Belli 2003b:95), but it is unclear if the individual was buried in an interior or exterior of the structure. In either case, this is an unclassifiable (possibly simple, simple) grave in a housemound or house platform. Ebersole notes that “The head of this individual was placed to the south with the spine apparently to the west. Excavators believe, however, that the person may have been buried with his or her face downward based on the position of the mandible and remaining cranial fragments” (Estrada-Belli 2003b:95). From the burial plan, it appears that HOL.T.37.09.01 was interred on their right side in a south-north orientation. The body may have been positioned flexed, but the lack of lower limb fragments documented (and the presence of upper limb fragments) suggests an extended position. The head may have been placed face down, as suggested by the report, or facing east against the wall. No artifacts were associated with the burial.

HOL.T.37.09.01 was fragmentary (Figure 8.70), with no lower limbs or pelvis preserved. The cranium was very fragmentary with only the mandible in partial to complete preservation. A portion of frontal bone was preserved with the upper eye orbit. Only two teeth were recovered, mandibular left canine and mandibular left second incisor, although the resorbed alveolar portion suggests that many of the individual’s teeth were lost antemortem (Figure 8.71). The upper arm bone fragments were very eroded, and the hand and foot bones were recovered, although not well preserved. The fragmentary preservation of the remains does not allow for an age at death or biological sex estimation, although the reabsorption of the mandibular alveolar portion suggests an adult.

Figure 8.70 The fragmentary remains of HOL.T.37.09.01.

The enamel of the left mandibular canine was tested for δ18O, δ13C, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70853, while the δ18O was -4.4 (adjusted to -5.5) and δ13C was -8.2. The strontium value is on the very upper bounds for the Holmul local signature and not a statistical outlier. HOL.T.37.09.01 was an outlier for the Holmul site $\delta^{13}C$ box-and-whisker plots and the $^{87}Sr/^{86}Sr$ ratio for HOL.T.37.09.01 was the largest in the dataset at 0.70853. While not statistically an outlier in the box-and-whisker plot of the $^{87}Sr/^{86}Sr$ ratios, when plotted with the $\delta^{13}C$ ratios in the bagplot, its status as a possible non-local can be suggested. It is probable that HOL.T.37.09.01 was from elsewhere in the southern lowlands, although possibly from a northern lowland site like Ek' Balam (0.7086) or from the Belize River Zone at a site like Buenavista (0.7084).

Figure 8.71 Mandible of HOL.T.37.09.01.

HOL.T.30.33.09.01

Individual/Burial ID #:	**HOL.T.30.33.09.01; Burial 14**
Laboratory ID #:	HO-16-6
Site:	Holmul
Associated Period/Date:	Late Classic
Year Excavated:	2003 (J. Ebersole)
Archaeological Reports:	*Archaeological Investigations in the Holmul Region, Petén: Results of the Fourth Season, 2003*
Dentition Sampled:	Left maxillary canine
Burial Location and Construction:	South Group I, Structure 1, Room 2, Cut #4, Context 32, elite residence, simple pit covered in soft plaster
Burial Type, Manner, and Positioning:	Flexed on the right, W-E, head SW facing S
Associated Artifacts:	Olla rim and body sherds
Preservation:	Partial (25-50%)
Age-at-Death Estimation:	Adult?
Biological Sex Estimation:	Male? (femoral head diameter)
Observations:	Indeterminate
Stable Isotope Results:	$\delta^{18}O$: -4.6 (-5.3*) $\delta^{13}C$: -6.4 *adjusted for weaning

Table 8.25 Individual profile of HOL.T.30.33.09.01

HOL.T.30.33.09.01 ("Burial 14") was excavated from Room 2 of Structure 1 of South Group I. The individual was found in Cut 4, which was given the label of Context 32. The feature was 94cm EW by 80cm NS, with bone first found 109cm below datum or 24cm below the floor. This cut, which was identified by the presence of soft plaster that may have covered the burial, was in the northwest corner of the room.

HOL.T.30.33.09.01 was buried in single, primary manner in an elite residence in simple, pit grave with a plaster cap or cover. The individual was articulated in a flexed position in their right side. The body was oriented west to east with the head in the southwest facing south. This interred was accompanied by large sections of an olla rim and body.

HOL.T.30.33.09.01 was partially preserved, with the cranium and pelvis experiencing the most postmortem damage. The long bones were partially preserved, with the lower limbs being more preserved than the upper. The right femoral head was mostly preserved allowing for a diameter measurement. Many feet and hand bones were recovered, while few fragments of ribs and vertebrae preserved. Two teeth were preserved: both left permanent canines.

The individual is estimated to have been an adult, based on the size of the bones and lack of fusion lines on the visible epiphyses (right fibula, right humerus, and both femora). This estimation of age at death is extremely tentative, as these fusions can occur as young as 14 years (Scheuer and Black 2000). The right femoral head was nearly complete, allowing for a tentative measurement of the diameter, 50.70mm, indicating male (Figure 8.72). The skeletal remains, while partially present, suffered from postmortem damage, hindering any paleopathological evaluation.

The enamel of the left maxillary canine was tested for $^{87}Sr/^{86}Sr$, δ18O, and δ13C. The δ18O result was -4.6 (adjusted for weaning to -5.3) and δ13C was -6.4. Unfortunately, the $^{87}Sr/^{86}Sr$ test was unsuccessful and did not result in a ratio for HOL.T.30.33.09.01. Future strontium testing for this individual may clarify their local or non-local origin.

Figure 8.72 Right femoral head of HOL.T.30.33.09.01, demonstrating the state of preservation.

HOL.T.47.05.09-04.01

Individual/Burial ID #:	**HOL.T.47.05.09-04.01; Burial 16**
Laboratory ID #:	HO-16-7
Site:	Holmul
Associated Period/Date:	Late/Terminal Classic (Tepeu 1 vessel AD 600-700)
Year Excavated:	2004 (J. Ebersole)
Archaeological Reports:	-
Dentition Sampled:	Right (?) maxillary third molar
Burial Location and Construction:	South Group I, Structure 103, vaulted residence, simple, simple construction: on plaster floor buried with construction fill
Burial Type, Manner, and Positioning:	Grave interment, single, primary burial, flexed, unknown side, oriented N-S with head to N
Associated Artifacts:	Small ceramic vessel of Macal Variety Orange Red (Tepeu 1 AD 600-700)
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult (18+years)
Biological Sex Estimation:	Indeterminate
Observations:	Indeterminate
Stable Isotope Results:	$\delta^{18}O$: -3.9 $\delta^{13}C$: -5.3

Table 8.26 Individual profile of HOL.T.47.05.09-04.01

HOL.T.47.05.09-04.01 ("Burial 16") was excavated in 2004 from Structure 103 in South Group I at Holmul. Trench 47 was placed east-west on the southern half of the mound. In excavation notes, Ebersole suggests that the burial was interred as Phase II of the structure was being constructed. The body (Context 17) was placed on a plaster floor surface (Context 4) adjacent to a wall (Context 16) and then buried by construction fill (Context 5). When the Maya were constructing Phase II, they were placing additional construction fill (Context 5) on and around the older building (Phase I), which is where the burial was placed and covered.

Figure 8.74 Photo of HOL.T.47 (Image Courtesy of HAP).

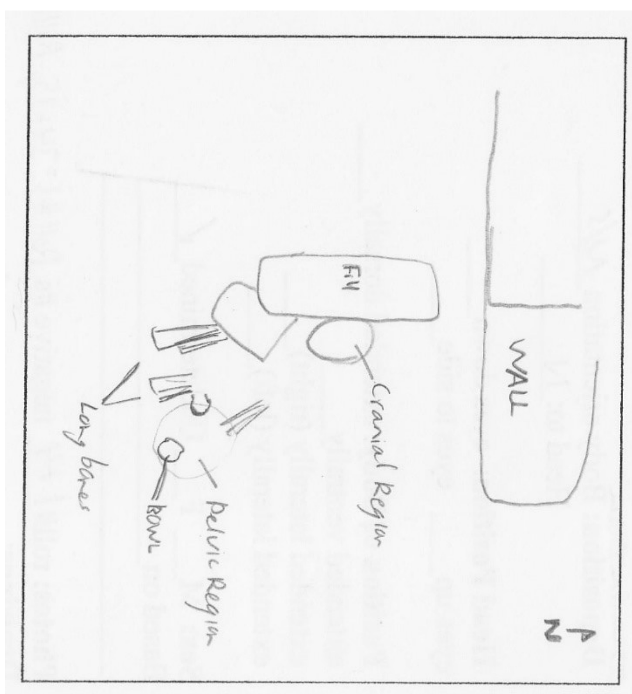

Figure 8.73 Field sketch of HOL.T.47
(Image Courtesy of HAP).

HOL.T.47.05.09-04.01 was a single, primary burial (Figure 8.73) placed during construction of a vaulted residence (vault stones were found). The grave construction (Figure 8.74) is that of a simple, simple interment (a formless grave in construction fill) accompanied by one small pottery vessel (HOL.T.47.17.02.03-04) measuring 4.5cm in height by 4cm in width with a couth 3cm wide. This vessel was judged to be similar to the Macal Variety Orange Red dating to Tepeu 1 or AD 600-700. This vessel was found in association with the pelvic region of the individual. There were no artifacts within the vessel. The skeletal remains were still articulated when excavated suggesting a flexed position, oriented north-south with the head positioned to the north.

The preservation of HOL.T.47.05.09-04.01 is very poor, resulting in a few eroded, long bone fragments and cranial fragments. Two teeth (Figure 8.75) were preserved, (1) an incisor or canine with fragile, cracked roots and an extremely worn occlusal surface (possibly filed?), and (2) a third maxillary molar (perhaps a right?) with a single root. The presence of a third molar, with a completed root, suggests this

Figure 8.75 The two preserved teeth of HOL.T.47.05.09-04.01.

individual was an adult of at least 18 years of age at death (Thoma and Goldman 1960). Due to the fragmentary and eroded nature of the remains, an estimation of biological sex and a paleopathological evaluation were not possible.

The enamel of the right (?) maxillary third molar was tested for δ18O, δ13C, and $^{87}Sr/^{86}Sr$. The δ18O was -3.9 and δ13C was -5.3. Unfortunately, the $^{87}Sr/^{86}Sr$ test was unsuccessful and did not result in a ratio for HOL.T.47.05.09-04.01. Future strontium testing for this individual may clarify their local or non-local origin.

HOL.T.28.33.09.01

Individual/Burial ID #:	**HOL.T.28.33.09.01; Burial 17**
Laboratory ID #:	HOL-16-8
Site:	Holmul
Associated Period/Date:	Late/Terminal Classic
Year Excavated:	2004 (Ebersole)
Archaeological Reports:	-
Dentition Sampled:	Right first maxillary molar
Burial Location and Construction:	South Group I, Structure 101, Room 1, elite residence, simple, (unnamed) grave, in bench
Burial Type, Manner, and Positioning:	Primary, single interment, flexed on the right, N-S, head NW facing SW
Associated Artifacts:	Unslipped ceramic olla (Bayal: Late to Terminal Classic)
Preservation:	Complete (75-100%)
Age-at-Death Estimation:	Adult (20s-30s: pubic symphysis, clavicle, third molars)
Biological Sex Estimation:	Male? (the right subpubic cavity, ischiopubic ramus ridge, mental eminence)
Observations:	Dental caries, dental modification, path on left first distal foot phalanx
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70817, $\delta^{18}O$: -4.5 (-5.2*) δ13C: -4.9 **local** *adjusted for weaning

Table 8.27 Individual profile of HOL.T.28.33.09.01

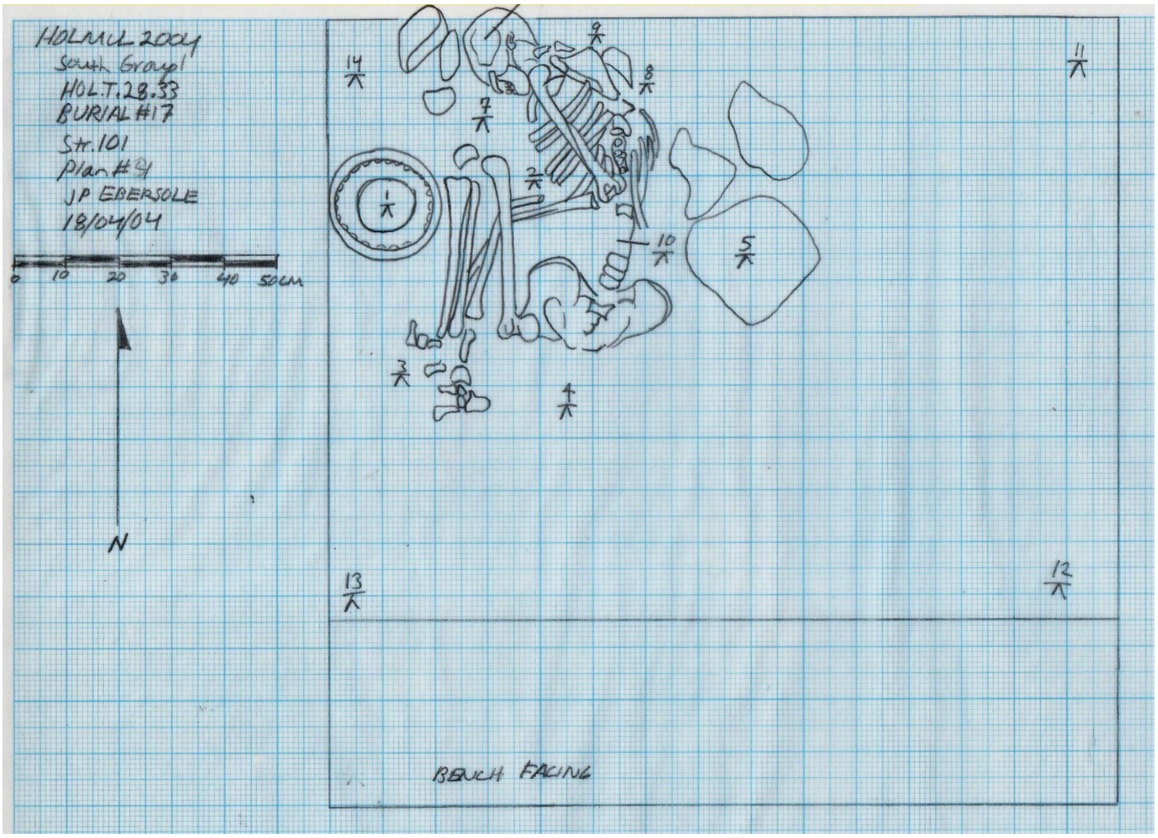

Figure 8.76 Burial Plan of HOL.T.28.33.09.01 (by J. Ebersole) (Image Courtesy of HAP).

HOL.T.28.33.09.01 ("Burial 17") was excavated from a plastered bench in Room 1 of Structure 101 in South Group I. In Trench 28, the burial was labeled Context 33 and located in the northwest corner of the room against the north and west walls.

This primary, single interment was found in South Group I, Structure 101, Room 1. HOL.T.28.33.09.01 was buried in a flex position on their right side with a North-South orientation. The head was positioned in the northwest facing southwest (Figure 8.76). The individual was buried just under a plaster surface of a bench during Phase II of construction. The excavators suggest that the individual could have been deposited during construction of the bench or after its completion (or even just for this burial). They

Figure 8.77 Burial photo of HOL.T.28.33.09.01 (Image Courtesy of HAP).

conclude that a burial cut was made into the plaster surface of the bench. The fill of the burial was similar to the fill of the bench, suggesting to the excavators that the bench fill was reused during burial. Further, they postulate that the apparent ring of stones around the burial was not an intentional placement of stones (like a cist), but instead the result of removal of inner stones to provide space for the body. This categorizes the construction of the grave as a simple (unnamed) type, where the interment is placed in a feature to give the appearance of a stone-lined grave or cist (Figure 8.77). The only associated artifact (Figure 8.78) within this burial was an unslipped ceramic olla (HOL.T.28.33.02.08) of the Bayal type, dating to the Late to Terminal Classic. This olla

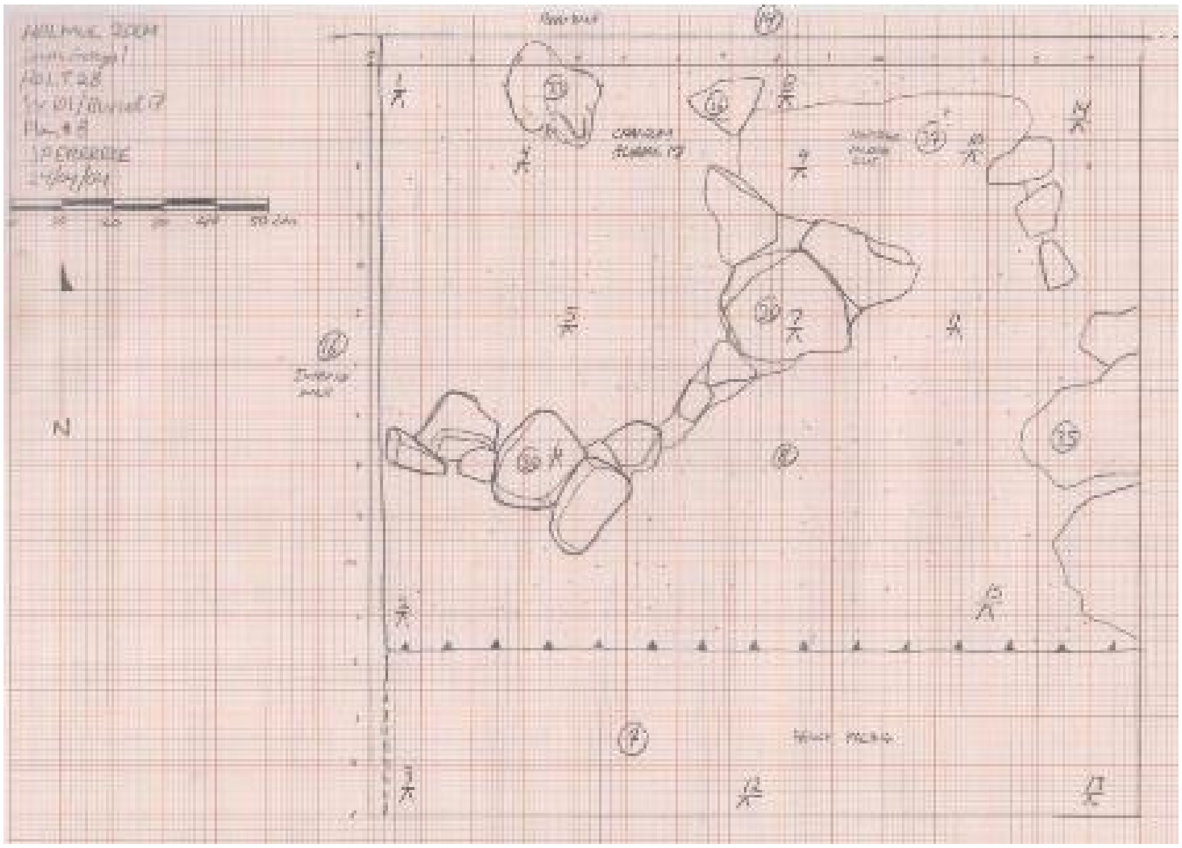

Figure 8.78 Plan of grave construction for HOL.T.28.33.09.01 (by J. Ebersole) (Image Courtesy of HAP).

was placed immediately west of the body, between the body and the wall (context 16) that separated Room 1 and Room 2.

HOL.28.33.09.01 was mostly complete, except for the fragmented cranium. The mandible was partially complete with some teeth remaining in situ. The dentition was mostly complete, only missing the mandibular incisors (although only two alveolar sockets remains for all the mandibular incisors, so the two incisors may have been lost antemortem), a right maxillary premolar, and the two third maxillary molars. The vertebral column was very fragmented, although 22 ribs in good condition, including both first ribs. The appendicular body was partially complete, with fragmented scapulae, partial clavicles, and a partially complete os coxae. All of the long bones were represented, mostly by shafts only and fragmented distal epiphyses. The right humerus was mostly complete, allowing for some measurements. The hand and feet were well preserved.

While the pelvis and cranium were partially preserved, an estimation can be suggested that HOL.T.28.33 was an adult male. The completed roots of the mandibular third molars suggest an individual greater than 18 years of age at death (Thoma and Goldman 1960). The fused medial epiphyses of the clavicle suggests an individual older than 20 years of age at death (if male, then older than 21 years of age) (Webb and Suchey 1985). The pubic symphyses scored a 4 on the Todd system, suggesting an age range of 25 to 26, and a 2 on the Suchey-Brooks system, suggesting an age range of 19 to 34 with a mean of 23.4 for males and 19 to 40 with a mean of 25 for females. HOL.T.28.33 is estimated to be biologically male, from the right subpubic cavity and ischiopubic ramus ridge both scoring as 3 (male), and a pronounced mental eminence (scored as 4).

The paleopathological evaluation revealed some minor pathological changes and dental modification. The proximal end of the first distal phalanx of the left foot had active bony addition, perhaps in reaction to a break of the hallux. The right third mandibular molar had dental caries on the distal surface of the crown causing a fracture to the crown, most likely postmortem. The dentition had little occlusal wear, only minorly on the mandibular canines. The central maxillary incisors were modified (LI1 as A4 or B6 and RI1 as B4) (Romero 1970).

The enamel of the right maxillary first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70817, while the $\delta^{18}O$ was -4.5 (adjusted to -5.2 for weaning) and $\delta^{13}C$ was -4.9. Statistically, HOL.28.33.09.01 was not considered an outlier for any of the stable isotope tests and most likely was local to Holmul or the Holmul region.

Considering the Burials of Holmul, South Group I.

The burials excavated from South Group I of Holmul can be separated temporally and geographically into the burials of Structure 1 and the burials from the later, low mounds on the plaza. HOL.T.28.04.08.01 was found in a simple pit grave cut into the floor in front of a bench in Room 1 of Structure 1. Further mortuary data is not available, although the osteological evaluation revealed paleopathology that indicated an active bone infection of the left elbow. Stable isotope data suggests that this was an individual local to Holmul or the Holmul region.

HOL.T.30.20.09.01 was excavated from a cut through the floor in the southeastern corner of Room 2, on the other side of the wall from HOL.T.28.04.08.01 in Room 1. HOL.T.30.33.09.01 was an additional simple pit burial cut into the floor of Room 2, located in the northwest corner of the room. Both of the individuals from Room 2 were placed flexed and facing towards the interior of the room. A sherd found in HOL.T.30 is identified as Zacatel Cream Polychrome: Zacatel Variety, which dates to the middle of the Late Classic period (Callaghan 2016). It is worthy of note that the female individual (HOL.T.30.20.09.01) in Room 2 had a possible non-local origin, which suggests a patrilocal residency.

The low mounds of South Group I are thought to have been later additions to the plaza, perhaps indicating a reoccupation of the group. HOL.T.28.33.09.01 from Structure 101 was interred with an unslipped ceramic olla (HOL.T.28.33.02.08) of the Cambio Unslipped: Variety Unspecified of the Late Classic. The burial of HOL.T.47.05.09-04.01 from Structure 103 included a small ceramic vessel (HOL.T.47.17.02.03-04), which the excavators thought to have been similar to the Macal Variety of Orange Red vessels dating to the Late Classic.

The mound in which HOL.T.37.09.01 was interred was of a building in a significantly different architectural design and construction than the primary structures. Because of the lack of cardinal alignment, narrow doorways, and thin plaster floors, the excavators posited that this was a later reoccupation of the group, perhaps in the Terminal Classic. Further, the stable isotope analyses suggested their non-local origin, which is interesting considering the differing architectural design of the mound. The ceramics from Structures 101 and 103, along with the different architectural design, suggest the low mounds of South Group I were constructed after the primary structures, although at this point, there is little evidence that is was in the Terminal Classic rather than the Late Classic.

The burials of these low mounds were not in clear cuts into a plaster floor, as compared to the Structure 1 burials. HOL.T.37.09.01 seemed to have been placed adjacent to a wall. HOL.T.47.05.09-04.01 was placed on a plaster floor and the room was subsequently filled in. HOL.T.28.33.09.01 was within or under a bench. They all seem to have been placed in a flexed position, although it remains unclear with HOL.T.37.09.01.

Holmul, South Group I

HAP ID	HOL.T.28.04.09.01	HOL.T.30.20.09.01	HOL.T.37.09.01	HOL.T.30.33.09.01	HOL.T.47.05.09-04.01	HOL.T.28.33.09.01
Sample ID	HO-16-3	HO-16-4	HO-16-5	HO-16-6	HO-16-7	HO-16-8
also known as	HAP 2	HAP 9	HAP 12	HAP 14	HAP 16	HAP 17
Period	Late Classic	Late Classic	Terminal Classic	Late Classic	Late/Terminal Classic	Late/Terminal Classic
Age-at-Death	Adult (18+yrs)	Adult (20-33yrs)	Adult?	Adult?	Adult?	Adult (20s-30s)
Biological Sex	Indeterminate	Female	Indeterminate	Male?	Indeterminate	Male?
Dental Pathology	LEH	LEH, dental modification, dental calculus, resorbed mandibular sockets,	Mandibular alveolar resorption			Dental caries, dental modification, little occlusal wear
Pathology	Lesions (infection) on proximal, medial surfaces of radius and ulna	osteophyte addition to vertebral bodies				path on hallux
Burial Type	Grave interment	Grave interment	Grave interment	Grave interment	Grave interment	Grave interment
Burial Manner	Primary, single	Primary, single	Primary, single	Primary, single	Primary, single	Primary, single
Body Positioning	?	Flexed, left side, S-N, facing N	Right side, S-N	Flexed, right side, W-E, facing S	Flexed, N-S	Flexed, right side, N-S, facing SW
Burial Location	Elite residential, placed in floor in front of bench	Elite residential, placed in floor SE corner of room	Housemound or house platform	Elite Residential, placed in floor NW corner of room	Elite residential, placed on floor covered by construction fill	Elite residential, placed in bench in NW corner of room

Grave Construction	simple, pit	simple, pit	unclassifiable (simple, simple?)	simple, pit	simple, simple	simple, (unnamed)
Associated Artifacts	None mentioned	Bone with drill hole	None	Olla fragments	Small ceramic vessel	Olla vessel
Tooth Sampled	LM^1	LM^1	LC_1	LC^1	M^3	RM^1
$^{87}Sr/^{86}Sr$	0.70808	0.70847	0.70853			0.7082
$\delta^{18}O_{ap}$	-6.9 (-7.6*)	-4.3 (-5.0*)	-4.4 (-5.1*)	-4.6 (-5.3*)	-3.9	-4.5 (-5.2*)
$\delta^{13}C_{ap}$	-4.1	-5.4	-8.2	-6.4	-5.3	-4.9
Local or Non-Local	Local	Non-local?	Non-local?			Local

Table 8.28 Summary of the burials of Holmul South Group I

The Osteobiographies of Burials from Unclear Contexts

HOL.T.24.23.07.01

Individual/Burial ID #:	**HOL.T.24.23.07.01**
Laboratory ID #:	HO-16-2
Site:	Holmul
Associated Period/Date:	Late/Terminal Classic
Year Excavated:	2002(?)
Archaeological Reports:	*Archaeological Investigations at Holmul, Petén, Guatemala: Preliminary Results of the Third Season, 2002*
Dentition Sampled:	Mandibular right first molar
Burial Location and Construction:	Group 13, residential
Burial Type, Manner, and Positioning:	Unknown
Associated Artifacts:	Unknown
Preservation:	Fragmentary (0-25%): singular tooth
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Large dental caries at lingual CEJ
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70809, $\delta^{18}O$: -3.0 (-3.7*) $\delta^{13}C$: -3.4 **local** *adjusted for weaning

Table 8.29 Individual profile of HOL.T.24.23.07.01

In 2002, Mario Penados and Edy Barrios conducted excavations in Group 13 of Holmul. Group 13 is a large residential group located a few meters to the south of the Group II ritual complex. Late Classic and Terminal Classic material has been found at this group. Barrios placed a 3x3 unit (T.24) that revealed two walls constructed of large roughly cut stones and pebbles. These two walls were placed roughly 2 meters apart, leading Barrios to suggest this was either a small structure or the construction of consecutive walls to enclose the courtyard. The 2002 report, *Archaeological Investigations at Holmul, Petén, Guatemala: Preliminary Results of the Third Season, 2002*, mentions a “poorly preserved burial found accompanied by a coarse, straight walled bowl of probably Terminal Classic date” (Estrada-Belli 2002:8). This burial was documented as HOL.T.24.10 ("Burial 3"). It is possible that single molar found and packaged HOL.T.24.23.07.01 is from this burial, but it is impossible to know as the documentation is lacking. The packaging of this tooth also indicates "Groupo 13, 2004," which is unusual since Group 13 was only excavated in 2002. It is possible this tooth was repackaged in 2004, resulting in that date on the tinfoil.

As mentioned above, the report from 2002 briefly states that HOL.T.24.10 was poorly preserved, but found with a bowl. The field drawings (Figure 8.79) for this burial suggest a flexed burial on the individual's left, oriented north-south (head to the north).

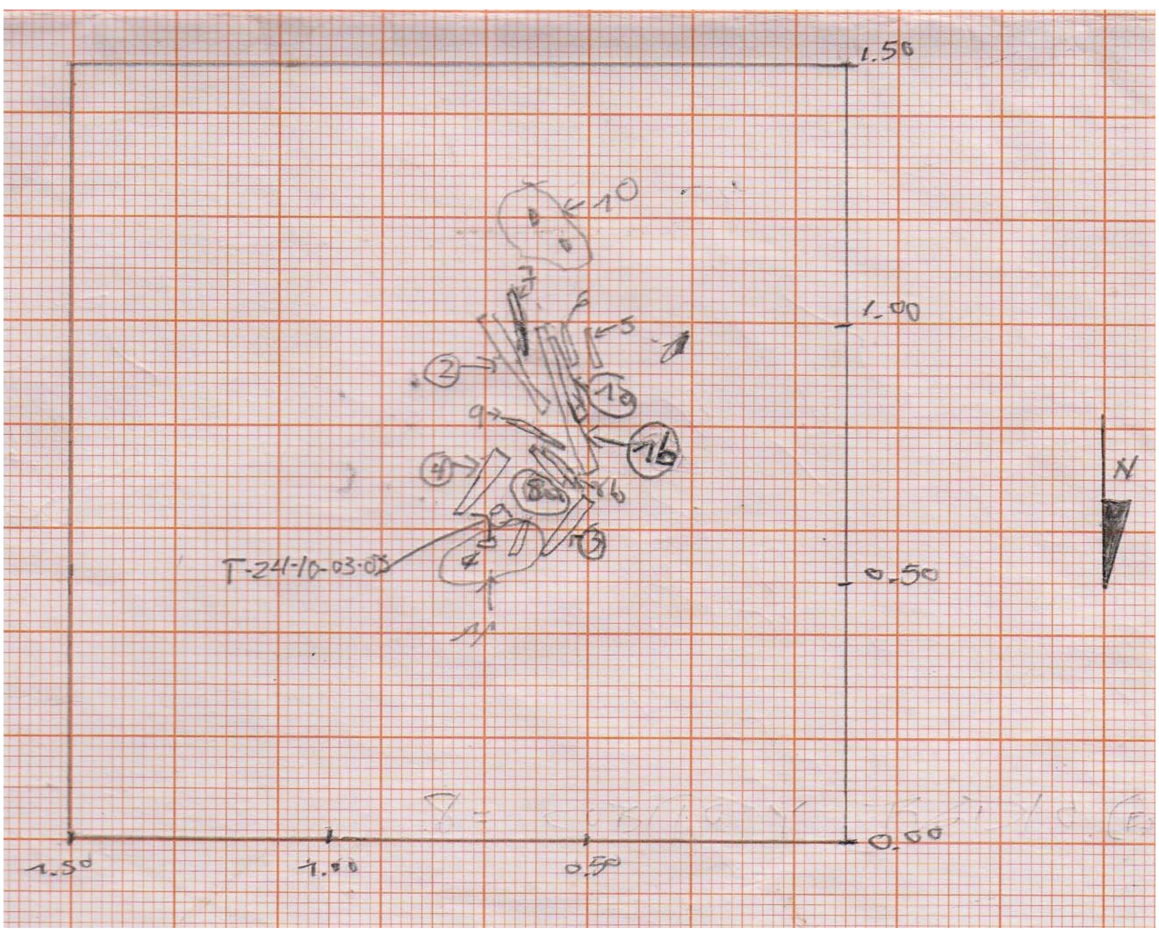

Figure 8.79 Field sketch of HOL.T.24.10 (drawing by Edy Barrios) (Image Courtesy of HAP).

Figure 8.80 Right mandibular first molar of HOL.T.24.23.07.01.

The drawing also positions the bowl near the head of the individual. The simple-simple grave was found located in a residential context (housemound/house platform). Again, it is impossible to say if the molar found corresponds with HOL.T.24.10.

The single molar (Figure 8.80), labeled HOL.T.24.23.07.01, was identified as a right first mandibular molar. Due to the completed root formation, it is likely that this individual was at least eight years of age at death (Thoma and Goldman 1960; Smith 1991), but could have been any age older than eight years. Due to the singular molar, the estimated biological sex of the individual is indeterminate. The molar has large dental caries on the lingual surface at the cementum enamel junction.

The enamel of the right first mandibular molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70809, while the $\delta^{18}O$ was -3.0 (adjusted to -3.7) and $\delta^{13}C$ was -3.4. Statistically, HOL.T.24.23.07.01 was not an outlier and most likely from Holmul or the Holmul region.

11-6-20/58620.01

Individual/Burial ID #:	**11-6-20/58620.01; "Burial 3"**
Laboratory ID #:	HO-16-23
Site:	Holmul
Associated Period/Date:	Unknown (Classic?)
Year Excavated:	1910-1911
Archaeological Reports:	-
Dentition Sampled:	Right second maxillary molar
Burial Location and Construction:	Unknown
Burial Type, Manner, and Positioning:	Unknown
Associated Artifacts:	Unknown
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult?
Biological Sex Estimation:	Indeterminate
Observations:	Occlusal wear
Stable Isotope Results:	^{87}Sr/^{86}Sr: 0.70825 δ18O: -3.9 (-4.2*) δ13C: -3.6 **local** *adjusted for weaning

Table 8.30 Individual profile of 11-6-20/58620.01

There is no contextual information for this burial, except for the label of "Burial 3" by the Peabody Museum. Possible burials include Skeleton 3 from Ruin X and Skeleton 3 from Group II Building B. Due to the complete lack of context, a mortuary analysis is not possible. An osteological evaluation was conducted at the Peabody Museum. There were very few skeletal elements preserved. A few unidentifiable cranial fragments were present, along with one lateral maxillary incisor, one maxillary canine with occlusal wear, three maxillary premolars, a right second maxillary molar, a maxillary third molar, and an occusally worn second mandibular molar. Other dentition included a fragmented molar, a very worn tooth (third molar or premolar), and three additional premolars and a right first maxillary molar without wear. It is possible that the usually unworn first molar could indicate a second person. An unidentifiable vertebral fragment and two rib fragments were preserved. The medial portion of the left clavicle was preserved, with a large, fused medial epicondyle, suggesting an adult individual. A fragment of the proximal right ulna was preserved, along with two other fragments of long bone shafts.

The enamel of the right second maxillary molar (Figure 8.81) was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70825, while the $\delta^{18}O$ result was -3.9 (adjusted for weaning to -4.2) and $\delta^{13}C$ was -3.6. Statistically, 58620.01 was not an outlier and most likely from Holmul or the Holmul region.

Figure 8.81 Right second maxillary molar of 11-6-20/58620.01; “Burial 3”.

La Sufricaya

The Osteobiographies of La Sufricaya, Group I, Structure 1

The majority of excavations at La Sufricaya, from 2001 to 2005, focused on the large structure on the main group (Figures 8.82 and 8.83). This structure houses the Early Classic polychrome painted murals, depicting the elites of La Sufricaya and their interactions with Teotihuacanos. Special attention was paid to understanding the architectural sequencing of the structure, its function, and the preservation of the murals. The earliest identified construction phase (Phase II) consisted of Room 1, also referred to as Structure 1 Sub 1, a simple building positioned on a 30cm high plinth on the northwestern corner of the raised court of Group I (Estrada-Belli 2002). Tzakol 3 ceramics found associated with this phase suggest an Early Classic date. Another room (Structure 1 Sub 3) has been interpreted as a small temple or shrine, suggesting a ceremonial function of the complex during this phase (Estrada-Belli 2003b).

During the next phase of construction (Phase III), the room's roof was razed, the room was filled with rubble, and a new plastered platform floor was constructed over the building of the previous phase (Estrada-Belli 2002). Numerous rooms were constructed during this time. A 30cm high two-course stone bench, oriented on the central axis running east-west, was constructed in the center of the complex (SUF.ST.20). A staircase covered in polychrome plaster was also built during this phase (Estrada-Belli 2003b). Tzakol 3 ceramics also date this possible palace phase of the building to the Early Classic period. At some point, this construction was buried in rubble and sealed by a plaster floor. A subsequent phase (Phase IV) consisted of Late or Terminal Classic perishable buildings, possibly residences, built upon the now flat surface.

Two burials from Structure 1 have been selected for analysis due to the presence of dentition for stable isotope analysis. The first was that from the excavation SUF.ST.09 on the eastern edge of the structure, and the second from SUF.ST.20 where the bench was discovered.

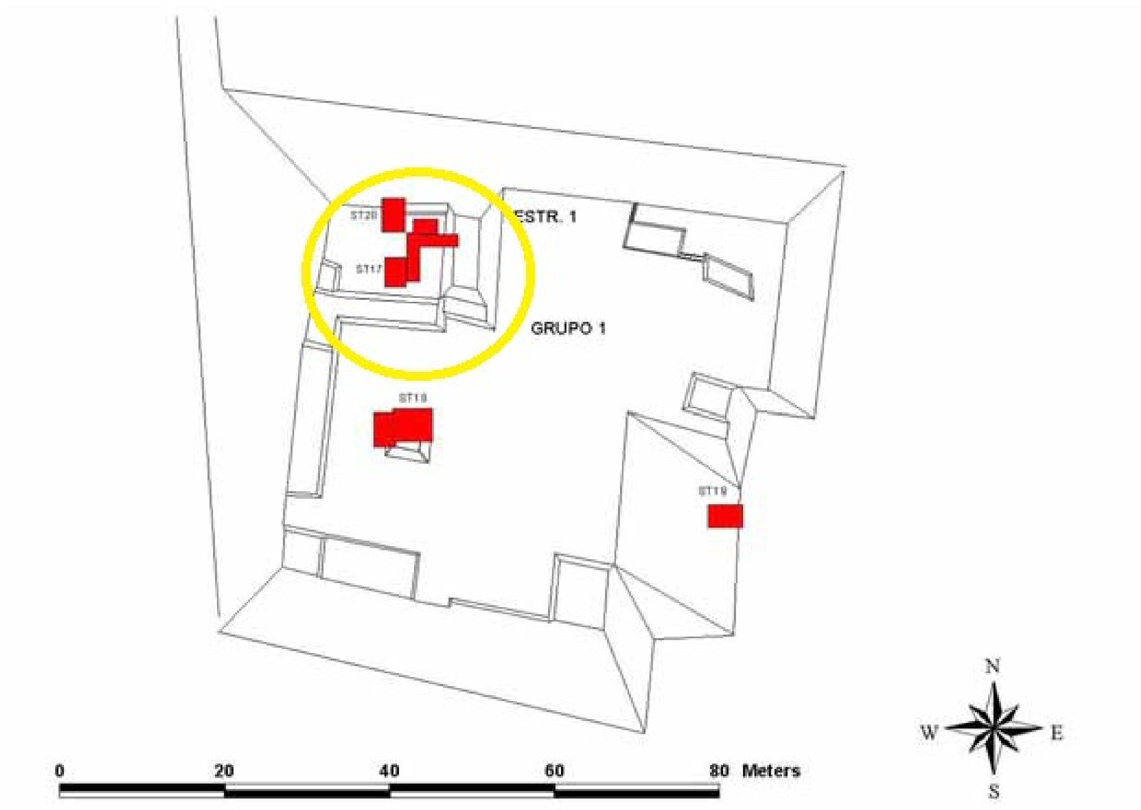

Figure 8.82 Plan view of Group I with Structure 1 encircled in yellow. Adapted from Estrada-Belli 2003b:17.

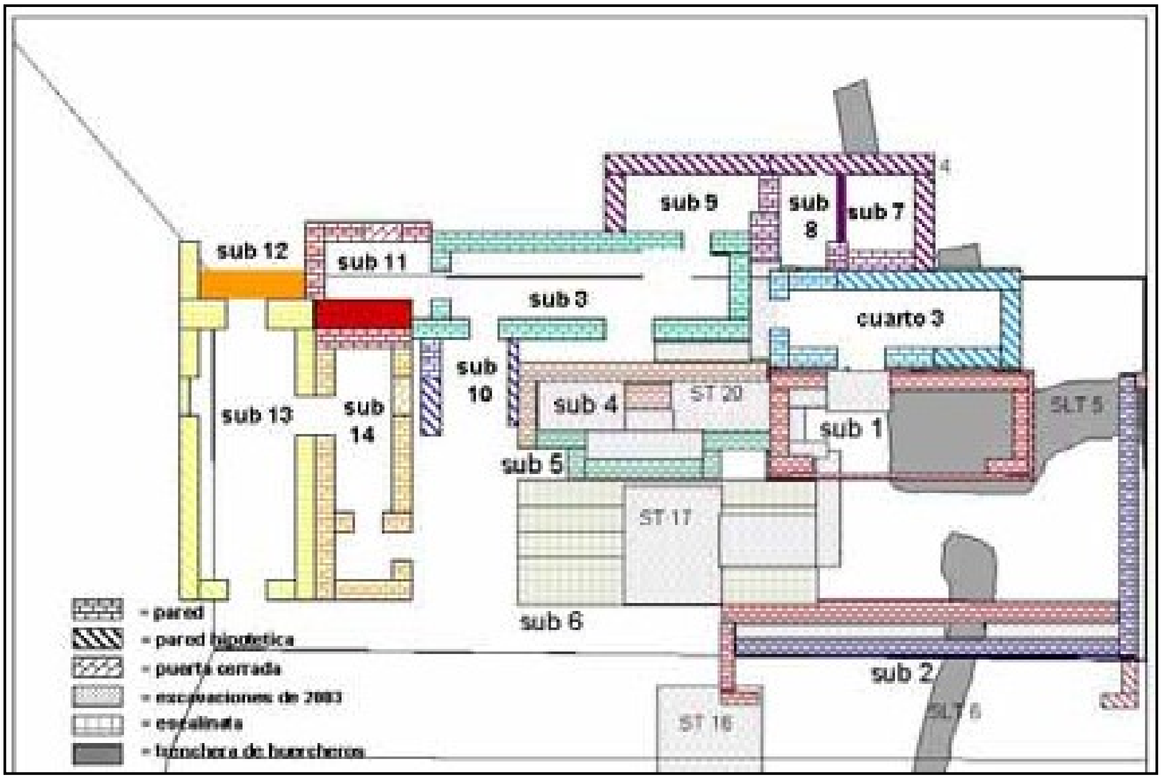

Figure 8.83 Plan drawing of Structure 1 at La Sufricaya (Estrada-Belli 2004b: Figure 8).

SUF.ST.09.02.09.03.01 (?)

Individual/Burial ID #:	**SUF.ST.09.02.09.03.01(?); HAP Burial #6**
Laboratory ID #:	SUF-16-26
Site:	La Sufricaya
Associated Period/Date:	Early Classic (?)
Year Excavated:	2002
Archaeological Reports:	-
Dentition Sampled:	Left first maxillary molar
Burial Location and Construction:	Group I, Structure 1
Burial Type, Manner, and Positioning:	Unknown
Associated Artifacts:	Unknown
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Infans II (11±2.5yrs)
Biological Sex Estimation:	Indeterminate
Observations:	Dental calculus, filing/wear?
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70842, $\delta^{18}O$: -5.1 (5.8*) $\delta^{13}C$: -6.9 **local** *adjusted for weaning

Table 8.31 Individual profile of SUF.ST.09.02.09.01

Very little contextual information is available regarding the excavation of the burial SUF. ST.09.02.09.01. The labeling of the burial suggests that it was excavated from ST 09 (Figure 8.84), which was an extension unit south off of the looter's trench SLT05 of Structure 1 at La Sufricaya. Further description of the mortuary context is not available.

The skeleton of SUF.ST.09.02.09.01 is fragmentary with some cranial fragments, partial dentition, and a few long bone fragments present for analysis. The mandible is mostly complete (Figure 8.85), as is the anterior portion of the maxilla (Figure 8.86). The only tooth in situ is that of the left first mandibular molar. The alveolar sockets are

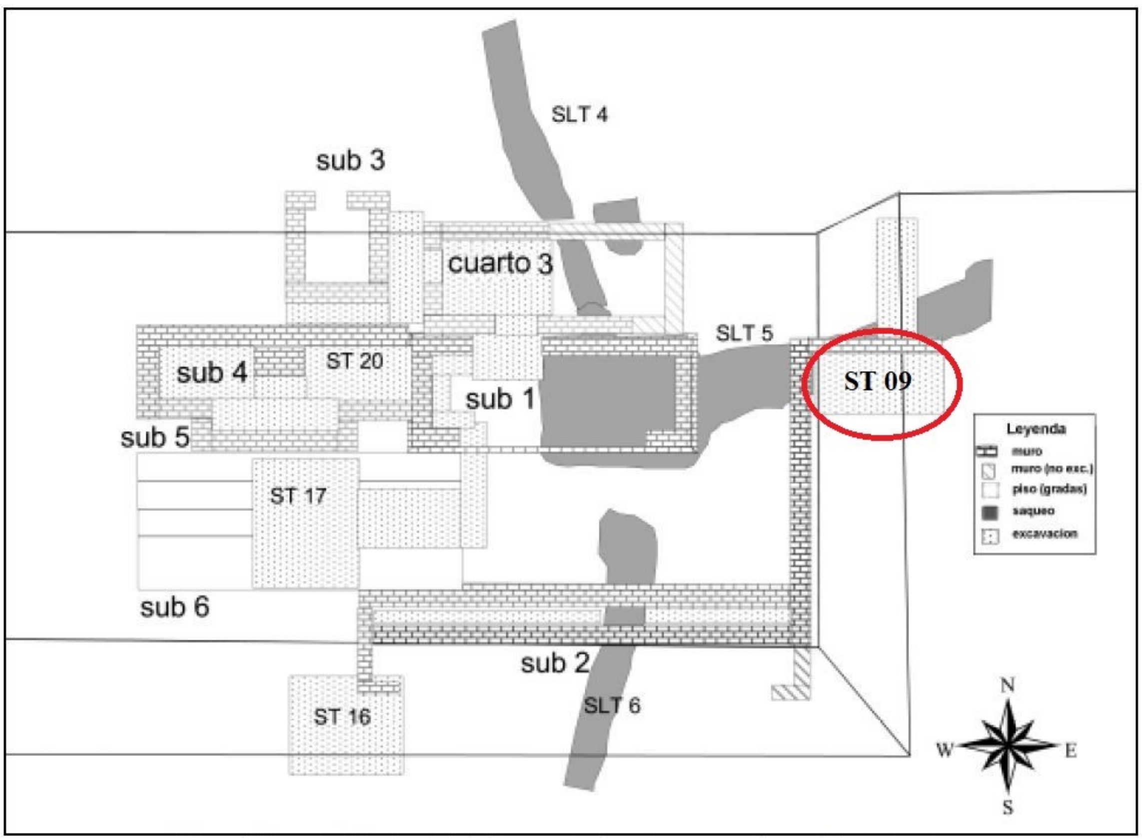

Figure 8.84 Plan drawing of Structure 1 at La Sufricaya with excavation ST.09 encircled in red. Adapted from Estrada-Belli 2003b:30.

Figure 8.85 Mandible of SUF.ST.09.02.09.03.01.

mostly available to observe, while the dentition is only partially present (Figure 8.87). Based on the eruption of only the first molars, using Ubelaker's (1999) chart, this individual has an estimated age-at-death of 11 ± 2.5 years. Considering that the roots of the premolars have not yet completed forming, the estimation technique of Thoma and Goldman (1960) concurs with Ubelaker's chart with the estimation of 10-13 years. Aside from dental calculus and possible dental filing (also possibly occlusal wear), no paleopathological changes were observed.

In 2013, Friedrich selected the right first maxillary molar for stable isotope analysis of $\delta^{18}O$ and $^{87}Sr/^{86}Sr$. She reported the $^{87}Sr/^{86}Sr$ ratio was 0.7076 and the $\delta^{18}O$ (converted to δ18O of ingested water) was -1.7. For this study, the $^{87}Sr/^{86}Sr$ ratio for the left first maxillary molar was 0.70842, while the $\delta^{18}O$ ratio was -5.1 (adjusted for weaning to 5.8) and the $\delta^{13}C$ was -6.9. Friedrich's (2013) $^{87}Sr/^{86}Sr$ results suggest that

Figure 8.86 Maxilla of SUF.ST.09.02.09.03.01.

this individual may not have been local, but the statistical analysis of this study disagrees and suggests that SUF.ST.09.02.09.03.01 was a local individual to La Sufricaya.

Figure 8.87 Dentition of SUF.ST.09.02.09.03.01.

SUF.ST.20.27.09.01

Individual/Burial ID #:	**SUF.ST.20.27.09.01; HAP Burial #11**
Laboratory ID #:	SUF-16-27
Site:	La Sufricaya
Associated Period/Date:	Early Classic?
Year Excavated:	2003 (J. Foley)
Archaeological Reports:	*Archaeological Investigations in the Holmul Region, Petén: Preliminary Results of the Fourth Season, 2003*
Dentition Sampled:	Right first mandibular molar
Burial Location and Construction:	Group I, Structure 1
Burial Type, Manner, and Positioning:	Simple, simple, bundle?
Associated Artifacts:	Textile impression on plaster
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Occlusal wear and caries
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70848, $\delta^{18}O$: -6.0 (-6.7*) $\delta^{13}C$: -5.8 **local** *adjusted for weaning

Table 8.32 Individual profile of SUF.ST.20.27.09.01

In 2003, SUF.ST.20.27.09.01 was recovered during excavations in Group I, Structure 1 of La Sufricaya. While the report from that field season does not mention the burial, it does mention the excavations of SUF.ST.20 (Estrada-Belli 2003b). Field notes further elaborate upon this unit and mention the burial. Unit SUF.ST.20 (Figure 8.88) began as a 2x2.5 m trench, which was later expanded one meter to the west and one meter to the north, stretching over the northern edge of Structure 1. This unit revealed various construction phases, as well as the elaborate stucco frieze of the western face of Structure 1 sub 1, and the possible throne bench. The burial was placed within a cut (SUF.ST.20.26) into a limestone plaster floor (SUF.ST.20.19). The excavator remarks in her notes that a piece of plaster associated with the burial contained textile impressions, which may suggest that the individual was buried within a textile wrapped bundle. Little temporal information is supplied, excepting that all of the construction phases of Structure 1 occurred during the Early Classic period (Estrada-Belli 2003b).

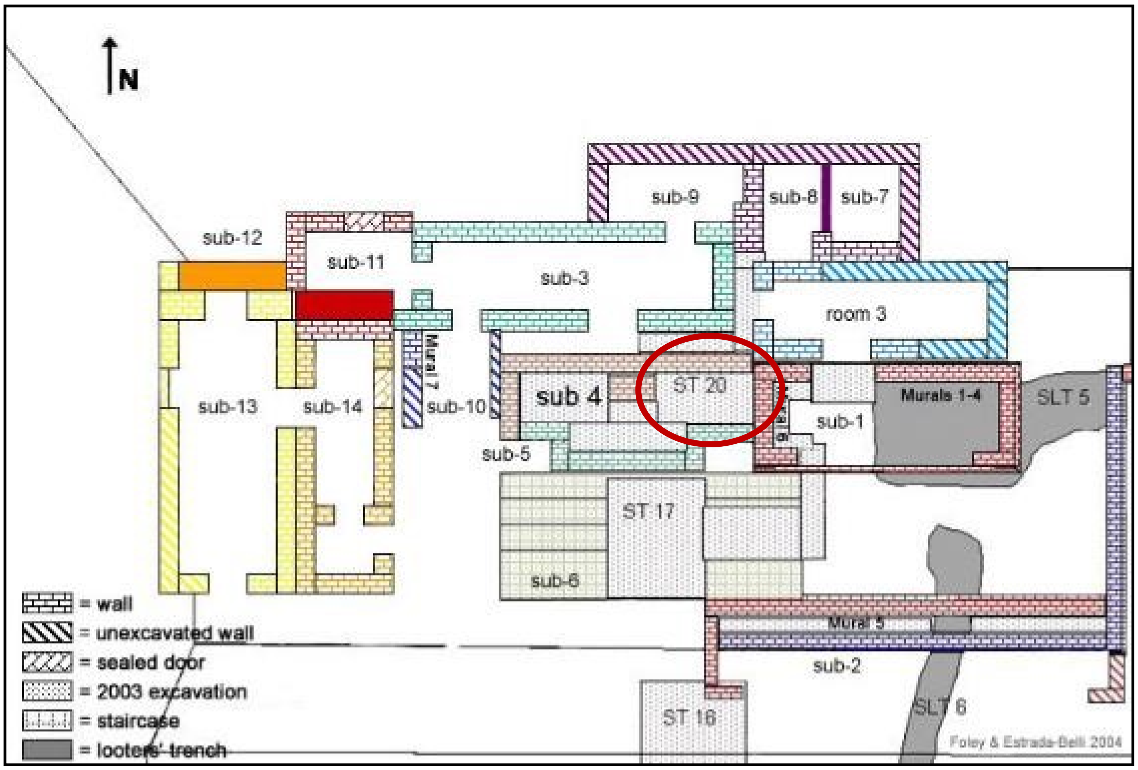

Figure 8.88 Plan drawing of Structure 1 at La Sufricaya with excavation ST.20 encircled in red. Adapted from Estrada-Belli 2004b: Figure 8.

The skeletal remains of SUF.ST.20.27.09.01 are extremely fragmentary and eroded (Figure 8.89) . The fragments preserved include a possible os coxae fragment, three fragments of a tibia, various long bone fragments, and two vertebral arch fragments. The dentition (Figure 8.90) preserved include one mandibular premolar with an extremely eroded root, one maxillary premolar without a preserved root, one mandibular incisor with an eroded root, and three molars without preserved roots, but with occlusal wear and occlusal caries. Due to preservation and taphonomic processes, it is not possible to estimate age-at-death or biological sex.

Figure 8.89 Long Bone Fragments of SUF.ST.20.27.09.01.

In 2013, Friedrich selected the left first maxillary molar for stable isotope analysis of $\delta^{18}O$ and $^{87}Sr/^{86}Sr$. She reported the $8^{87}Sr/^{86}Sr$ result was 0.7085 and the $\delta^{18}O$ (converted to $\delta^{18}O$ of ingested water) was -3.2. For this study, the right first mandibular was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70848, while the $\delta^{18}O$ was -6.0 (adjusted to -6.7) and the $\delta^{13}C$ was -5.8. Statistically, SUF.ST.20.27.09.01 was not an outlier and most likely from La Sufricaya or the Holmul region.

Figure 8.90 Dentition of SUF.ST.20.27.09.01.

The Osteobiographies of La Sufricaya, Group I, Structure 146

Structure 146 of La Sufricaya is one of the small mounds to the south of Structure 1 on the platform that is Group I (Figure 8.91). This structure was first excavated in 2003 (SUF.SL.07 and SUF.ST.18) to identify its construction phases. SUF.ST.18 was expanded in 2004 with the operation SUF.T.23 to understand the western extent of Structure 146 and understand its relationship to its neighbor to the northwest, Structure 148.

Initially, Structure 146 was hypothesized to have functioned as a temple platform or funerary shrine associated with the Early Classic phase of Structure 1 (Estrada-Belli

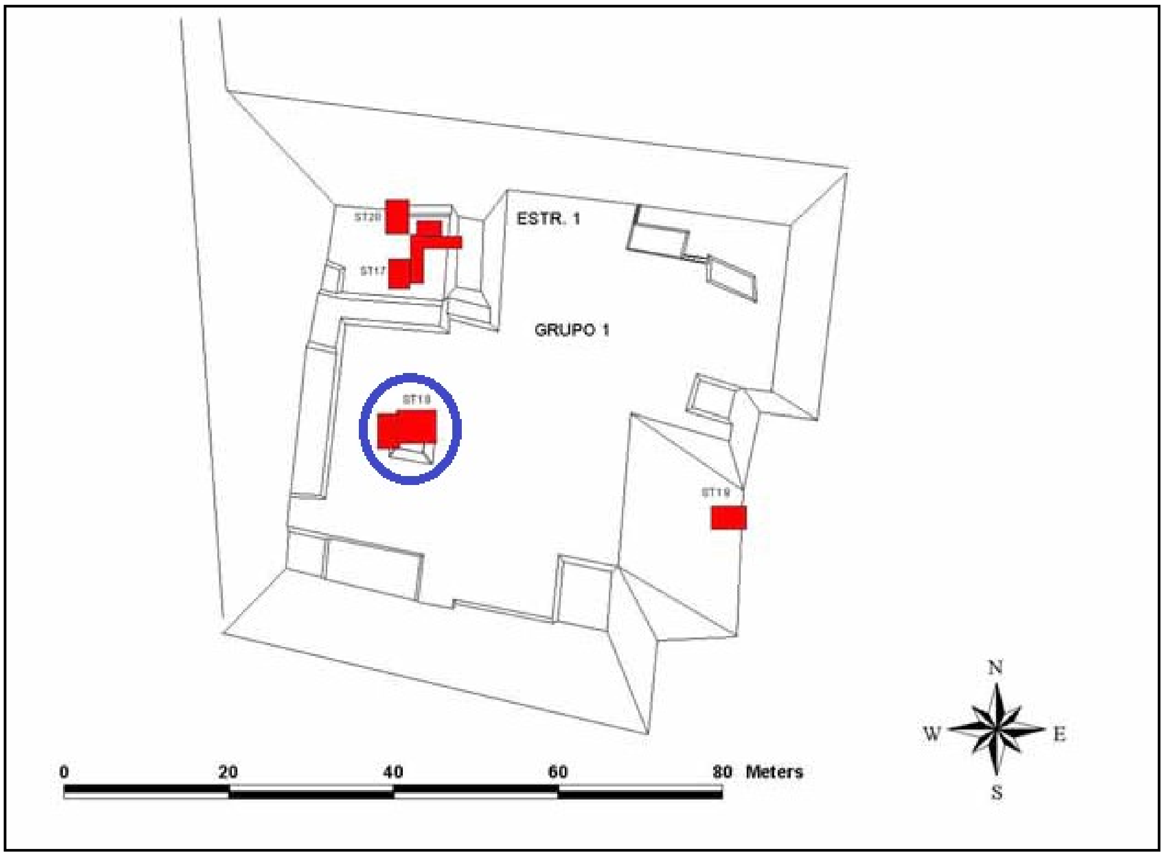

Figure 8.91 Plan view of Group I of La Sufricaya. Structure 146 in blue circle. Excavations from 2003 in red. Adapted from Estrada-Belli 2003b:17.

2003b). With the continued investigations in 2004, excavations revealed an Early Classic rectangular vaulted structure with carved blocks forming the walls. At the end of the Early Classic, this structure was demolished and two low platforms were constructed, possibly supported perishable residential structures (Estrada-Belli 2004b). The three mortuary contexts of Structure 146 (Figure 8.92) were associated with this Late Classic occupation: SUF.T.23.56.09.01 (HAP Burial #18), SUF.T.23.54.09.01 (HAP Burial #19), and SUF.T.23.66.09.01 (HAP Burial #21). The individuals from Burials 19 and 21 were selected for analysis due to the availability of dentition for stable isotope analysis.

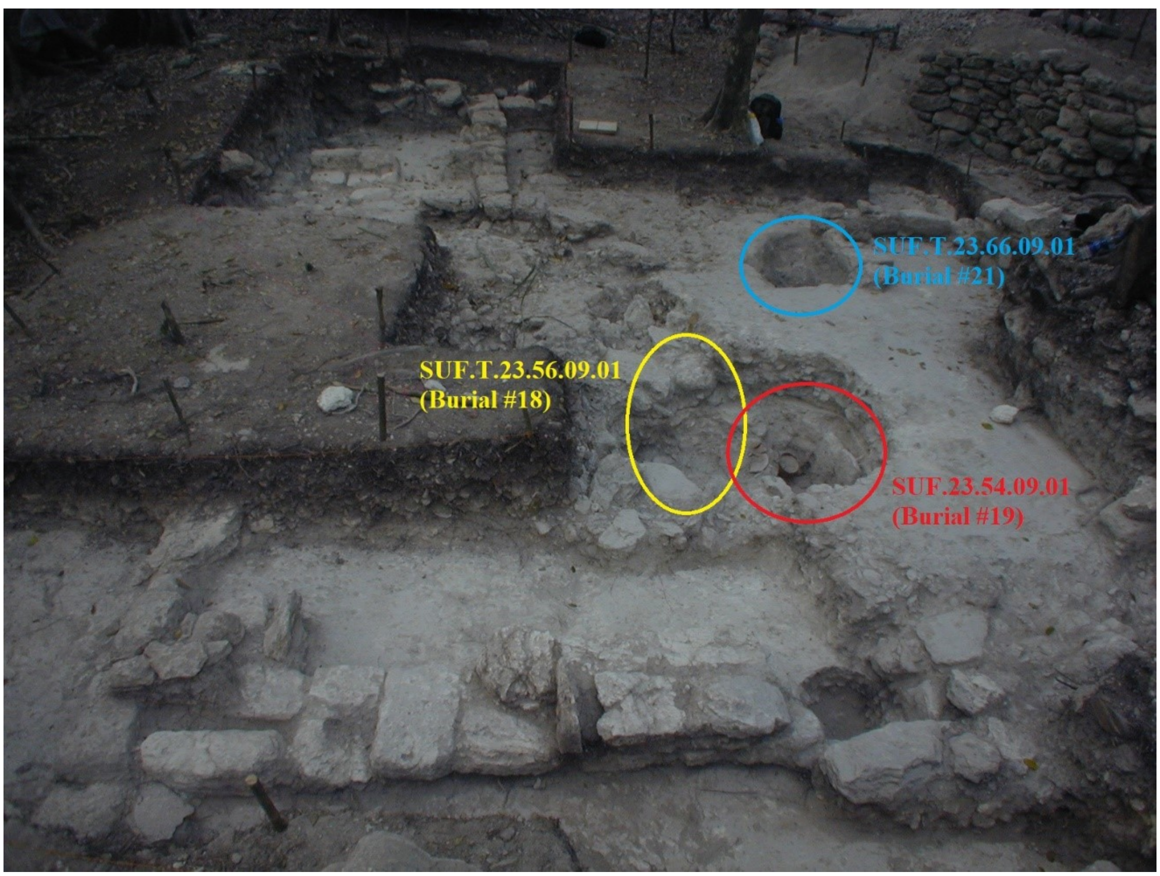

Figure 8.92 View from the south of the burial locations within Structure 146.
Adapted from Estrada-Belli 2004: Figure 13.

SUF.T.23.54.09.01

Individual/Burial ID #:	**SUF.T.23.54.09.01; HAP Burial #19**
Laboratory ID #:	SU-16-28
Site:	La Sufricaya
Associated Period/Date:	Late Classic
Year Excavated:	2004
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Informe Preliminar de la Temporada 2004*
Dentition Sampled:	First mandibular molar
Burial Location and Construction:	Group I, Structure 146, residence? crypt, simple variety
Burial Type, Manner, and Positioning:	Primary, single interment; unknown positioning
Associated Artifacts:	Shell pendant and ceramic vessel
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	occlusal wear
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70809 $\delta^{18}O$: -4.9 (-5.6*) $\delta^{13}C$: -4.8 **non-local?** *adjusted for weaning

Table 8.33 Individual profile of SUF.T.23.54.09.01

During the excavations of Structure 146 of Group I, SUF.23.54.09.01 (HAP Burial #19) was found in a grave interment of the crypt type, simple variety (Figure 8.93). The archaeologists described a cut (SUF.T.23.52) oriented north-south with parallel rows of rectangular stones (SUF.T.23.57), acting as the crypt stone walls, and covered with capstones (SUF.T.23.71). The fragmented remains were accompanied by a shell pendant (SUF.T.23.10.01) and a ceramic vessel (SUF.T.23.53.02.01) placed at the north end of the burial (Figure 8.94). This vessel was a mostly intact, small polychrome bowl with a ring base. This burial was disturbed in antiquity during the adjacent interment of SUF.T.23.56.09.01 (Burial #18). During this subsequent interment, one or

Figure 8.93 Photo (plan view) of the crypt of SUF.T.23.54.09.01
(Image Courtesy of HAP).

two of the stones of the western crypt wall were removed to allow for the placement of a ceramic plate and the simple, pit grave of SUF.T.23.56.09.01 (Burial #18) to the west.

The skeletal remains of SUF.23.54.09.01 are extremely fragmented (Figure 8.95). Six long bone fragments and five teeth were found extremely eroded. Due to the limited preservation, it is not possible to estimate age-at-death or biological sex. The only pathological changes observed were occlusal wear of the dentition.

Figure 8.94 Ceramic vessel (SUF.T.23.53.02.01)
interred with SUF.T.23.54.09.01 (Image Courtesy
of HAP).

The enamel of a first mandibular molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70809, while the $\delta^{18}O$ result was -4.9 (adjusted to -5.6) and $\delta^{13}C$ was -4.8. The $^{87}Sr/^{86}Sr$ was a possible outlier, suggesting that SUF.T.23.54.09.01 may have not originated in the Holmul region, but was from elsewhere in the Central Maya area.

Figure 8.95 The skeletal remains of SUF.T.23.54.09.01.

SUF.T.23.66.09.01

Individual/Burial ID #:	**SUF.T.23.66.09.01; HAP Burial #21**
Laboratory ID #:	SU-16-29
Site:	La Sufricaya
Associated Period/Date:	Late Classic
Year Excavated:	2004
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Informe Preliminar de la Temporada 2004*
Dentition Sampled:	Right first maxillary molar
Burial Location and Construction:	Group I, Structure 146, residential(?), crypt Simple Variety
Burial Type, Manner, and Positioning:	Primary, single interment, unknown positioning
Associated Artifacts:	None
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Indeterminate
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70852, $\delta^{18}O$: -4.3 (-5.0*) $\delta^{13}C$: -4.9 **local** *adjusted for weaning

Table 8.34 Individual profile of SUF.T.23.66.09.01

SUF.T.23.66.09.01 (HAP Burial #21) was found following the removal of the crypt capstones (SUF.T.23.73). This crypt (simple variety) was lined by stones (SUF.T.23.68) and had a plaster floor surface (SUF.T.23.72), upon which the individual was placed (Figure 8.96). The skeletal material was found extremely fragmented, with dentition recovered at the northern and southern portions of grave, suggesting a postmortem disturbance of the body. The preservation of the remains did not allow for the documentation of body positioning.

The skeletal remains recovered include many small, eroded long bone fragments and six teeth (Figure 8.97). Based on the extremely fragmented and eroded nature of the

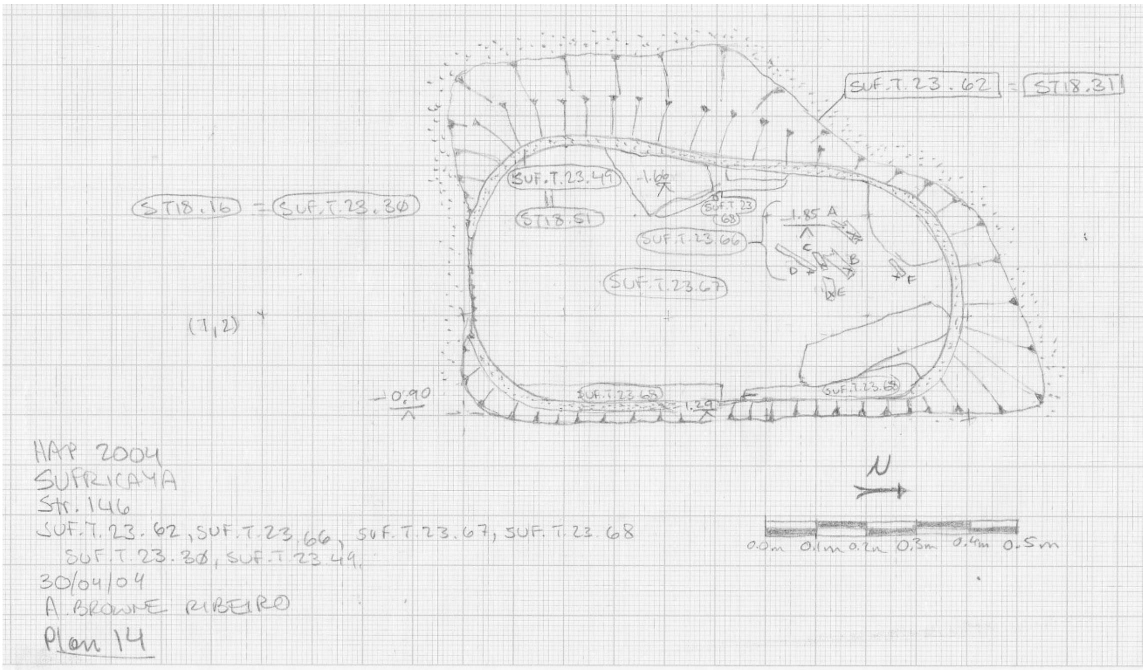

Figure 8.96 Plan Drawing of SUF.T.23.66.09.01 by A. Browne Ribeiro (Image Courtesy of HAP).

remains, it is not possible to estimate age-at-death or biological sex or observe any pathological changes.

Figure 8.97 Dentition of SUF.T.23.66.09.01.

The enamel of the right first maxillary molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$ and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70852, while the $\delta^{18}O$ result was -4.3 (adjusted for weaning effect to -5.0) and $\delta^{13}C$ was -4.9. Statistically, SUF.T.23.66.09.01 was not an outlier and most likely from La Sufricaya or the Holmul region.

The Osteobiographies of La Sufricaya, Group XVI, Structure 3

In 2005, the HAP investigated the groups to the north of Group 1, specifically Structure 3 of Group XVI and the Ballcourt of La Sufricaya. Structure 3 is one of only

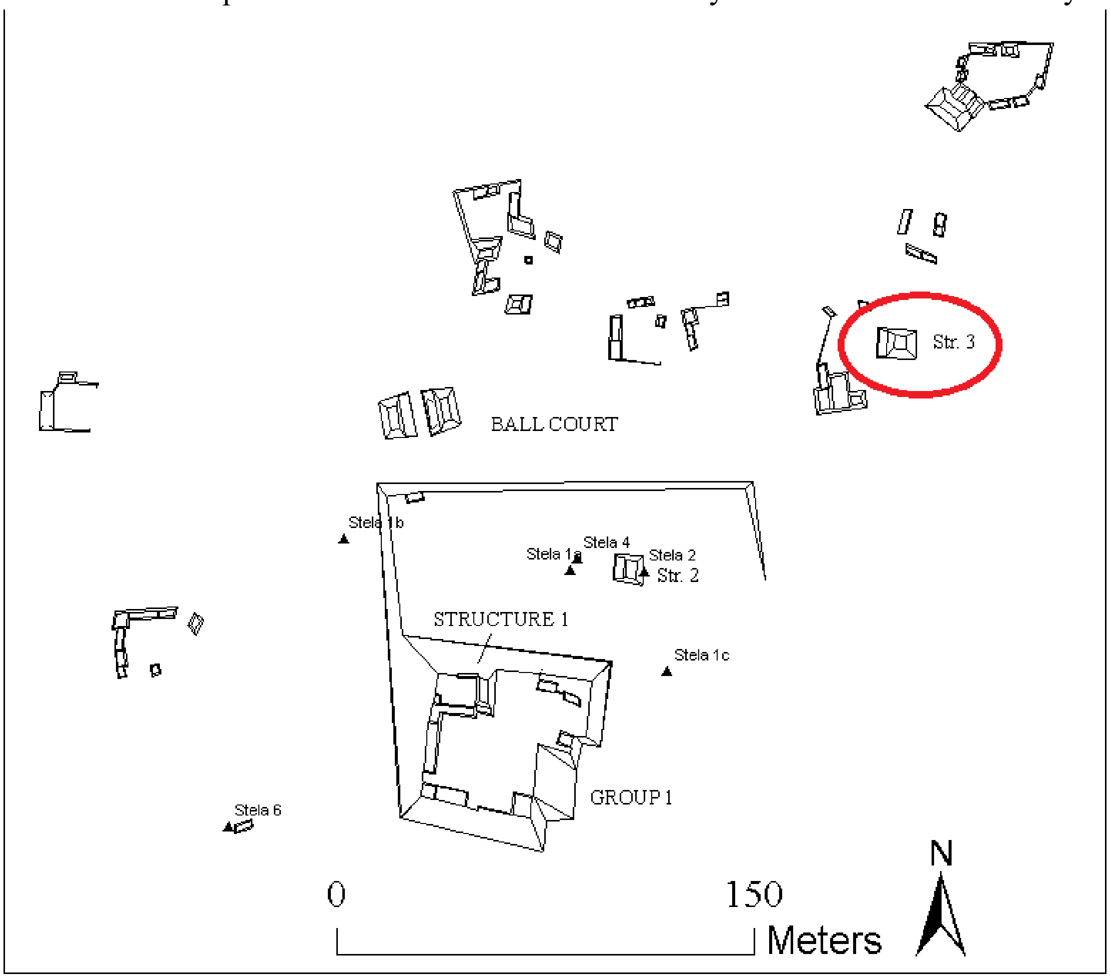

Figure 8.98 Map of the center of La Sufricaya. Structure 3 of Group XVI encircled in red. Adapted from Estrada-Belli 2005:12.

two pyramidal structures at La Sufricaya (the other being Structure 2), both located to the northeast of Group I. Due to the form of the structure and its rarity at La Sufricaya, the archaeologists posited that it functioned as a temple during its peak period of occupation- the Early Classic (Estrada-Belli 2005).

The investigations at Structure 3 aimed to investigate the large looter's trench (SUF.L8) on its eastern side in order to understand the architectural phases and chronology of the building. This investigation revealed that Structure 3 had two major phases of construction (Estrada-Belli 2005). The first phase involved of the construction of the pyramidal base, possibly during the Early Classic. A possibly south-facing room was built atop this platform with a plaster floor or low platform placed to the east of the structure. During the Late Classic, a second phase of construction enclosed the original pyramidal platform base and the Early Classic room. A new, probably south-facing room, was constructed on this Late Classic mound base.

SUF.L8.01.09.01

Individual/Burial ID #:	**SUF.L8.01.09.01**
Laboratory ID #:	SU-16-31
Site:	La Sufricaya
Associated Period/Date:	Late Classic (?)
Year Excavated:	2005 (Tokovinine)
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén. Informe Preliminar de la Temporada 2005*
Dentition Sampled:	Right third maxillary molar
Burial Location and Construction:	Group XVI, Structure 3 (Looter's trench), Residential Temple-Pyramid?
Burial Type, Manner, and Positioning:	Unknown
Associated Artifacts:	Unknown- possibly ceramic vessels and shell beads
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult (third molar)
Biological Sex Estimation:	Indeterminate
Observations:	None observed
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70875, $\delta^{18}O$: -3.9 $\delta^{13}C$: -6.6 **non-local??** (or high error)

Table 8.35 Individual profile of SUF.L8.01.09.01

While cleaning the looter's trench (SUF.L8) of Structure 3, human remains and possible funerary artifacts were found, although lacking contextual information due to the destruction by the looters. For SUF.L8.01.09.01, only long bone fragments and some dentition were recovered, such as a third molar (possibly the right third maxillary), right first maxillary incisor, left second maxillary incisor, and a right maxillary premolar. Due to the presence of the third molar, the age-at-death can be estimated to have been adult, while the estimation of biological sex is not possible. No pathological changes were observed of the few remains. No mortuary context is available, except for the artifacts in the same deposit as the human remains (Figure 8.99), including a small ceramic dish

(SUF.L8.01.03.01), fragments of a vessel (SUF.L8.01.02.02), and seven shell beads (SUF.L8.01.03.01-07).

Figure 8.99 Artifacts found in SUF.L88 (Estrada-Belli 2005:17).

The archaeologists suggest that the burial, before being disturbed by looters, was interred into the fill of the Early Classic room, possibly at the beginning of the Late Classic construction or at some point during the Late Classic occupation (Estrada-Belli 2005). If this structure functioned as a temple, the interred might have had a high status or been a member of the elite.

The enamel of the right third maxillary molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$ and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70875, while the $\delta^{18}O$ result was -3.9 and $\delta^{13}C$ was -6.6. The statistical analysis suggests that the $^{87}Sr/^{86}Sr$ is different, but when considering the

Figure 8.100 Human remains found in SUF.L8.

high error that occurred when running the isotopic test, the outlier is more likely a result of the error. This sampled will be re-run to obtain a new result.

The Osteobiographies of La Sufricaya, Group VI, Structure 110

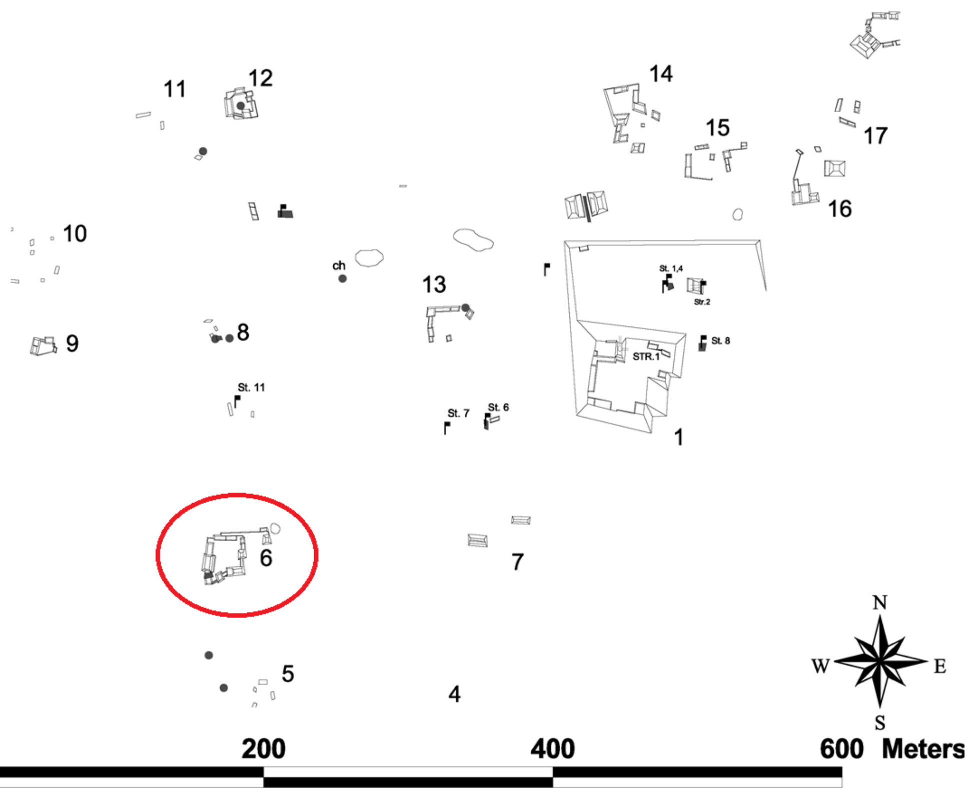

Figure 8.101 Map of La Sufricaya with Group VI encircled in red. Adapted from Estrada-Belli 2002:25.

SUF.T.11.06.09.01

Individual/Burial ID #:	**SUF.T.11.06.09.01; HAP Burial #5**
Laboratory ID #:	SU-16-25
Site:	La Sufricaya
Associated Period/Date:	Terminal Classic (associated artifacts)
Year Excavated:	2002 (B. Watters)
Archaeological Reports:	*Archaeological Investigations at Holmul, Guatemala: Preliminary Results of the Third Season, 2002*
Dentition Sampled:	Left First Mandibular Molar
Burial Location and Construction:	Group VI, Structure 110- residential
Burial Type, Manner, and Positioning:	Primary, single interment, flexed on the left, S-N, head S facing N
Associated Artifacts:	? "artifacts dating to Terminal Classic"
Preservation:	Partial (25-75%)
Age-at-Death Estimation:	Adult (third molars)
Biological Sex Estimation:	Male (cranium morphology)
Observations:	None observed
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70851, $\delta^{18}O$: -4.9 (-5.6*) $\delta^{13}C$: -5.6 **local** *adjusted for weaning

Table 8.36 Individual profile of SUF.T.11.06.09.01

SUF.T.11.06.09.01 was excavated from Structure 110 of Group VI, a residential group at La Sufricaya. Structure 110 was a vaulted building within the residential courtyard group of Group VI. The burial was cut into an exterior plaster floor and accompanied by artifacts dated to the Terminal Classic period (Estrada-Belli 2002). Unfortunately, the details regarding the associated artifacts are lacking. According to the plan view drawing of SUF.T.11.06.09.01, this individual was a primary burial of a single interment, positioned flexed on the left and oriented south-north with the head to the south and facing north. The grave construction was that of a simple pit type located in a floor of a vaulted residential building (Figure 8.102).

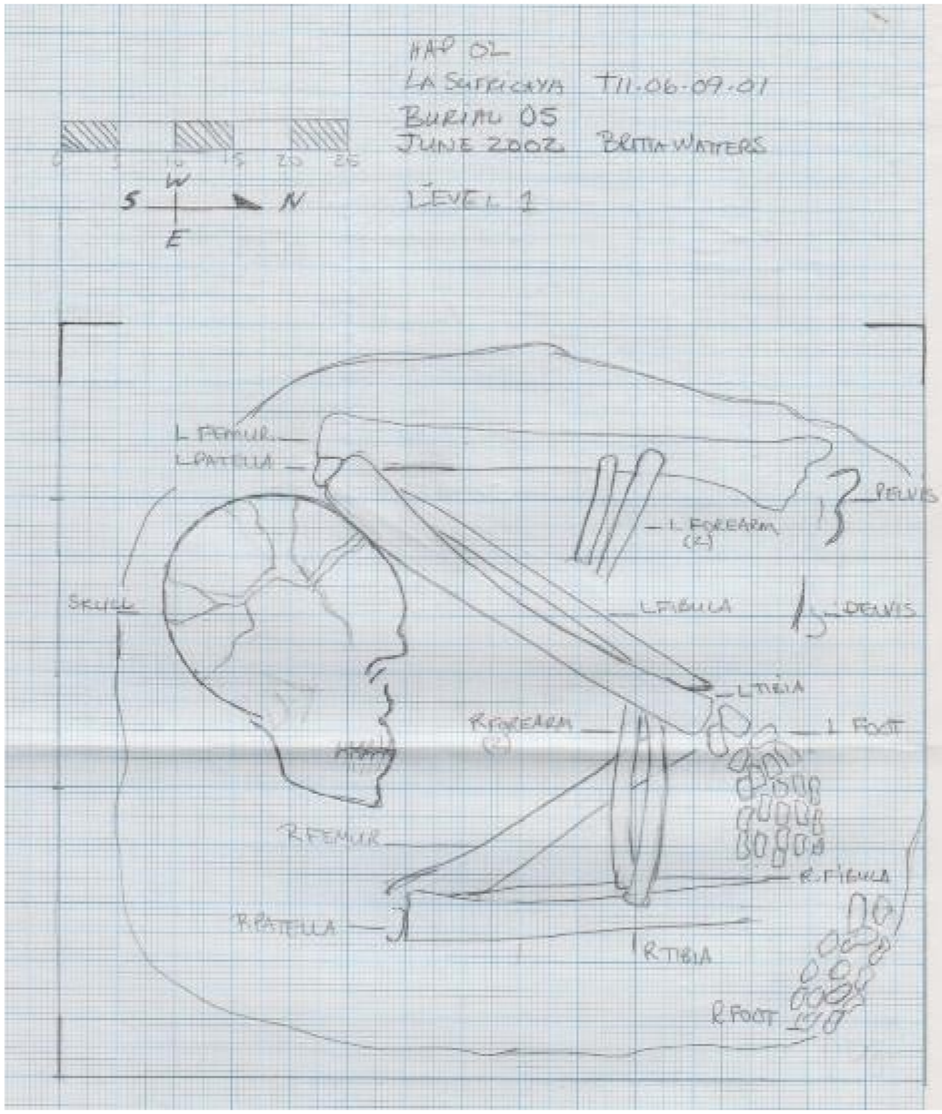

Figure 8.102 Plan drawing of SUF.T.11.06.09.01 by B. Watters (Image Courtesy of HAP).

SUF.T.11.06.09.01 was overall partially preserved, while the splanchnocranium and neurocranium were nearly complete. The dentition was also nearly complete, only missing the maxillary second left incisor, the maxillary right first molar (which was sampled by Friedrich (2013) for isotopic analysis), and the mandibular right third molar. The axial skeleton was immensely fragmented, while the appendicular body was partially complete. The shoulder and pelvic girdles were very fragmented with only the clavicles being partially preserved and fragments of the left ilium identifiable. The long bones of SUF.T.11.06.09.01 were partially preserved with shaft fragments from all except the left radius. The proximal end of the left femur was complete, allowing for a measurement of the femoral head (43.63mm). The bones of the hands and feet were fragmentary as well.

Due to the partial preservation of the skeleton and the lack of preservation of

Figure 8.103 Mandible of SUF.T.11.06.09.01.

elements for estimation of age-at-death, the estimation of adult age relies on the development of the third molars, but general lack of occlusal wear on the dentition suggests this individual was not an adult of advanced age. Due to the nearly complete

Figure 8.104 Maxilla of SUF.T.11.06.09.01.

splanchnocranium and neurocranium, an estimation of biological sex was possible. The mastoid processes were scored as a 4, while the supraorbital margins scored between 4 and 5. The mental eminence was massive and scored as 5. The cranial morphology suggests an estimation of a biological sex of male. The left femoral head was able to be measured (43.63mm), which is inconclusive. Further, the fragment of the left greater sciatic notch (Figure 8.105) was scored between 3 and 4, which is also ambiguous, leaning male. Based on the cranial morphology and the greater sciatic notch, SUF.T.11.06.09.01 can be estimated to have been a probable male. No paleopathological changes were observed of this partial skeleton.

In 2013, Friedrich selected the right first maxillary molar for stable isotope analysis of $\delta^{18}O$ and $^{87}Sr/^{86}Sr$. She reported the $^{87}Sr/^{86}Sr$ result was 0.7085 and the $\delta^{18}O$ (converted to $\delta^{18}O$ of ingested water) was -2.7. For this study, the left first mandibular was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$ and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70851, while the $\delta^{18}O$

was -4.9 (adjusted for weaning to -5.6) and the $\delta^{13}C$ was -5.6. Statistically, SUF.T.11.06.09.01 was not an outlier and most likely from La Sufricaya or the Holmul region.

Figure 8.105 Left greater sciatic notch of SUF.T.11.06.09.01.

The Osteobiographies of Burials from Unclear Contexts

Individual/Burial ID #:	**SUF.T.03.09.01; HAP Burial #28 (SUF 2)**
Laboratory ID #:	SU-16-30
Site:	La Sufricaya
Associated Period/Date:	?
Year Excavated:	2001(?)
Archaeological Reports:	-
Dentition Sampled:	Left second maxillary molar
Burial Location and Construction:	Unknown
Burial Type, Manner, and Positioning:	Unknown
Associated Artifacts:	Unknown
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult (third molar)
Biological Sex Estimation:	Indeterminate
Observations:	LEH, caries
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70830, $\delta^{18}O$: -4.1 (-4.4*) $\delta^{13}C$: -6.8 **local** *adjusted for weaning

Table 8.37 Individual profile of SUF.T.03.09.01

There is no contextual information for this burial, except for the labeling of the remains as SUF.T.03.09.01 and Burial #3 of the 2001 excavations. On the paper Burial List in the HAP Laboratory, this burial is relabeled as HAP Burial #28, due to the duplicate Burial # 3 from Holmul. Neither the skeletal remains nor the excavation context SUF.T.03 are mentioned in any HAP field reports. It is possible that, if this burial was excavated in 2001, it was from Structure 1 of La Sufricaya, as the excavations during that field season focused on this structure of Group I. In Friedrich's (2013) thesis, she samples this individual's dentition for isotope analysis, but does not provide any further context for the individual. Due to the complete lack of context, a mortuary analysis is not possible.

The skeletal remains labeled SUF.T.03.09.01 consist of a few eroded cranial fragments, vertebral fragments, a fragmented maxilla, and some dentition. The right first

Figure 8.106 Dentition of SUF.T.03.09.01.

and second molars, premolars, and canine were in situ in a maxillary fragment. All four maxillary incisors, the three left maxillary molars, both left maxillary premolars, and the left maxillary canine were preserved. The right first maxillary molar had large dental caries on its mesial surface. Nearly all of the dentition had significant, defined examples of linear enamel hypoplasia (Figure 8.106). The preservation of a third molar allows for the estimation that this individual was an adult at death. The biological sex is not able to be estimated.

In 2013, Friedrich selected the right first maxillary molar[3] for stable isotope analysis of $\delta^{18}O$ and $^{87}Sr/^{86}Sr$. She reported the $^{87}Sr/^{86}Sr$ result was 0.7081 and the $\delta^{18}O$ (converted to $\delta^{18}O$ of ingested water) was -2.5. For this project, the enamel of the left second maxillary molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$ and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70830, while the $\delta^{18}O$ result was -4.1 (adjusted to -4.4) and $\delta^{13}C$ was -6.8. Statistically,

[3] It is most likely that she sampled the right **third** maxillary molar, as the first molar was in situ and had not previously been sampled.

SUF.T.03.09.01 was not an outlier and most likely from La Sufricaya or the Holmul region.

Considering the Burials of La Sufricaya Two Early Classic individuals were found buried in Structure 1 of Group 1, which may have been a palace at the time. SUF.ST.09.02.09.03.01 was buried on the eastern edge of the structure, although further archaeological and mortuary context is not available. This individual, estimated to have been 11±2.5 years of age-at-death, was of local origin and buried in a palace context, which may suggest their identity as a sacrificial victim. SUF.ST.20.27.09.01 was also a local individual buried in the Early Classic Structure 1, but placed, wrapped in a textile bundle, within a cut into a plaster floor of the possible throne room. Due to lack of further archaeological context, more in-depth conclusions regarding their identity is not possible.

The burials of Structure 146 were roughly contemporary, during the Late Classic period. While Structure 146 was possibly a temple platform or funerary shrine during the Early Classic, it possibly functioned as a residential structure during the Late Classic. Chronologically, a cut was made into the floor (SUF.T.23.30) and SUF.T.23.54.09.01 (Burial #19) was interred into its crypt and covered with capstones, followed by the burial of SUF.T.23.56.09.01 (Burial #18). This mortuary deposit disturbed the crypt of SUF.T.23.54.09.01 by removing one or more of the stones from its western wall. The ceramic plate (SUF.T.23.55.02.01) was interred in this newly created space, as SUF.T.23.56.09.01 was interred into its simple pit grave just west of the crypt of SUF.T.23.54.09.01. SUF.T.23.56.09.01 was covered by fill, not capstones. SUF.T.23.66.09.01 (HAP Burial #21) was interred in a cut in the same floor

(SUF.T.23.30), following the placement of the crypt wall stones and the plastering of the crypt floor. The capstones were placed over the burial and the area covering all three burials was sealed with a thin layer of marl, possibly acting as a living surface.

SUF.T.23.54.09.01 (HAP Burial #19) was estimated to have been a non-local individual originating from elsewhere in the Central Maya area. As the Late Classic was a time of instability, it is not surprising that a non-local individual was buried in a residential structure constructed on a former ceremonial structure. The subsequent intrusive burial of SUF.T.23.56.09.01 (Burial #18) may have been placed in an act of ancestor veneration to SUF.T.23.54.09.01, who originated elsewhere but may have been one of the first of the family to settle at La Sufricaya.

All three of these individuals were found in extremely fragmentary condition, either due to taphonomic processes or burial reentry during antiquity. Dentition for SUF.T.23.66.09.01 (Burial #21) was found throughout the grave, supporting the latter hypothesis of reentry. In addition, the crypt stones of the western wall also appear to have been disturbed. The archaeologists describe the clustering and north-south alignment of four long bones (presumably femora and humeri) of SUF.T.23.56.09.01 (Burial #18). This arrangement may suggest a bundle burial or a flexed burial, either possibly disturbed in antiquity. Further, the interment of SUF.T.23.56.09.01 (Burial #18) disturbed the previous crypt grave of SUF.T.23.54.09.01 (Burial #19). The disturbance of all three of the burials of the residential Structure 146 may indicate acts of ancestor veneration or the consequences of continued building construction.

Also during the Late Classic, SUF.L8.01.09.01 was interred in Structure 3 of Group XVI. Unfortunately, the looter's destroyed the mortuary context of what might have been an elite individual buried in a ceremonial structure. Further, the stable isotope analysis was inconclusive due to high error during the testing. The individual will have to be re-sampled and re-tested to estimate their geographic origin.

SUF.T.11.06.09.01, a probable adult male, was buried flexed in a simple pit burial located in a floor of a vaulted Terminal Classic residential building (Structure 110). The stable isotope results indicate that this individual was a local and his burial in a vaulted residential building near the site core suggests he was an elite.

La Sufricaya

HAP ID	SUF.ST.09.02.09.03.01	SUF.ST.20.27.09.01	SUF.T.23.54.09.01	SUF.T.23.66.09.01	SUF.L8.01.09.01	SUF.T.11.06.09.01	SUF.T.03.09.01
Sample ID	SU-16-26	SU-16-27	SU-16-28	SU-16-29	SU-16-31	SU-16-25	SU-16-30
aka	HAP 6	HAP 11	HAP 19	HAP 21		HAP 5	HAP 28/3/2
Period	Early Classic	Early Classic	Late Classic	Late Classic	Late Classic	Terminal Classic	
Location	Group I, Str. 1	Group I, Str. 1	Group I, Str. 146	Group I, Str 146	Group XVI, Str. 3	Group VI, Str. 110	
Age-at-Death	Infans II (11±2.5yrs)	Indeterminate	Indeterminate	Indeterminate	Adult	Adult	Adult
Biological Sex	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Dental Pathology	calculus, possible filing	occlusal wear and caries	occlusal wear			Male?	
Burial Type			Grave interment	Grave interment		Grave interment	
Burial Manner			Primary, single	Primary, single		Primary, single	
Body Positioning						Flexed, left Side, S-N, facing N	
Burial Location		Palace?	Residence?	Residence?	Temple-Pyramid?	Vaulted residential,	
Grave Construction		simple, simple	crypt, simple	crypt, simple		simple, pit,	
Associated Artifacts		plaster with textile impressions	Shell pendant and ceramic vessel	none	possibly 2 ceramic vessels and 7 shell beads	"Terminal Classic artifacts"	
Tooth Sampled	M^1	M_1	M_1	RM^1	M3	LM_1	LM^2
$^{87}Sr/^{86}Sr$	0.70842	0.70848	0.70809	0.70852	*0.70875*	0.70851	0.70830

$\delta^{18}O_{ap}$	-5.1 (-5.8*)	-6.0 (-6.7*)	-4.9 (-5.6*)	-4.3 (-5.0*)	-3.9	-4.9 (-5.6*)	-4.1 (-4.4*)
$\delta^{13}C_{ap}$	-6.9	-5.8	-4.8	-4.9	-6.6	-5.6	-6.8
Local or Non-Local	Local	Local	Non-Local?	Local		Local	Local

Table 8.38 Summary of the burials of La Sufricaya *Italicized* emphasizes a result with high laboratory error

Cival

The Osteobiographies of Cival, Civic/Ceremonial Center

The earliest construction phases in the ceremonial center of Cival (Figure 8.107) date to the Middle Preclassic period, as early as 900 BC, when the hilltop was leveled to create a wide, open plaza, and an E-Group was erected (Estrada-Belli 2011). A burial (CIV.T.28.11.09.01) located in a chultun under this first paving of the plaza, and the eventual North Pyramid, was radiocarbon dated to 850-800 BC. During the Late Preclassic, around 350 BC, pyramid complexes were added to the plaza, including the Group I to the east and the North, South, and West Pyramids. Group I was first constructed around 350 BC, followed by several construction phases through AD 100, resulting a broad platform supporting three pyramidal structures and two stepped platforms. Excavations revealed a Late Preclassic sub-structure under Group I with painted stucco and anthropomorphic masks. Skeletal remains (CIV.T.01.09.01 & CIV.T.01.04.09.01) were found during these tunnel excavations. The North Pyramid, also constructed and modified during this time, was a large structure consisting of a two-stage pyramidal platform with a smaller pyramidal platform on top, led to by an inset stairway (Estrada-Belli 2011). Just northeast of the North Pyramid, a midden was located on the northern-most slope of the main built-up plaza ("the Northern Sector"). Skeletal remains (CIV.T.22.13.09.01) were found within this midden.

The Far West Group is located 130m west of the main plaza and composed of 10 structures. Structure 33 is oriented to the west, measuring 41m north-south and 8m east-

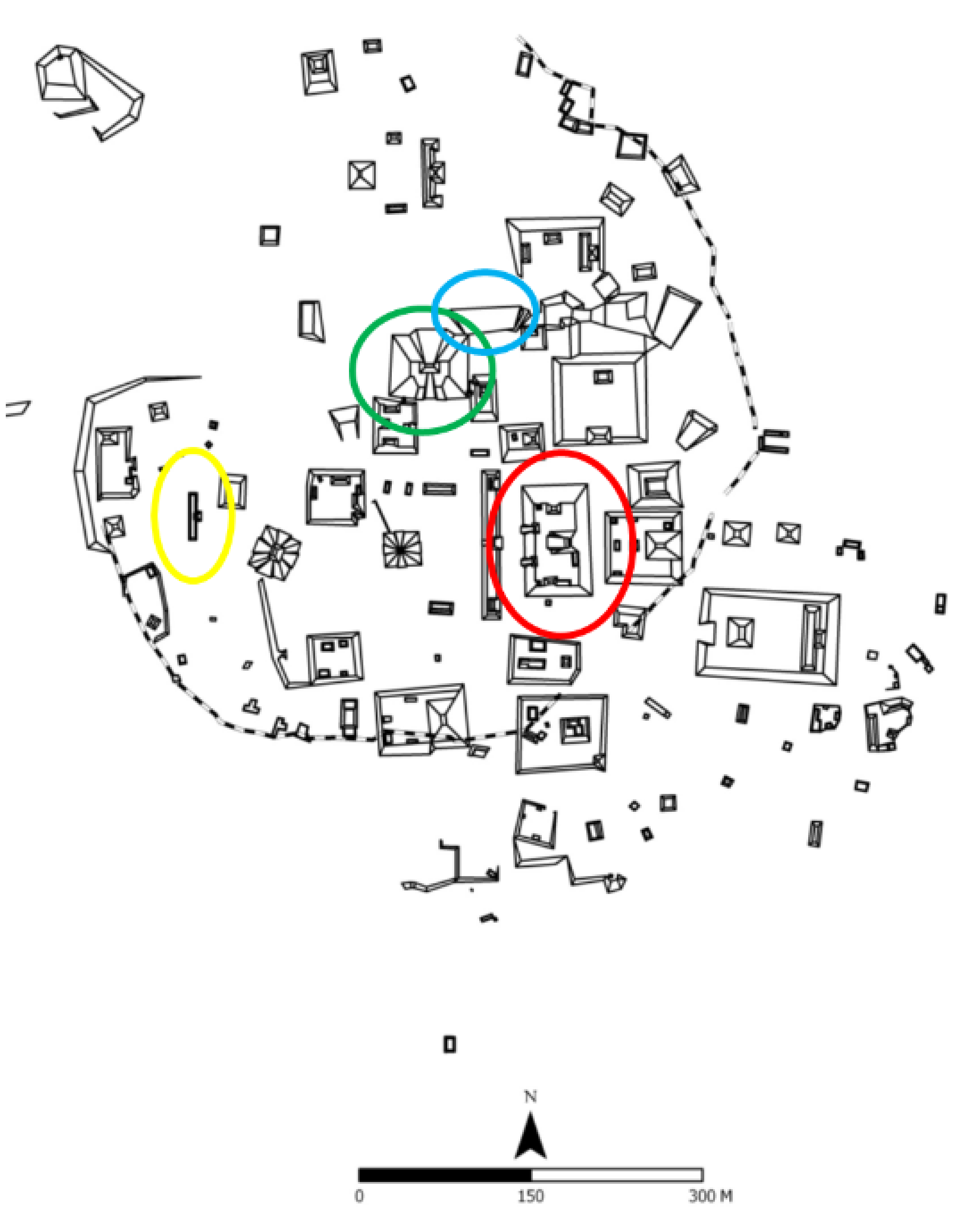

Figure 8.107 Map of the Civic/Ceremonial Center of Cival, Group 1 encircled by red, the North Pyramid in green, the Far West Group Structure 33in yellow, the location of the Northern Sector Midden in blue (Adapted from Estrada-Belli 2014:28).

west, with the height averaging 2.5m (Estrada-Belli 2007). During excavations, the burials CIV.T.45.11.09.01 and CIV.T.45.11.09.02 were found. The shape of this platform is similar to the east platforms of E-Groups, and in fact, it is in axis with a pyramid (Structure 31) on the west side of the plaza. Excavations revealed that the first floor of the plaza in this group, as well as Structure 31, were constructed in the Mamon phase of the Middle Preclassic period, while the second construction phase occurred during the Late Preclassic (Estrada-Belli 2007).

CIV.T.01.09.01

Individual/Burial ID #:	**CIV.T.01.09.01; "CIV.CT1"**
Laboratory ID #:	CI-16-39
Site:	Cival
Associated Period/Date:	Late Preclassic
Year Excavated:	2003
Archaeological Reports:	*Archaeological Investigations in the Holmul Region, Petén: Preliminary Results of the Fourth Season, 2003*
Dentition Sampled:	Right first maxillary molar
Burial Location and Construction:	Group I, Structure 1
Burial Type, Manner, and Positioning:	Unknown
Associated Artifacts:	Unknown
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	None observed
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70783, $\delta^{18}O$: -5.0 (-5.7*) $\delta^{13}C$: -6.2 **local** *adjusted for weaning

Table 8.39 Individual profile of CIV.T.01.09.01

In 2003, excavations in the civic/ceremonial center of Cival focused on Structure 1 of Group I (Figure 8.108). Looter's trenches had revealed a sub-structure with painted stucco and anthropomorphic masks (Figure 8.109). The tunnel CIV.T.01 began in the front of Structure 1 continuing to the east in order to uncover the extent of the masks. Skeletal remains were found associated with this tunnel, although further mortuary context was not reported.

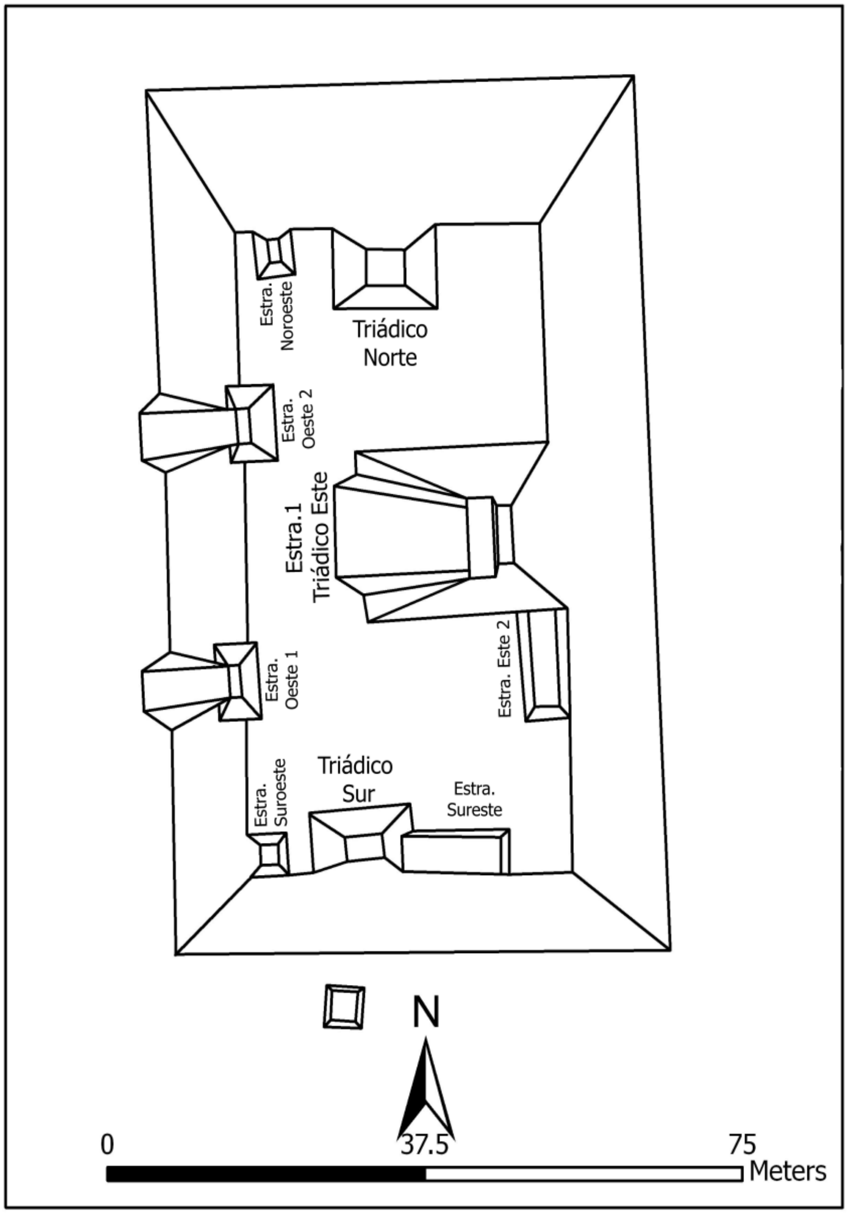

Figure 8.108 Map of Cival, Group I by A. Velasquez (Velazquez 2011:42).

The dentition labeled CIV.CT1 (Figure 8.110) consisted of a left first maxillary incisor, one maxillary canine, two maxillary premolars, a right first maxillary molar, a right second maxillary molar, three mandibular premolars, two fractured molars, a fragmented incisor, a third molar, and two root fragments. A small fragment of the maxilla accompanied these teeth. Estimations of age-at-death and biological sex are not possible. No dental pathologies were observable.

The enamel of the right maxillary first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70783, while the $\delta^{18}O$ was -5.0 (adjusted for weaning to -5.7) and $\delta^{13}C$ was -6.2. Statistically, CIV.T.01.09.01was not an outlier and most likely from Cival or the Holmul region.

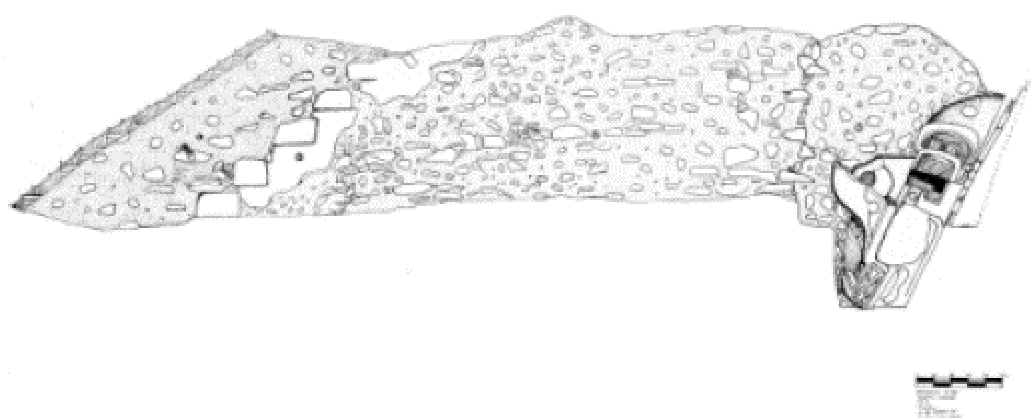

Figure 8.109 Profile drawing from 2003 of CIV.T.01 by A. Castillo (Estrada-Belli 2003:151).

Figure 8.110 Selected dentition of CIV.T.01.09.01.

CIV.T.01.04.09.01

Individual/Burial ID #:	**CIV.T.01.04.09.01; "CIV.T1.04.09.01"**
Laboratory ID #:	CI-16-40
Site:	Cival
Associated Period/Date:	Late Preclassic
Year Excavated:	2004
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Informe Preliminar de la Temporada 2004*
Dentition Sampled:	Left first mandibular molar
Burial Location and Construction:	Group I, Structure 1
Burial Type, Manner, and Positioning:	Unknown
Associated Artifacts:	Unknown
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Minor occlusal wear, possible incisor modification
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70792, $\delta^{18}O$: -5.0 (-5.7*), $\delta^{13}C$: -3.5 **local** *adjusted for weaning

Table 8.40 Individual profile of CIV.T.01.04.09.01

In 2004, tunnel excavations continued in Group I, Structure 1 to further expose the masks on the sub-structure (Figure 8.111). Skeletal remains labeled CIV.T1.04 were recovered, although no mortuary context was reported. The elements found include dentition, two cranial fragments, two mandibular fragments, a long bone fragment, and a complete right zygomatic. The dentition (Figure 8.112) includes one left first mandibular molar, two mandibular premolars, one mandibular canine, one worn or filed maxillary first incisor, and a left first maxillary molar. Estimations of age-at-death and biological sex are not possible. Other than minor occlusal wear and possible modification of the incisor, no observations were possible.

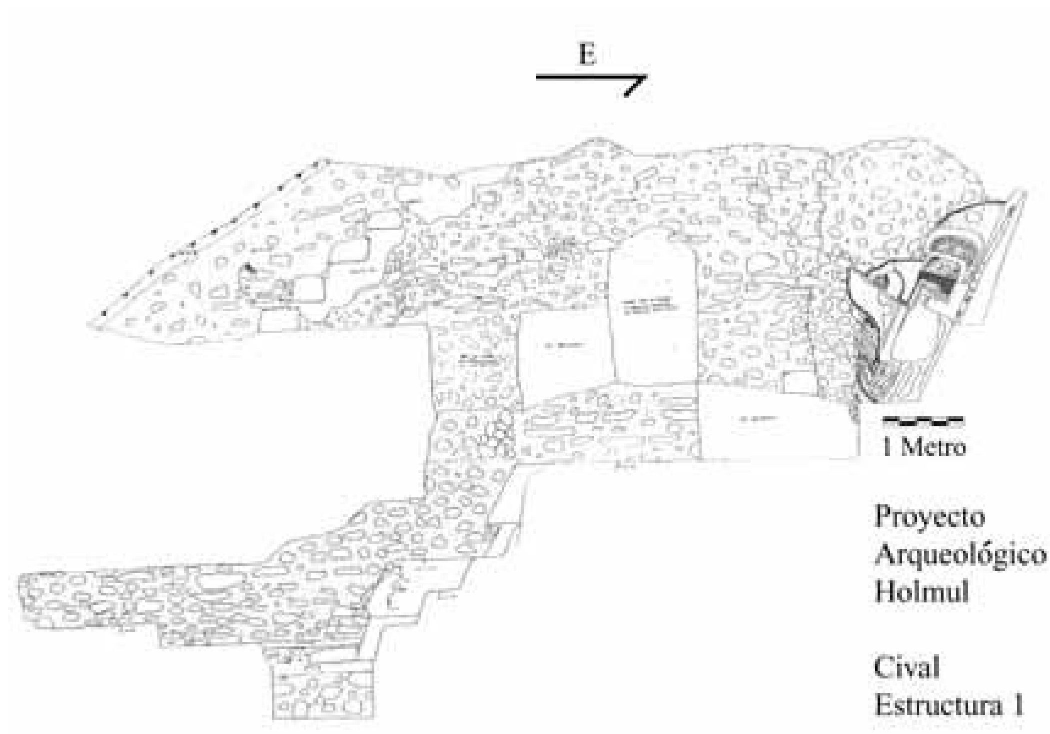

Figure 8.111 Profile drawing from 2004 of CIV.T.01 by A. Castillo (Estrada-Belli 2004: Figure 5).

The enamel of the left mandibular first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70792, while the $\delta^{18}O$ was -5.0 (adjusted for weaning to -5.7) and $\delta^{13}C$ was -3.5. Statistically, CIV.T.01.04.09.01 was not an outlier and most likely from Cival or the Holmul region.

Figure 8.112 Selected dentition of CIV.T.01.04.

CIV.T.28.11.09.01

Individual/Burial ID #:	**CIV.T.28.11.09.01; HAP Burial #33**
Laboratory ID #:	CI-16-33
Site:	Cival
Associated Period/Date:	Middle Preclassic (850-800 BC C14)
Year Excavated:	2007
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul, Cival, La Sufricaya, y K'o. Informe Preliminar de la Temporada 2007*
Dentition Sampled:	Left second maxillary molar
Burial Location and Construction:	Chultun under the North Pyramid
Burial Type, Manner, and Positioning:	Primary, single burial interment, partially flexed (left) and extended (supine), head to S, facing W
Associated Artifacts:	None
Preservation:	Complete (75-100%)
Age-at-Death Estimation:	20-30 years (auricular surface)
Biological Sex Estimation:	Male (GSN, cranial morph)
Observations:	Dental caries, occlusal wear, addition on first prox foot phalanx, lesions on medial shafts of clavicles
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70783, $\delta^{18}O$: (lab error) $\delta^{13}C$: -6.9 **local** *adjusted for weaning

Table 8.41 Individual profile of CIV.T.28.11.09.01

In 2007, excavations at the North Pyramid of Cival aimed to secure looter's trenches and establish a sequence of construction phases for the structure. Unit CIV.T.28 was placed on the southern base of the pyramid (Figure 8.113) to investigate its staircase and understand the different levels of the plaza. Six plaza floors were documented, possibly related to the six construction phases of the North Pyramid. The earliest leveling of the plaza used construction fill and midden material and was covered with a layer of plaster. Underneath this first construction phase, a chultun was found in the bedrock (Figure 8.114). This chultun had a central, cylindrical chamber connected by steps and passageways to five side chambers on a lower level. The central chamber contained the grave of CIV.T.28.11.09.01.

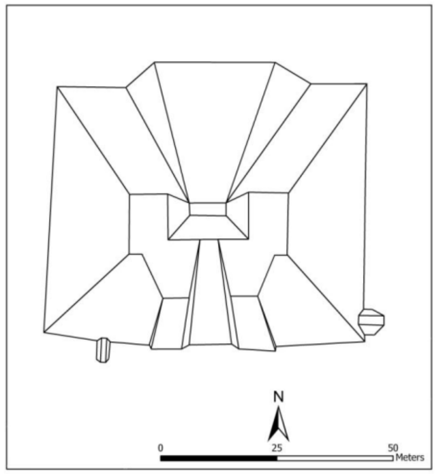

Figure 8.113 Map of Cival North Pyramid by
A. Velasquez (Velasquez 2011: 55).

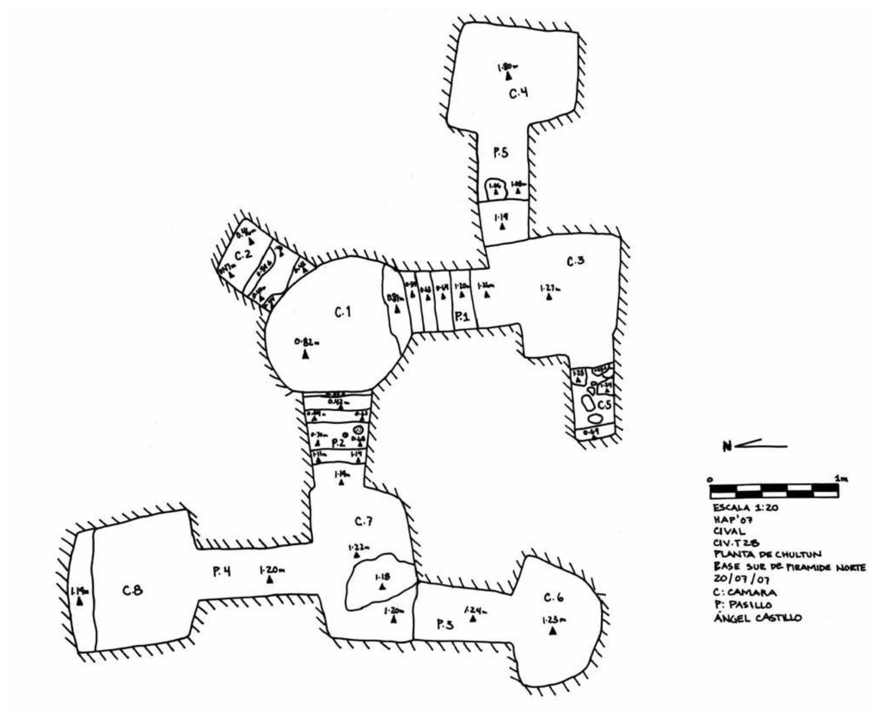

Figure 8.114 Plan of the chultun under the North Pyramid by A.
Castillo (Estrada-Belli 2007:41).

The individual was placed in this central chamber of the chultun covered by stone slabs acting as capstones. The burial type and manner are that of a single, primary grave interment. The body was oriented with the head to the south, facing west, in a partially flexed, yet partially extended position. The person was laid on their left side with the right arm extended behind the vertebrae and the left arm flexed. The pelvis was oriented supine with the right femur well preserved, but the lower leg disturbed. The left leg is described as flexed (Estrada-Belli 2007). It is possible that this orientation is a result of size and shape of the chultun, as well as difficulty in maneuvering the body within the chamber.

No associated artifacts were found with this burial, although small artifacts were found within the chultun chamber, including seven obsidian blades (CIV.T.28.11.5.01),

Figure 8.115 Photo of CIV.T.28.11.09.01 (Estrada-Belli 2007:42).

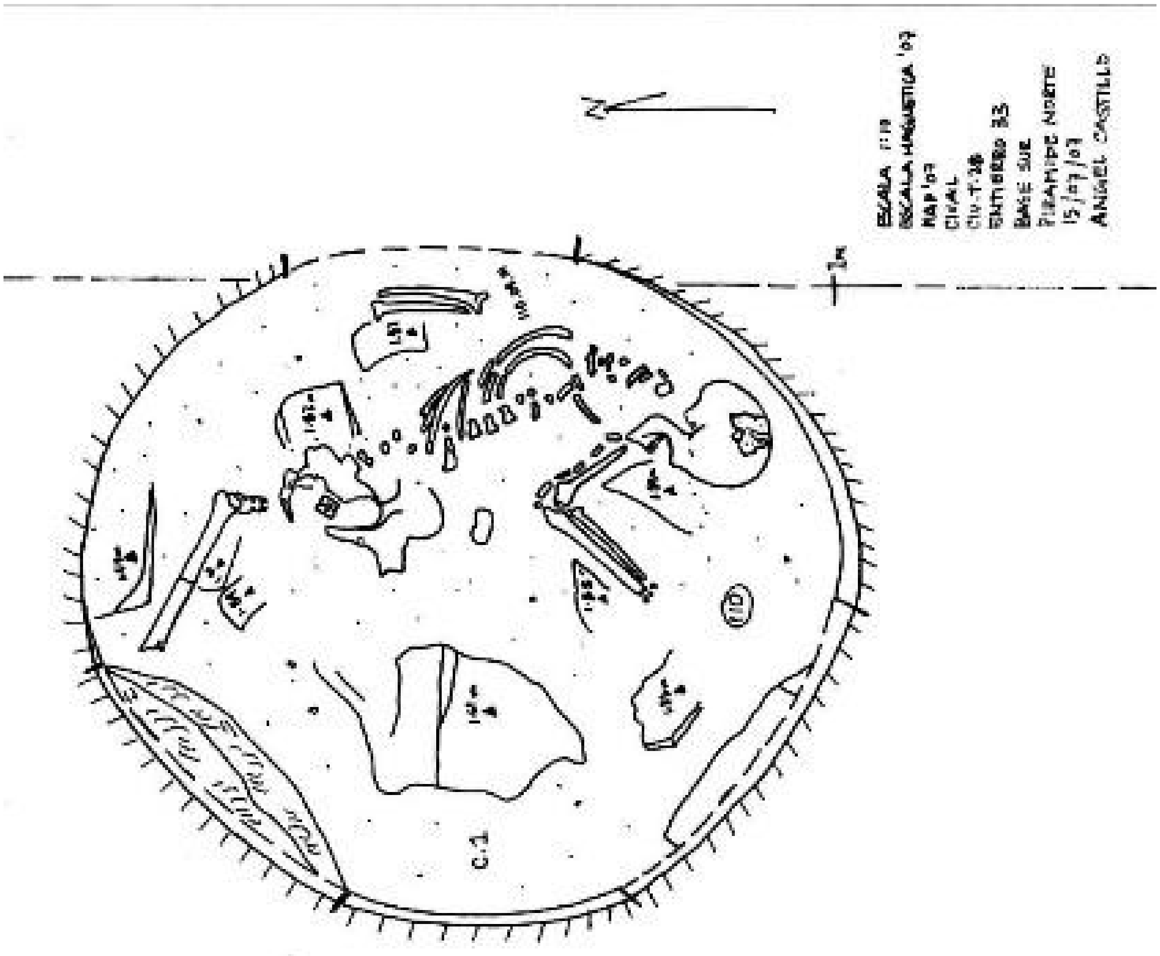

Figure 8.116 Drawing of CIV.T.28.11.09.01 by A. Castillo.

pieces of red clay (CIV.T.28.11.03.02), green stone ax (CIV.T.28.11.07.01), the head of a black figurine (CIV.T.28.11.02.01), a miniature bowl and disc (CIV.T.28.11.03.02), and a partially complete, incised ceramic plate (CIV.T.28.11.03.01). These ceramic artifacts were similar to those of the Middle Preclassic period (Estrada-Belli 2007), confirmed by a radiocarbon date from the burial of 2670±40 BP, calibrated to 840-800 BC (1-sigma 68% probability and 900-790 BC with 2-sigma 98% probability) (Estrada-Belli 2011).

CIV.T.28.09.01 is mostly complete, relative to other Cival burials. The cranium is partially complete, with fragments of all the cranial bones present, including most of the sphenoid, occipital, and both temporal bones. The maxilla and mandible are well preserved, with most of the teeth still in their sockets. The only teeth missing, probably postmortem with no sign of alveolar resorption, are all four first incisors and the maxillary left second incisor. Most of the vertebrae are accounted for, although fragmented, and there are many fragments of both the right and left ribs. Of the appendicular body, both scapulae are fragmented and both clavicle shafts are present. There are large fragments of both ilia and ischia, with the left auricular surface nearly complete. All the long bones of the arms are present, although mostly with just shaft fragments preserved. Both femora are present, with the left being more complete with fragments of both the distal and proximal ends. Only the shaft of the right femur is preserved. The left tibia is also mostly complete, with some postmortem damage to the proximal end. Of the hand bones, most are represented by metacarpal shaft fragments and proximal phalanx fragments. The left foot is more preserved than the right, with nearly complete left calcaneus, talus, navicular, medial cuneiform, lateral cuneiform, and all five metatarsals. There are fragments of a right lateral cuneiform, a right first metatarsal, and a right fifth metatarsal. There are also six, unsided, proximal foot phalanges, including a first.

The mastoid processes, the mental eminence, and nuchal crest are scored as 3-4, which is estimated as ambiguous, leaning male. The left greater sciatic notch is quite narrow, scored 4, and the preauricular sulcus is not present, both suggesting a biological sex estimation of male (Figure 8.118).

There is evidence of incomplete fusion (Figure 8.117) of the ischial tuberosity and of the distal epiphysis of the left tibia, suggesting the individual was in their late teens or early twenties (Scheuer and Black 2000). The auricular surface, while suffering from some postmortem damage, has signs of distinctive billowing, leading to a score of 1-2, also suggesting an individual in their 20s (Lovejoy, Meindl, Mensforth, et al. 1985). The auricular surface and the partial fusion of epiphyses allow for an estimation of age-at-death to be 20-30 years.

There is occlusal wear on most of the dentition excepting the second and third molars, while most of the molars have dental caries on their occlusal and buccal surfaces. All four of the third molars have extreme dental caries (Figure 8.119). There may be some bone lesions on the inferior medial surfaces of both clavicles, although the postmortem damage prevents a conclusion. There are also healed bone lesions on a first proximal foot phalanx, perhaps the result of an injury to that digit. There are also possible

Figure 8.117 Partial epiphyseal fusion of CIV.T.28.11.09.01.

Figure 8.118 Left os coxae of CIV.T.28.11.09.01.

lesions on the occipital bone and temporal bones, although postmortem surface damage also obscures any conclusions.

The enamel of the left second maxillary molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70783, while the $\delta^{13}C$ was -6.9. The $\delta^{18}O$ has high error and was not a successful run. The $\delta^{18}O$ will be re-run to confirm that CIV.T.28.09.01 was not an outlier and most likely from Cival or the Holmul region.

Figure 8.119 Mandible (left) and first proximal foot phalanx (right) of CIV.T.28.11.09.01.

CIV.T.22.13.09.01

Individual/Burial ID #:	**CIV.T.22.13.09.01; HAP Burial #25**
Laboratory ID #:	CI-16-32
Site:	Cival
Associated Period/Date:	Late Preclassic
Year Excavated:	2005
Archaeological Reports:	Investigaciones Arqueológicas en la Región de Holmul, Petén. Informe Preliminar de la Temporada 2005
Dentition Sampled:	Left first maxillary molar
Burial Location and Construction:	Northern slope of main plaza (“Northern Sector”), midden, partial cist
Burial Type, Manner, and Positioning:	Primary, single individual interment, partially extended flexed, W-E, head facing S
Associated Artifacts:	Small ceramic pot, three pomacea shells
Preservation:	Partial (25-75%)
Age-at-Death Estimation:	Adult?
Biological Sex Estimation:	Female?
Observations:	Occlusal Wear
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70813, $\delta^{18}O$: -5.3 (-6.0*) $\delta^{13}C$: -6.9 **local** *adjusted for weaning

Table 8.42 Individual profile of CIV.T.22.13.09.01

Due to the uprooting by a fallen tree, an accumulation of ceramic sherds on the surface suggested to archaeologists that a midden might be present at this location on the northern slope of the platform supporting the main civic/ceremonial center of Cival. An intrusive burial was found (CIV.T.22.13.09.01) cut into the midden deposit (Figure 8.120). The grave was constructed using rounded stones, covered by a layer of earth. The

Figure 8.120 Photo of CIV.T.22.13.09.01 (Image Courtesy of HAP).

construction phases suggest that this was placed during the Late Preclassic (Estrada-Belli 2005).

This primary, single individual interment was placed in a partial cist, positioned in n partially extended, flexed position, with the legs bent at the knee but not positioned up towards the chest (Figure 8.121). The individual was placed on their right side, with the burial oriented west-east, the head facing south. The associated artifacts include a small ceramic pot and three pomacea shells.

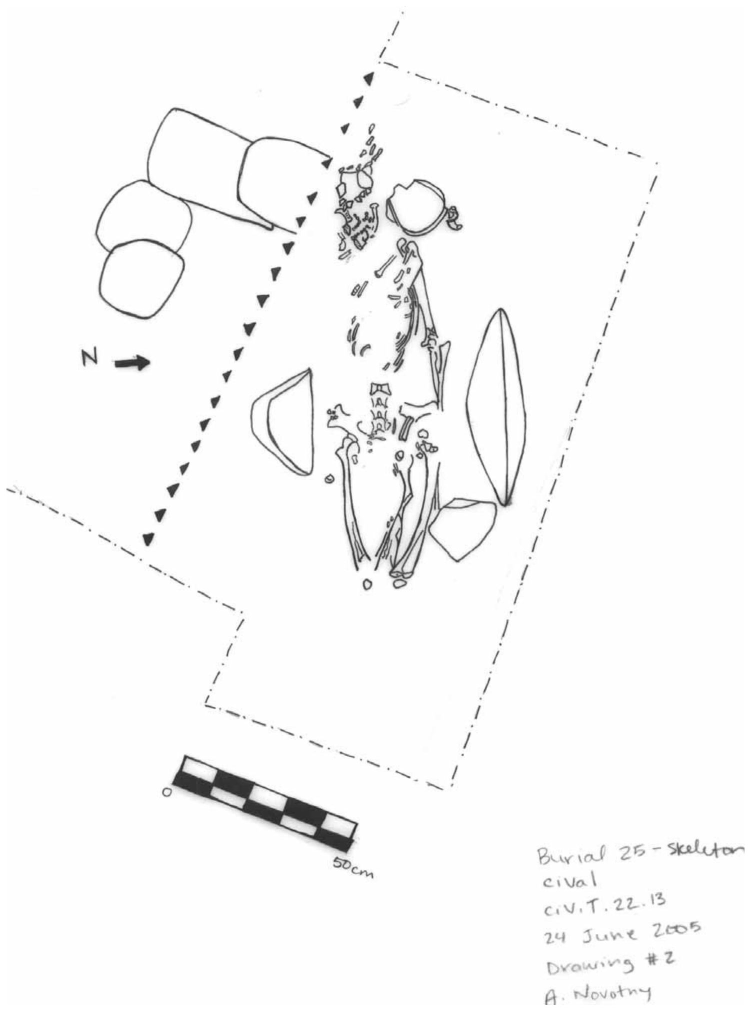

Figure 8.121 Plan Drawing of CIV.T.22.13.09.01 by A. Novotny
(Estrada-Belli 2005:120).

Figure 8.122 Dentition of CIV.T.22.13.09.01.

While the condition of the skeletal remains is very fragmented, many skeletal elements were present. Cranial fragments include that of the frontal, left parietal, and right temporal. The mandible is fragmented, with large pieces of the mandibular body retaining the right first and second molars. The loose mandibular dentition includes all four incisors, all four premolars, the left first molar, and the left second molar (Figure 8.122). The mandibular molars all have occlusal wear. Two fragments of the maxilla retained a canine, the right first and second premolars, and the right first and second molars. The loose maxillary dentition (Figure 8.122) includes the right first incisor, the right and left second incisors, the left first and second premolars, and the left first and second molars. The maxillary molars also have occlusal wear. There were a few vertebral and rib fragments recovered, as well as fragments of the right scapula and right clavicle.

There are fragments of both the left and right os coxae, with fragments of the left greater sciatic notch (scoring a 2), both left and right preauricular sulci (scoring 1), and both auricular surfaces. Unfortunately, postmortem damage to the auricular surfaces does not allow for an age-at-death estimation. The dental occlusal wear allows for a tentative estimation of adult. The fragments of the ilia recovered allow for a tentative biological sex estimate of female.

For the appendicular body, fragments of the right humerus and radius were recovered, as well as of the right femur and fibula. No left arm fragments were preserved, although fragments of the left femur, tibia, and fibula were present. Both patellae were partially preserved. For the hands, the left lunate, left trapezium, and left pisiform were preserved, as well as a sesamoid. Two fragmented left metacarpals and one fragmented right metacarpal were preserved, along with three proximal phalanges, one medial phalanx, and one distal phalanx. For the feet, only both naviculars and the left lateral cuneiform were preserved.

The enamel of the left first maxillary molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70813, while the $\delta^{18}O$ result was -5.3 (adjusted for weaning to -6.0) and $\delta^{13}C$ was -6.9. Statistically, CIV.T.22.13.09.01 was not an outlier and most likely from Cival or the Holmul region.

CIV.T.45.11.09.01 & CIV.T45.11.09.02

Individual/Burial ID #:	**CIV.T.45.11.09.01 & CIV.T.45.11.09.02; HAP Burial #34**
Laboratory ID #:	CI-16-34 and CI-16-35
Site:	Cival
Associated Period/Date:	Middle Preclassic (ceramics)
Year Excavated:	2007
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul, Cival, La Sufricaya, y K'o. Informe Preliminar de la Temporada 2007*
Dentition Sampled:	Left second mandibular molars (.01 and .02)
Burial Location and Construction:	Far West Plaza, Structure 33, religious/ceremonial, simple: simple
Burial Type, Manner, and Positioning:	Problematic deposit, secondary, multiple individuals, bundle?
Associated Artifacts:	None
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Of all remains: dental caries, calculus, occlusal wear, bone lesions on tibiae and radius fragments, dental modification for inlays in three incisors
Stable Isotope Results:	CI-16-34: $^{87}Sr/^{86}Sr$: 0.70793, **local** $\delta^{18}O$: -4.8 (-5.2*), $\delta^{13}C$: -5.5 CI-16-35: $^{87}Sr/^{86}Sr$: 0.70818 **local** $\delta^{18}O$: -4.8 (-5.1*), $\delta^{13}C$: -5.7 *adjusted for weaning

Table 8.43 Individual profile of CIV.T.45.11.09.01 & CIV.T.45.11.09.02

Excavations in the Far West Group focused on the Structure 33 platform, aiming to understand its function and its architectural phases. Unit CIV.T.45 was placed at the center of the Structure 33 platform. Context 11 refers to the fill used for the penultimate version of the platform (Figure 8.123). The ceramics within this context suggest the dating of this construction phase to the Middle Preclassic period. Skeletal remains (CIV.T.45.11.09) were found within the construction fill, not in anatomical position and grouped together. The archaeologists observed that there were multiple individuals as three fragments of the mandible were present. The placement in construction fill suggests a simple grave type of the simple variety, with multiple individuals in a secondary context. The presence of carpals and metacarpals suggest that this may have been a bundle burial preserving the bones usually lost in a secondary burial.

The skeletal remains of CIV.T.45.11.09 contain more than two individuals, confirming the observations of the excavators. Of the first mandible, only the most anterior portion was preserved, with some alveolar resorption and some open sockets for

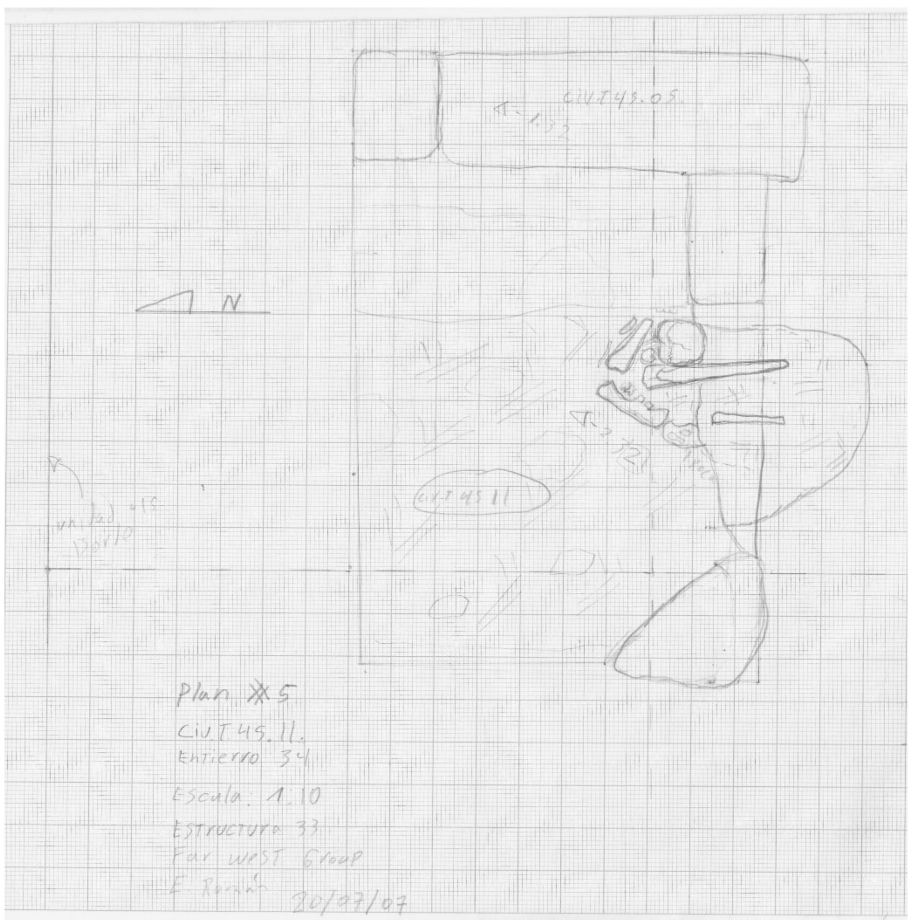

Figure 8.123 Plan drawing of CIV.T.45.11.09 by E. Roman (Image Courtesy of HAP).

both first incisors, the left second incisor, the left canine, both left premolars, and the first left molar. The mental eminence of the first mandible scores a 3-4. The second mandible was nearly complete, just missing the condyles. This mandible had available sockets for a complete arcade of teeth, although the left first and right third molars were still present in their sockets. The left third molar socket appears to be in the process of alveolar resorption. Further, the left first molar has significant occlusal wear. The mental eminence of this mandible scores a 3. Further mandible fragments include four fragments of coronoid processes, a left ramus with condylar neck, a right ramus with masseteric tuberosity, and a fragment of the right portion of the mandibular body with healed sockets for the left first and second molars, first left premolar, and possible the left canine. The left second premolar socket was empty, yet showed no signs of alveolar resorption. Additional mandibular fragments include a fragment of a mandibular body with the left mental foramen and a fragment of mandibular body with the right first and second molar present.

The mandibular dentition present (Figure 8.124), but not in situ, include eight premolars, a right first and second molar and left first molar that can be fitted to the second mandible, five additional molars, a worn second mandibular incisor, and two additional first molars. The maxillary dentition includes a left second incisor, a fragmented incisor with remains of an inlay pocket, left and right fight incisors also with inlay pockets, a first left incisor with occlusal wear, and a right second incisor with occlusal wear. Further maxillary dentition present include four lateral incisors, four canines, four premolars, a left first molar, a right first molar, two left second molars, and two right second molars. The deciduous dentition present include a maxillary first molar, a left second incisor, and a left first incisor.

Figure 8.124 Multiple Mandibular Fragments from
CIV.T.45.11.09.01.

Cranial fragments present include fragments of temporal mastoid processes, small fragments of parietal and occipital bones, and a complete left temporal. The mastoid of this temporal scored a 2-3. Further cranial fragments include frontal fragments with portions of the eye orbit, two right zygomatic bones, and a fragment of a frontal bone with both nasal bones attached.

The fragments of long bones include those of tibiae, fibulae, radii, ulnae, and femora. There are small fragments of vertebrae and ribs, as well as a left clavicle shaft fragment. There are two foot phalanges, tarsal fragments, ten proximal hand phalanges, two medial hand phalanges, shaft fragments, and one first distal hand phalange. The left lunate and trapezium are present, as well as 12 shaft fragments of metacarpals.

The presence of both deciduous dentition and permanent third molars suggest that there are both adults and infans/juveniles within the remains (Figure 8.125). An estimation of biological sex is not possible. There is occlusal wear, dental calculus, and dental caries on many of the teeth, as well as modification for inlays on three incisors. Two tibia fragments have active bone lesions (Figure 8.126), as does a radial shaft fragment.

Figure 8.125 Dentition from CIV.T.45.11.09.01.

The enamel of two left second mandibular molars (two individuals) were tested for $^{87}Sr/^{86}Sr$, δ18O, and δ13C. For the left second mandibular molar of the second, mostly complete mandible, the $^{87}Sr/^{86}Sr$ was 0.70793, while the δ18O was -4.8 (adjusted to -5.4) and δ13C was -5.5. For the additional left second mandibular molar, the $^{87}Sr/^{86}Sr$ was 0.70818, while the δ18O was -4.8 (adjusted to -5.4) and δ13C was -5.7. Statistically, both individuals were not outliers and most likely from Cival or the Holmul region.

Figure 8.126 Tibial fragment of CIV.T.45.11.09.01.

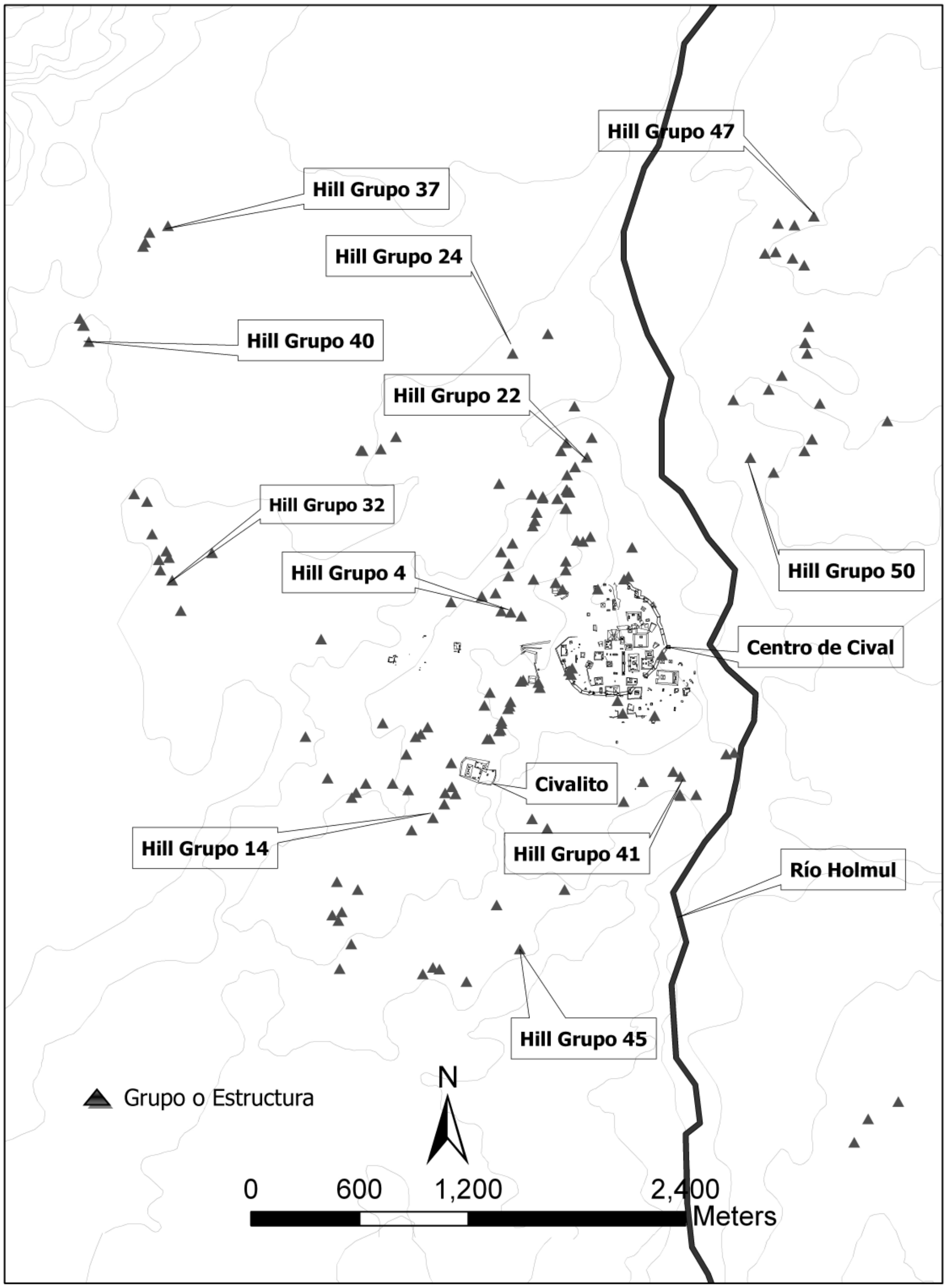

Figure 8.127 Residential hill groups of Cival (Velasquez 2011:75).

CIV.T.63.03.09.01

Individual/Burial ID #:	**CIV.T.63.01.09.01**
Laboratory ID #:	CI-16-37
Site:	Cival
Associated Period/Date:	Late Preclassic?
Year Excavated:	2008
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Cival, Y K'o. Informe Preliminar de la Temporada 2008*
Dentition Sampled:	Right first maxillary molar
Burial Location and Construction:	Residential Hill Group XXXVII, simple:simple on bedrock
Burial Type, Manner, and Positioning:	Primary, single individual grave interment, extended supine, W-E
Associated Artifacts:	Ceramic over skull
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Indeterminate
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70844, $\delta^{18}O$: -5.5 (-6.2*) $\delta^{13}C$: -6.2 **local** *adjusted for weaning

Table 8.44 Individual profile of CIV.T.63.03.09.01

Hill Group XXXVII was a residential complex located 3.5km from the civic/ceremonial center of Cival. It is composed of four structures, one to each the north, east, and west, as well as one in the northeast (Estrada-Belli 2008). An excavation was placed in the center of the group, aiming to establish the construction phases of the group. Due to the lack of floors or walls delineated within the unit, it was not possible to estimate any construction phases, however, skeletal remains (CIV.T.63.03.09.01) were found placed directly on the bedrock (CIV.T.63.05).

The individual was placed extended supine and oriented west-east, with a fragmented ceramic vessel placed over the skull (Figure 8.128). The archaeologists note

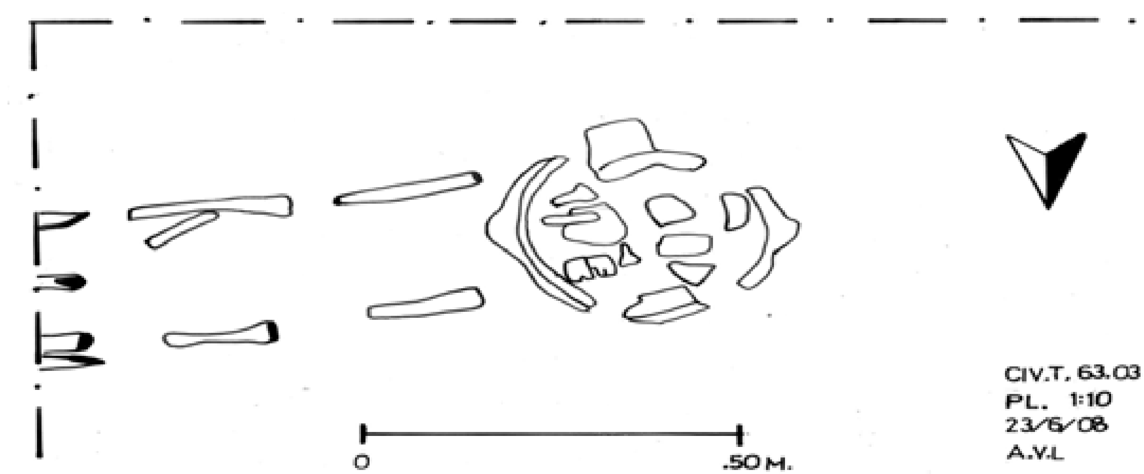

Figure 8.128 Plan drawing of CIV.T.63.03.09.01 by A Velasquez (Estrada-Belli 2008:40).

the lack of any formal grave construction, with the body being placed directly on the bedrock. The burial manner is that of a single individual interment in primary context.

The elements preserved for osteological analysis include some cranial fragments, some mandible fragments, some dentition, two fragments of a scapula, and small fragments of radii, ulnae, and humeri. An alveolar body fragment of the mandible has the roots of the first or second left molar in place and a socket for the second of third molar. The dentition (Figure 8.129) preserved includes all four mandibular incisors, one mandibular premolar, one maxillary canine, one second maxillary incisor, and the first and second right maxillary molars attached by alveolar. Due to its fragmentary and eroded condition, estimations of age-at-death and biological sex are not possible, as well as any paleopathological bservations.

The enamel of the right first maxillary molar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$. The $^{87}Sr/^{86}Sr$ result was 0.70844, while the $\delta^{18}O$ result was -5.5 (adjusted for weaning to -6.2) and $\delta^{13}C$ was -6.2. Statistically, CIV.T.63.03.09.01 was not an outlier and most likely from Cival or the Holmul region.

Figure 8.129 Dentition of CIV.T.63.03.09.01.

CIV.T.61.04.09.01

Individual/Burial ID #:	**CIV.T.61.04.09.01; "CIV.GR38.T61.04"**
Laboratory ID #:	CI-16-38
Site:	Cival
Associated Period/Date:	Late Preclassic?
Year Excavated:	2008
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Cival, Y K'o. Informe Preliminar de la Temporada 2008*
Dentition Sampled:	Mandibular Premolar
Burial Location and Construction:	Residential Hill Group XXXVIII, capped cist
Burial Type, Manner, and Positioning:	Primary, single individual grave interment, flexed supine, head to SW
Associated Artifacts:	None
Preservation:	Partial (25-75%)
Age-at-Death Estimation:	Adult (17-30yrs?)
Biological Sex Estimation:	Male (cranial morph)
Observations:	Occlusal wear, possible abscess of mandibular alveolar
Stable Isotope Results:	$\delta^{18}O$: -5.1 (-5.5*) $\delta^{13}C$: -4.6 *adjusted for weaning

Table 8.45 Individual profile of CIV.T.61.04.09.01

In Hill Group XXXVIII, an east-west excavation trench was placed in the south structure. Archaeologists aimed to understand the construction phases and ceramic chronology of this residential group, located 3.4km from the civic/ceremonial center of Cival. Two construction phases were delineated, 1) a leveling of the bedrock with a floor and walls and 2) a covering of the structure with fill. In the northwest corner of the unit, a grave was found with interred remains (CIV.T.61.04.09.01).

Little mortuary context is mentioned in the report; however, the grave construction can be inferred partially from the drawn profile of the unit (Figure 8.130). The grave appears to have stone walls and capstones, suggesting a capped cist construction. In his thesis, Velásquez (2011) described the primary single individual as flexed, yet supine, and oriented towards the southwest.

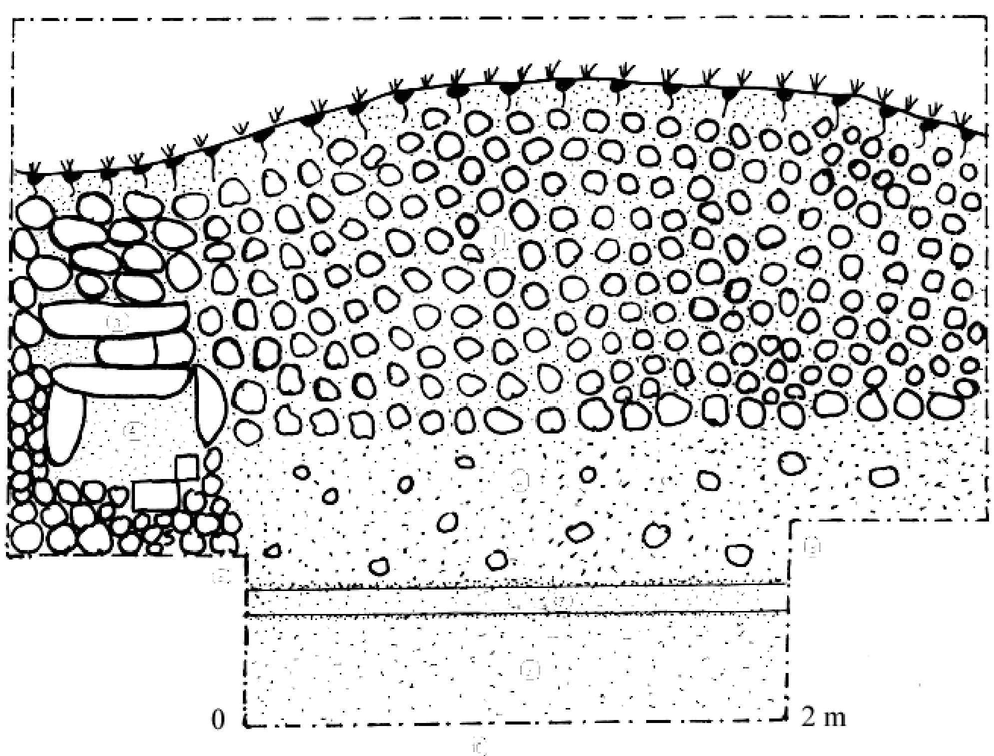

Figure 8.130 West Profile of CIV.T.61.04 (Estrada-Belli 2008:34).

While the cranium of the individual is fragmented and has postmortem damage, the cranial bones can be fitted together to form most of the braincase. The frontal bone is complete, with prominent supraciliary arches and supraorbital ridges (scoring 4-5). The supraorbital margins are very blunt (scoring 4-5). The parietal bones are connected at the sagittal suture, although the right parietal is fragmented with major postmortem damage. There is a fragment of the occipital bone with the external occipital protuberance with large, protruding nuchal crest (scoring 4-5).

The mandible is fragmented on the right side (Figure 8.131), with the mental eminence preserved (scoring 4-5). The left side of the mandible has roots in sockets, while the crowns have broken off for all four incisors, the left canine, and the two left premolars. The mandible has alveolar resorption of the left first molar, and possibly the second as well. There is a large abscess of the alveolar in the position of the third molar, which probably contributed to the antemortem loss of the molars and the resorption. It is also possible that this abscess is the space for a not-yet erupted third molar. There are two

Figure 8.131 Mandible of CIV.T.61.04.09.01.

small fragments of the maxilla that join at the intermaxillary suture, which was not fused (Figure 8.132). The left maxillary canine, while broken postmortem, is in situ in the maxilla. The loose dentition includes the right second maxillary incisor with occlusal wear, a mandibular incisor with wear, two mandibular premolars, one maxillary premolar, and a third molar crown lacking roots due to postmortem damage.

The presence of a third molar and the possible space for an unerupted molar in the mandible, suggests an estimation of age-at-death as adult, but probably 17-21 years of age (Thoma and Goldman 1960). I would expand this estimate to be 17-30, as third molar eruption is highly variable and the intermaxillary suture has not fused (Persson and

Figure 8.132 Maxilla of CIV.T.61.04.09.01.

Thilander 1977). The scoring of the cranial morphology estimates that the biological sex of this individual was male (Figure 8.133).

The fragmentary axial elements present include a complete second cervical vertebra, fragments of cervical vertebrae, and two small rib fragments. The appendicular elements include fragments of both the left and right clavicles and the acromion process and glenoid process of the right scapula. The long bones include the shafts of the left and right ulnae, the proximal shaft of the right humerus and a fragment of its humeral head, distal shaft fragments of a radius, and the shaft of the left humerus.

The enamel of a mandibular premolar was tested for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$. The $\delta^{18}O$ was -5.1 (adjusted to -5.7*) and $\delta^{13}C$ was -4.6. The $^{87}Sr/^{86}Sr$ test was not successful and will need to be re-run for any conclusions are made regarding the geographic origins of CIV.T.61.04.09.01.

Figure 8.133 External occipital protuberance of CIV.T.61.04.09.01.

The Osteobiographies of Burials from Unclear Contexts

CIV.T.55.03.09.01

Individual/Burial ID #:	**CIV.T.55.03.09.01**
Laboratory ID #:	CI-16-36
Site:	Cival
Associated Period/Date:	Unknown
Year Excavated:	2008
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Cival, Y K'o. Informe Preliminar de la Temporada 2008*
Dentition Sampled:	Left first mandibular molar
Burial Location and Construction:	Unknown location, uncapped cist?
Burial Type, Manner, and Positioning:	Primary, single individual interment, flexed on left, oriented S-N
Associated Artifacts:	Unknown
Preservation:	Partial (25-75%)
Age-at-Death Estimation:	Adult (third molar)
Biological Sex Estimation:	Male (GSN)
Observations:	Minor occlusal wear, possible perimortem trauma
Stable Isotope Results:	$\delta^{18}O$: -4.3 (-5.0*), $\delta^{13}C$: -5.8 *adjusted for weaning

Table 8.46 Individual profile of CIV.T.55.03.09.01

Contextual information for excavation unit 55 is not present within the report from 2008, except for a preliminary osteological evaluation of CIV.T.55.03.09.01 in the appendix. This section of the report mentions that the individual was found in a cist without a capstone, positioned flexed on their left side and oriented south-north (Estrada-Belli 2008). Further mortuary and excavation context was not reported, nor were field notes found.

CIV.T.55.03.09.01 was previously examined and fragmented elements were glued together, allowing for the scoring of the cranial morphology for an estimation of biological sex. The cranium (Figure 8.134consists of a fragmented, and glued, frontal bone with a supraorbital margin scoring a 4 and the supraorbital ridge scoring a 2. Both parietal bones are present and glued to the frontal bone. The occipital bone was also mended together with a nuchal crest scoring a 3. Both temporal bones were present with the mastoid processes scoring 3. The mandible was fragmented but glued together with no in situ dentitions, but all alveolar sockets present, including the third molars (Figure 8.135). The mental eminence scored a 4. The mandible dentition present includes: the first second incisor, all four premolars, the left and right first molars, the right second molar, and a third molar. The maxillary dentition present includes: right second incisor,

Figure 8.134 Cranium of CIV.T.55.03.09.01.

Figure 8.135 Mandible of CIV.T.55.03.09.01.

both canines, all four premolars, and both first and second molars. The presence of the third molar allows for an estimation of age-at-death of adult. The only dental pathology present is minor occlusal wear on the mandibular first molars.

The skeleton remains preserved include fragments of both clavicles, a small fragment of the left scapula, complete first and second cervical vertebrae, as well as another complete cervical vertebra and fragments of thoracic and lumbar vertebrae. Only a fragment of the anterior/superior portion of the sacrum was preserved. The ribs were completely fragmented. A fragment of the right auricular surface and a nearly complete left ilium were preserved (Figure 8.136). The left greater sciatic notch was preserved and

Figure 8.136 Left os coxae of CIV.T.55.03.09.01.

very narrow and the left preauricular sulcus is nearly absent, suggesting a biological sex of male, which supplements the somewhat ambiguous cranial morphology.

Shaft fragments of all the long bones were present, with the left humerus, the right radius, and the left femur being the most complete. The maximum diameter of the left femoral head was measured to be 44.97mm, which is ambiguous regarding an estimation of biological sex. Fragments of the right patella were preserved, as well as a lunate, six shaft fragments of metacarpals, and four fragments of proximal hand phalanges. The right and left tali were mostly complete, while the first calcaneus was very fragmented. A navicular bone was present, as well as a first, second, third, and fifth metatarsals.

In the field report for the 2008 season, Varinia Matute Rodriguez presented a preliminary osteological analysis of the burials (Estrada-Belli 2008). She proposed that fractures to the left parietal bone may indicate perimortem trauma to the head, but it is as possible that the fracture was postmortem and a result of taphonomic processes. Excavation context might assist in the interpretation. She also suggested that there were perimortem fractures to the left humerus, radius, and ulna, however these fractures were glued together, which rendered it difficult to examine. It is as likely that these fractures are postmortem and of a taphonomic nature.

The enamel of the left first mandibular molar was tested for $\delta^{18}O$ and $\delta^{13}C$. The $\delta^{18}O$ result was -4.3 (adjusted for weaning to -5.0) and $\delta^{13}C$ was -5.8. The $^{87}Sr/^{86}Sr$ test was not successful and will need to be re-run before any conclusions can be made regarding the geographic origins of CIV.T.55.03.09.01.

Considering the Burials of Cival

All of the burials evaluated from Cival date to the Middle or Late Preclassic period, during Cival's rise and florescence and before the power shifted back to Holmul for the Classic period. In the civic ceremonial center, the dentition of two individuals were found during tunnel excavations to explore the sub-structure with painted stucco and anthropomorphic masks. Any mortuary context was not reported. Both individuals buried within this ceremonial structure were suggested to be local to Cival from the stable isotope analyses. The lack of context renders it difficult to deduce any further elements of these individuals' identities.

Also interred in the center of Cival, CIV.T.28.11.09.01 was a young adult male with dental caries and wear buried in a multi-chambered *chultun*. Radiocarbon dated the individual to 840-880 BC (calibrated), and the stable isotope analysis suggests that he was local to Cival. Puleston (1971) argued against the primary function of *chultunes* as burial chambers. He remarked that even when used as burial chambers, it was clearly their secondary function and not initially intended for burial use. Welsh (1988) identified four *chultun* burials at Mountain Cow, three at Uaxactun, four at Tikal, and one at Dzibilchaltun. He dates three of the *chultun* burials at Mountain Cow to between AD 0 and 100, with the fourth not being datable. The three from Uaxactun also are not dated. At Tikal, one of the *chultun* burials is the oldest at the site, dating to 600-450 BC, with the three other *chultun* burials dating between AD 400 and 700. At Dzibilchaltun, the *chultun* burial dates to AD 150-250. Many of these burials date to the Preclassic, suggesting a prevalence for using *chultunes* as burials during that time. More recent excavations at Nakum confirm this trend, with four burials found within *chultunes*, all dating to the Preclassic (Hermes et al. 2005). Cagnato (2017) argues that *chultunes* acted as ritual locales, as symbolic caves, with the human remains acting as offerings. The Preclassic origin of many Maya chultun burials suggest that these rituals were present as early as 840 BC.

On the northern edge of Cival's center, an adult female was found in a partial cist burial intruding into a midden. This is not an unusual burial location, as Haviland (1985) suggests that most Maya burials might have been interred in middens, leading to the distribution of skeletal fragments in various locations at Tikal. CIV.T.22.13.09.01 was accompanied by a small ceramic pot and shells, and the stable isotope analysis suggests she was local to Cival.

In the Far West Group of Cival's center, multiple individuals were found in the construction fill of the penultimate construction of the Structure 33 platform, dating the Middle Preclassic period. This problematic deposit may have been a formal burial, but it is difficult to determine. The skeletal remains (CIV.T.45.11.09) of both adults and juveniles were found within the construction fill, not in anatomical position and grouped together. It may represent a simple grave type of the simple variety, with multiple individuals in a secondary context. However, the presence of carpals and metacarpals suggest that this could have been a bundle burial that preserved the bones usually lost in a secondary burial. The stable isotope analysis for two individuals revealed local origins.

In the Residential Hill Groups of Cival, two individuals were tested for stable isotope ratios. CIV.T.63.03.09.01, of local origin, was found extended supine in a simple, simple grave with a ceramic vessel placed over the skull. CIV.T.61.04.09.01 was an adult male with dental wear and a possible mandibular alveolar abscess. He was positioned flexed in a capped cist with no associated artifacts. Unfortunately, the stable isotope needs to be re-run to estimate his geographic origin.

Cival

HAP ID	CIV.T.01.09.01	CIV.T.01.04.09.01	CIV.T.28.11.09.01	CIV.T.22.13.09.01	CIV.T.45.11.09.01	CIV.T.45.11.09.02	CIV.T.63.03.09.01	CIV.T.61.04.09.01	CIV.T.55.03.09.01
Sample ID	CI-16-39	CI-16-40	CI-16-33	CI-16-32	CI-16-34	CI-16-35	CI-16-37	CI-16-38	CI-16-36
aka	CIV.CT1	CIV.T1.04	HAP 33	HAP 25	HAP 34 A	HAP 34 B		CIV.GR38.T61.04	
Period	Late Preclassic	Late Preclassic	Preclassic (850-800 BC)	Late Preclassic	Middle Preclassic	Middle Preclassic	Late Preclassic?	Late Preclassic?	
Location	Group I, Str. 1, tunnel to mask	Group I, Str. 1, tunnel to mask	North Pyramid chultun	Northern Slope of Main Plaza (Northern Sector midden)	Far West Group Str. 33	Far West Group Str. 33	Residential Hill Group 37	Residential Hill Group 38	unknown (Unit 55)
Age-at-Death	Ind.	Ind.	20-30yrs	Adult?	Ind.	Ind.	Ind.	Adult (17-30yrs?)	Adult
Biological Sex	Ind.	Ind.	Male	Female?	Ind.	Ind.	Ind.	Male	Male
Dental Pathology			Large dental caries, occlusal wear	Occlusal wear	Dental caries, calculus, occlusal wear, dental mod. For inlays			Occlusal wear, possible mandibular alveolar abscess	Minor occlusal wear
Pathology			Addition/ lesions on foot phalanx, lesions on						possible perimortem trauma

			medial shafts of clavicles						
Burial Type			Grave Interment	Grave Interment	Prob. Deposit	Prob. Deposit	Grave Interment	Grave Interment	Grave Interment
Burial Manner			Primary, single	Primary, single	Secondary, multiple	Secondary, multiple	Primary, single	Primary, single	Primary, single
Body Positioning			Partially flexed (left) and extended (supine), S-N, facing W	Partially extended flexed on right, W-E, facing S			Extended supine, W-E	Flexed supine, head to SW	Flexed on left, S-N
Burial Location	Religious/ Ceremonia l	Religious/ Ceremonia l	Religious/ Ceremonia l	Religious/ Ceremonia l Midden	Religious/ Ceremonia l	Religious/ Ceremonia l	Residentia l	Residentia l	unknown
Grave Construction			Chultun	Partial cist	Simple, simple	Simple, simple	Simple, simple	Capped cist	Uncapped cist?
Associated Artifacts			None	small ceramic pot, 3 pomacea shells	None	None	Ceramic over skull	None	
Tooth Sampled	RM^1	LM_1	LM^2	LM^1	LM_2	LM_2	RM^1	PM_x	LM_1
$^{87}Sr/^{86}Sr$	0.70783	0.70792	0.70783	0.70813	0.70793	0.70818	0.70844		
$\delta^{18}O_{ap}$	-5.0 (-5.7*)	-5.0 (-5.7*)		-5.3 (-6.0*)	-4.8 (-5.2*)	-4.8 (-5.1*)	-5.5 (-6.2*)	-5.1 (-5.5*)	-4.3 (-5.0*)
$\delta^{13}C_{ap}$	-6.2	-3.5	-6.9	-6.9	-5.5	-5.7	-6.2	-4.6	-5.8
Local or Non-Local	Local	Local	Local	Local	Local	Local	Local		

Table 8.47 Summary of the burials of Cival

K’o

K’o (Figure 8.137) was founded during the Late Middle Preclassic (600-350 BC) with continuous inhabitation throughout the Classic period and into the Terminal Classic. Human skeletal remains excavated at K’o date to all periods of occupation, including the Late/Terminal Preclassic, Early Classic, and Late/Terminal Classic. The osteobiographies that follow include individuals excavated in the Residential Groups IV, XII, XXXVIII, and XXXIX.

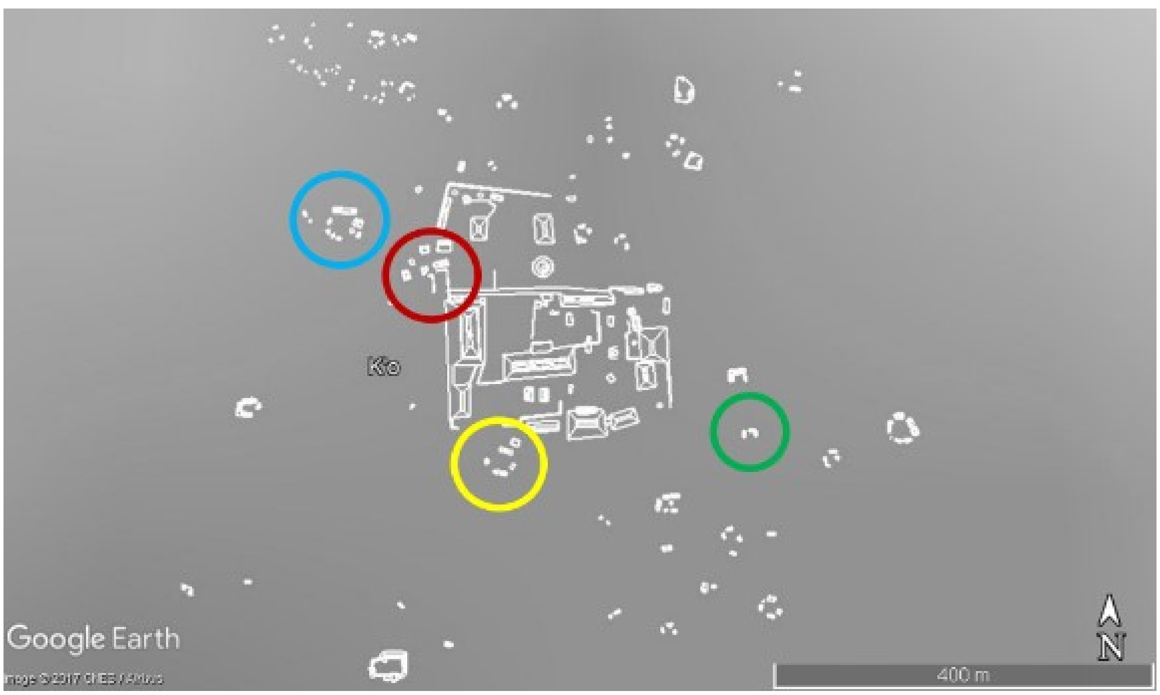

Figure 8.137 Map of K’o. Group XXXXVIII encircled in blue, Group XXXIX encircled in red, Group IV in yellow, and Group XII in green (Google Earth Pro). Image Courtesy of HAP.

The Osteobiographies of K'o, Residential Group XXXVIII

Group XXXVIII (Figure 8.138) is located approximately 200 meters to the northwest of the site core. Structure 45 of Group XXXVIII is the eastern structure of this residential group, suggesting its role as a mortuary shrine to those ancestors interred within. Excavations at this structure aimed to clean and stabilize the intrusive and destructive looter's trenches, and then to explore the function of the structure (Estrada-Belli 2008).

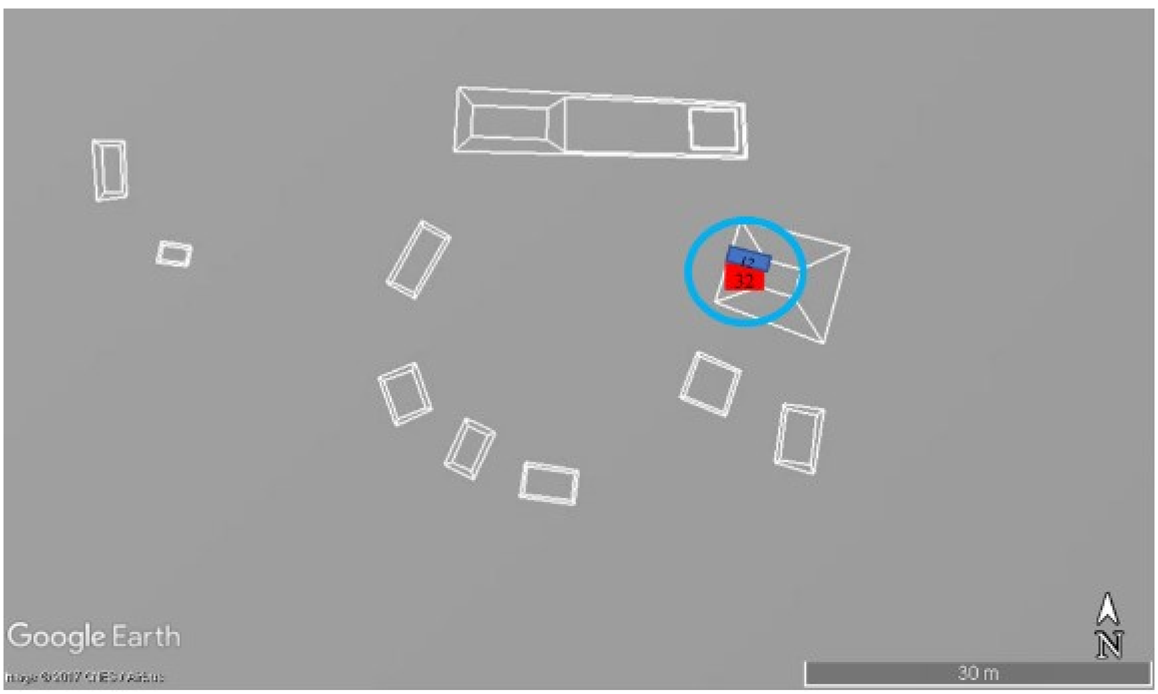

Figure 8.138 Map of Group XXXVIII (Looter's Trench 12 and Unit 32 encircled in blue) (Google Earth Pro). Image Courtesy of HAP.

KOL.L.07.01.09.01

Individual/Burial ID #:	**KOL.L.07.01.09.01**
Laboratory ID #:	KO-16-42
Site:	K'o
Associated Period/Date:	Late/Terminal Preclassic
Year Excavated:	2008
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Cival, Y K'o. Informe Preliminar de la Temporada 2008*
Dentition Sampled:	Right first maxillary molar
Burial Location and Construction:	Elite Residential Ceremonial Building, elaborate crypt
Burial Type, Manner, and Positioning:	Grave Interment, unknown manner, oriented S-N
Associated Artifacts:	Looted
Preservation:	Fragmentary-Looted (0-25%)
Age-at-Death Estimation:	Adult?
Biological Sex Estimation:	Indeterminate
Observations:	Dental modification
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70842, $\delta^{18}O$: -4.3 (-5.0*), $\delta^{13}C$: -6.8 **local** *adjusted for weaning

Table 8.48 Individual profile of KOL.L.07.01.09.01

Five construction phases and a looted grave were exposed during the salvage excavations and cleaning of Looter's Trench 12 (Figure 8.139), located on the western side of Structure 45. The earliest construction phase dates to the Terminal Preclassic, as does the second construction phase that contained the burial KOL.L.07.01.09.01, while the last phase dates to the Late Classic.

The grave construction was described as well preserved, although looted. The dimensions of the grave measured to be 195 cm in length, 45 cm in width, and 110 centimeters in height, being oriented north-south (Tomasic 2009). Cranial fragments and dentition were found in the southeastern area of the floor, suggesting that the individual was oriented south-north within the grave. Fragments of stucco were collected from the

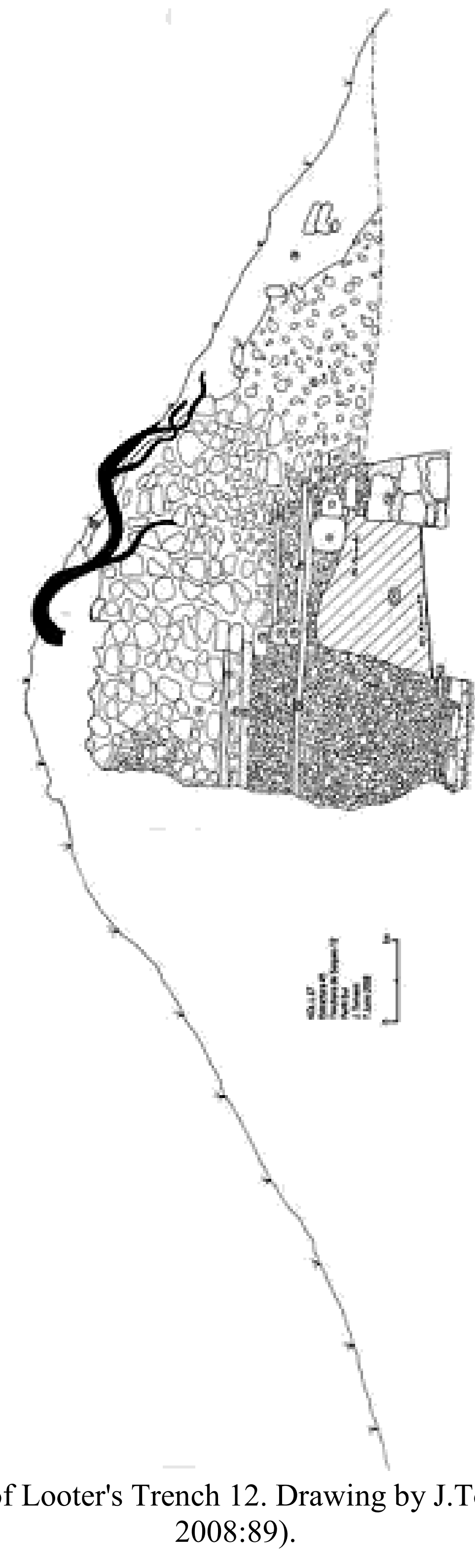

Figure 8.139 Profile of Looter's Trench 12. Drawing by J.Tomasic (Estrada-Belli 2008:89).

walls of the grave (Figure 8.140). Due to the size of the interment area and the plastered walls, the grave construction can be classified as an Elaborate Crypt. Further mortuary data was destroyed by the looters.

The osteological evaluation of the skeletal remains revealed the presence of at least two individuals. Within the dentition, in addition to the four mandibular premolars, two mandibular premolars had darker coloration. The maxillary dentition preserved included the right first incisor, the left and right second incisors, the left canine, and all three right molars. The mandibular dentition included the right first incisor, the aforementioned four premolars, the right first and second molars, and two fragmented

Figure 8.140 Photograph of the south wall of the crypt within Structure 45 (KOL.L.07.02) (Estrada-Belli 2008:90).

molar crowns. Further skeletal remains include some long bone fragments, cranial fragments, a fragmented first cervical vertebra, fragment of the mandible with evidence of alveolar resorption, and a medial hand phalanx.

The maxillary incisors were modified by filing and labial incision (Figure 8.141). The right first incisor was filed, resembling type B-4, while its labial incision was that of D-10 (Romero 1970). The right second incisor was filed as type B-1, while the left second incisor was filed as type B-2 (Romero 1970).

Figure 8.141 Modified dentition of KOL.L.07.01.09.01.

The poor preservation and disturbed skeletal remains limit any estimations of age-at-death or biological sex or an in-depth paleopathological evaluation. The presence of a third molar and alveolar resorption of the mandible suggest the individual was an adult. An estimation of biological sex is not possible with the preserved remains.

The enamel of the right maxillary first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70842, while the $\delta^{18}O$ was -4.3 (adjusted for weaning to -5.0) and $\delta^{13}C$ was -6.8. Statistically, KOL.L.07.01.09.01 was not an outlier and most likely from K'o.

KOL.T.32.06.09.01

Individual/Burial ID #:	**KOL.T.32.06.09.01**
Laboratory ID #:	KO-16-45
Site:	K'o
Associated Period/Date:	Terminal Early Classic
Year Excavated:	2008 (J.Tomasic)
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Cival, Y K'o. Informe Preliminar de la Temporada 2008*
Dentition Sampled:	Right first mandibular molar
Burial Location and Construction:	Elite Residential Ceremonial Building, capped cist or simple crypt (oriented N-S)
Burial Type, Manner, and Positioning:	Primary Burial Interment, unknown positioning
Associated Artifacts:	Eroded ceramic sherds
Preservation:	Partial (25-75%)
Age-at-Death Estimation:	Adult (third molar)
Biological Sex Estimation:	Indeterminate
Observations:	Occlusal wear
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70845, $\delta^{18}O$: -6.1 (-6.8*) $\delta^{13}C$: -6.9 **local** *adjusted for weaning

Table 8.49 Individual profile of KOL.T.32.06.09.01

Following the salvage work in Looter's Trench 12, a unit (KOL.T.32) was placed on its southern edge to expose the east-west axis of the structure and to clarify the construction phases (Figure 8.141). A grave containing KOL.T.32.06.09.01 was constructed during the fourth construction phase of Structure 45, dating to the end of the Early Classic period. Context 5 pertains to the grave itself, which has stone walls and

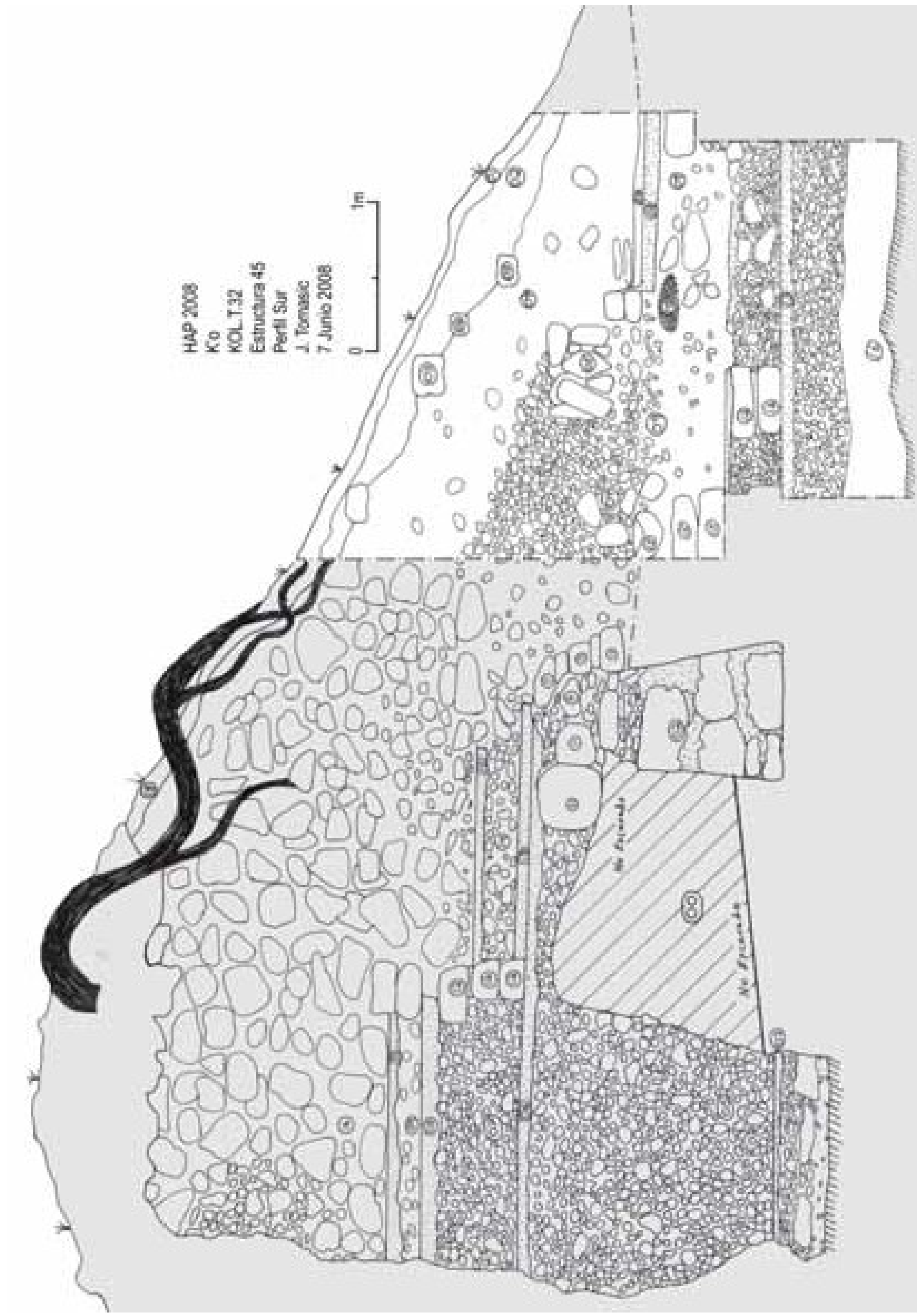

Figure 8.142 Profile drawing of KOL.T.32 with KOL.L.07 in grey. Drawing by J. Tomasic (Estrada-Belli 2008:148).

capstones, resulting in the classification of Capped Cist (or Simple Crypt), and is oriented north-south (Figure 8.143). The burial did not have any associated artifacts, aside from a few highly eroded ceramic sherds. Further mortuary data is not available.

Figure 8.143 Simple Crypt of KOL.T.32.06.09.01 (Context 5-capstones removed) (Estrada-Belli 2008:151).

The skeletal remains, while very eroded, have many elements represented. The cranial fragments include a portion of the frontal bone with the nasal bridge and attached nasal bones and fragments of the mandible and both coronoid processes. The maxillary dentition present include all four incisors, both canines, two premolars, both first molars, and the right third molar. The mandibular dentition includes all four incisors, both canines, a right premolar, and the right first molar. Further teeth were still in place in the

Figure 8.144 Photos representing the postmortem taphonomic damage to KOL.T.32.06.09.01.

mandible, including both left premolars, the left first molar, and the left second molar. Further small and eroded fragments present include that of vertebrae, the scapula, and the os coxae. A proximal shaft fragment of the right radius includes a radial tuberosity with taphonomic damage. There are further long bone fragments of the ulnae, radii, and the humeri, as well as the tibiae and femora. Elements of the extremities are present, including many shaft fragments of metacarpals, proximal phalanges, and medial phalanges. Further, a fragment of the calcaneus is present, along with a metatarsal shaft fragment and two phalanx shafts. The presence of hand and foot bones suggests that this is of a primary burial manner.

Due to the fragmented and eroded nature of the skeletal remains (Figure 8.144), it is not possible to estimate an age-at-death beyond that of an adult, due to the development of the third molar. An estimation of biological sex and any observations of paleopathology, beyond occlusal wear, are not possible. Any indication of dental modification is obscured by taphonomic processes.

The enamel of the right mandibular first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70845, while the $\delta^{18}O$ was -6.1 (adjusted for weaning to -6.8) and $\delta^{13}C$ was -6.9. Statistically, KOL.T.32.06.09.01 was not an outlier and most likely from K'o or the Holmul region.

KOL.T.32.10.09.01

Individual/Burial ID #:	**KOL.T.32.10.09.01**
Laboratory ID #:	KO-16-46
Site:	K'o
Associated Period/Date:	Terminal Early Classic
Year Excavated:	2008
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Cival, Y K'o. Informe Preliminar de la Temporada 2008*
Dentition Sampled:	Left first maxillary molar
Burial Location and Construction:	Elite Residential Ceremonial Building, possibly simple:simple
Burial Type, Manner, and Positioning:	Unknown
Associated Artifacts:	23 pieces of obsidian and a small green stone
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Occlusal wear, dental modification
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70840, $\delta^{18}O$: -2.9 (-3.6*) $\delta^{13}C$: -3.8 **local** *adjusted for weaning

Table 8.50 Individual profile of KOL.T.32.10.09.01

KOL.T.32.10.09.01 (Figure 8.145) was found in Unit 32, in context 10, also dating to the fourth construction phase, or the end of the Early Classic. This poorly preserved burial was accompanied by 23 obsidian pieces, nine of which are blade core production fragments and 14 are obsidian pebbles created by direct percussion (Estrada-Belli 2008). The assemblage may represent a set of divining stones used by a Maya shaman (Estrada-Belli 2008). No further mortuary information is available, aside from a plan view drawing. If this is a burial type of burial and not a cache, then it is possible that the grave construction is of a simple type, simple variety. The burial type, manner, and positioning of the body are unknown.

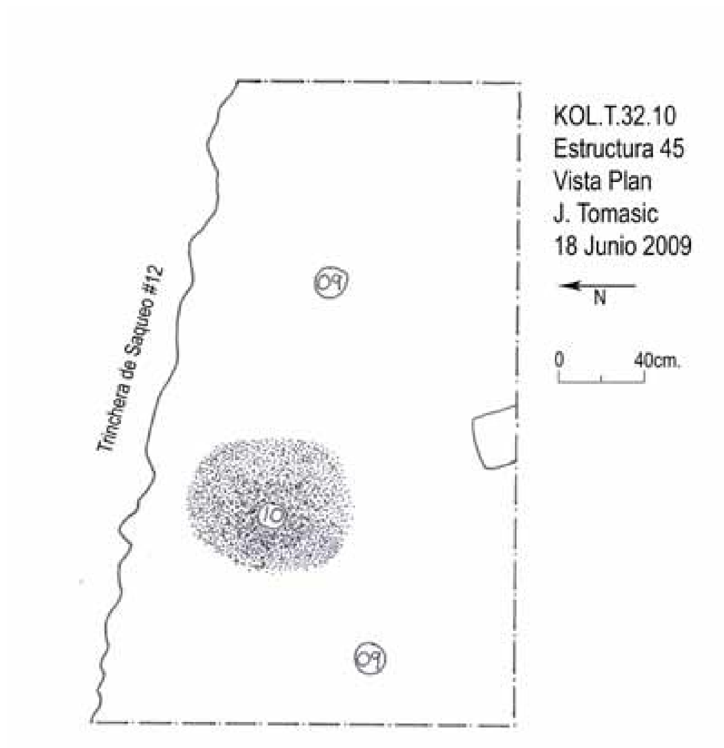

Figure 8.145 Plan drawing of KOL.T.32.10.09.01 by J. Tomasic (Estrada-Belli 2008:152).

The skeletal elements preserved for osteological analysis include some cranial fragments, fragments of both the right and left mandibular rami, and a tiny fragment of the maxilla. The maxillary dentition includes all four incisors, both canines, two premolars, and the right first molar. The mandibular dentition includes four incisors, one canine, three premolars, and a molar crown (first or second). While immensely eroded, dental modification was present on the first maxillary incisors, type B-5 (Romero 1970). Further modification may have been present on the second incisors and the canines, but the erosion obscures its type (Figure 8.146).

Figure 8.146 Dental modification of KOL.T.32.10.09.01.

A fragment was preserved of the right scapular with a portion of the glenoid fossa and infra-glenoid tubercle. Other elements preserved include a fragment of the first cervical vertebrae, fragments of metacarpal shafts, and a fragment of a proximal hand phalanx. Estimations of age-at-death and biological sex are not possible due to the fragmentary nature of the remains. The only paleopathological observation possible is that of occlusal wear on many of the dentition.

The enamel of the left maxillary first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70840, while the $\delta^{18}O$ was -2.9 (adjusted for weaning to -3.6).and $\delta^{13}C$ was -3.8. Statistically, KOL.T.32.10.09.01 was not an outlier and most likely from K'o or the Holmul region.

The Osteobiographies of K'o, Residential Group XXXIX

KOL.L.02.00.09.01

Individual/Burial ID #:	**KOL.L.02.00.09.01; HAP Burial #24**
Laboratory ID #:	KO-16-43
Site:	K'o
Associated Period/Date:	Early Classic
Year Excavated:	2005 (Tomasic)
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén. Informe Preliminar de la Temporada 2005*
Dentition Sampled:	Right first mandibular molar
Burial Location and Construction:	Group XXXIX Structure 3, stone lined tomb
Burial Type, Manner, and Positioning:	Burial, unknown manner and positioning
Associated Artifacts:	Drilled green stone beads
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult (third molar)
Biological Sex Estimation:	Indeterminate
Observations:	Dental caries
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70841, $\delta^{18}O$: -4.0 (-4.7*), $\delta^{13}C$: -5.6 **local** *adjusted for weaning

Table 8.51 Individual profile of KOL.L.02.00.09.01

Patio Group XXXIX (Figure 8.147) was excavated in 2005 with particular focus on salvage excavations within looter's trenches (Tomasic 2009). This high status residential group is located adjacent to the site core in the northwest quadrant of the site.

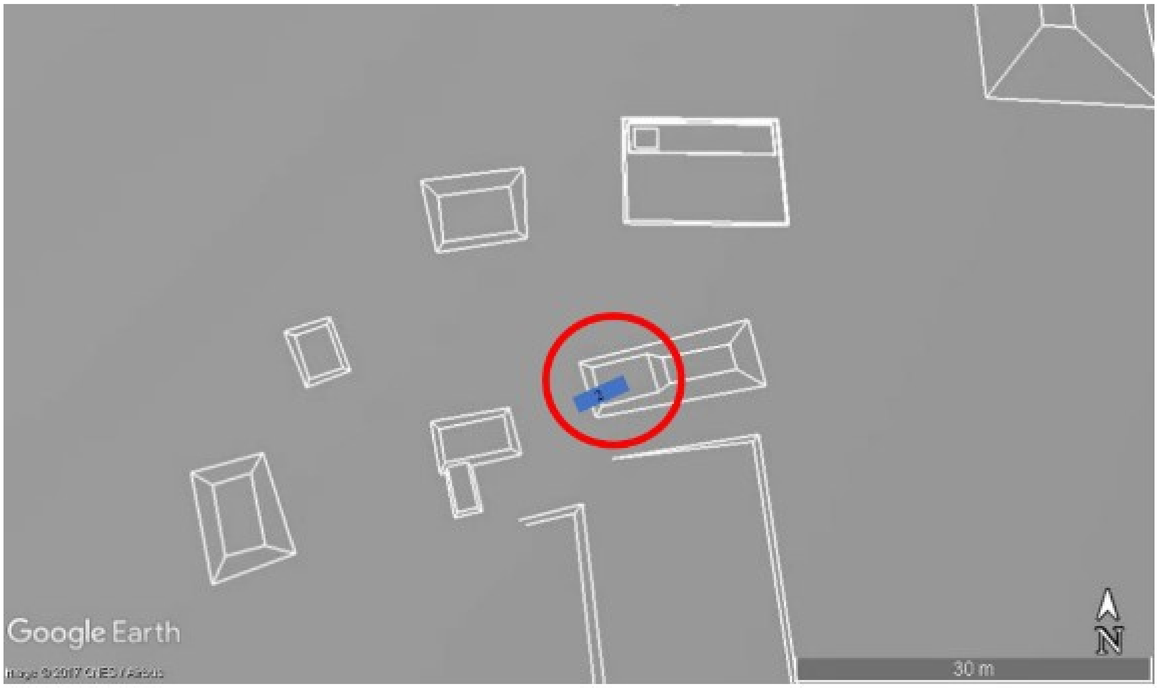

Figure 8.147 Map of Group XXXIX (Looter's Trench 2 encircled in red)
(Google Earth Pro). Image Courtesy of HAP.

Looter's Trench 2 (KOL.L.02) was cut into the western portion of Structure 3, intruding on a vaulted tomb (Figure 8.148). Context KOL.L.02.00 consists of the disturbed contents of the tomb and the discarded mortuary material around the tomb area (Estrada-Belli 2005). Context 14 is that of the vaulted tomb, while context 15 is the cut of the grave. From the stratigraphy revealed from the trench and associated sherds, the tomb and final phase of the structure is dated to the Early Classic (Tomasic 2009).

A cache (contexts 06, 07, 08, and 09) was also excavated during the salvage work at Trench 2 (Figure 8.149). The cache was placed beneath the western stairway of the structure. The covered ceramic vessel with appliqued face contained many artifacts, including marine coral, "Charlie Chaplin" jade and shell figurines, circular objects of shell and green stone, and fragments of flint, obsidian and shell. These types of caches have been found

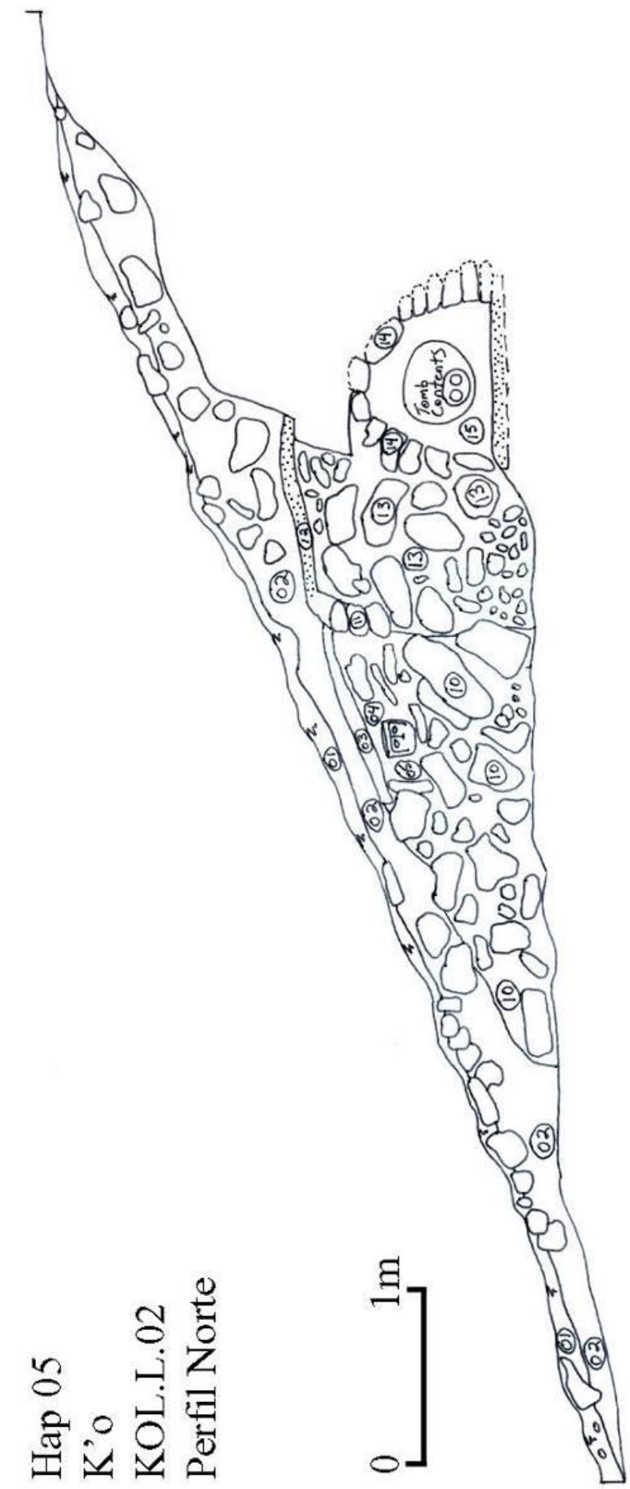

Figure 8.148 North profile of KOL.L.02. Structure 3, Patio Group 39. Drawing by J. Tomasic. (Tomasic 2009:272).

elsewhere in the Maya region acting as offerings for those interred within eastern structures (Chase and Chase 1994).

Little was reported regarding the mortuary context of the individual, in part due to the burial disturbance by the looters. The excavators refer to the burial construction as a vaulted tomb, which is confirmed by the profile drawing and classifying it as a Stone-lined Tomb. The skeletal remains were disturbed eliminating any conclusions of burial manner, body positioning, and orientation.

The skeletal remains recovered for this burial were fragmentary, including small cranial fragments, metacarpal fragments, long bone fragments, and four teeth.

Figure 8.149 Cache vessel found in KOL.L.02 (photo by J. Tomasic) (Tomasic 2009:274).

Preservation of the remains was poor, even of the dentition (Figure 8.150). The roots of the dentition were eroded, and one tooth was fragmented. The teeth had dental caries, but the rest of the skeletal remains were poorly preserved and further paleopathological evaluation was not possible. Due to the presence of a third molar, the age-at-death can be estimated to have been adult. An estimation of biological sex is not possible.

The enamel of the right mandibular first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70841, while the $\delta^{18}O$ was -4.0 (adjusted for weaning to -4.7) and $\delta^{13}C$ was -5.6. Statistically, KOL.L.02.00.09.01 was not an outlier and most likely from K'o or the Holmul region.

Figure 8.150 Dentition of KOL.L.02.00.09.01.

The Osteobiographies of K'o, Residential Group IV

KOL.T.26.03.09.01

Individual/Burial ID #:	**KOL.T.26.03.09.01; KOL.T.26.02(a)**
Laboratory ID #:	KO-16-41
Site:	K'o
Associated Period/Date:	Late Classic
Year Excavated:	2008
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Cival, Y K'o. Informe Preliminar de la Temporada 2008*
Dentition Sampled:	Left mandibular first molar
Burial Location and Construction:	Group IV Structure 60
Burial Type, Manner, and Positioning:	Grave Interment or Cache? body oriented S-N
Associated Artifacts:	Oval biface
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Infans II (9±2 years: root development)
Biological Sex Estimation:	Indeterminate
Observations:	Dental caries
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70797, $\delta^{18}O$: -5.0 (-5.7*), $\delta^{13}C$: -7.1 **non-local** *adjusted for weaning

Table 8.52 Individual profile of KOL.T.26.03.09.01

The high status residential Group IV (Figure 8.151) was excavated in 2008, located on the south edge of the site core. Unit 26 was placed on the western edge of Structure 60, the southernmost structure in the group (Estrada-Belli 2008). The burial of KOL.T.26.03.09.01 was found in Context 2 (Figure 8.152), a layer of sandy soil under the humus layer (Context 1). The skeletal remains recovered included long bone fragments to the north of some dentition, suggesting to the excavators that the body was oriented south-north. Further mortuary data was not observed and only one oval biface was reported as an associated artifact. Due to similar stratigraphic layers in KOL.T.15.05, the burial is dated to the Late Classic.

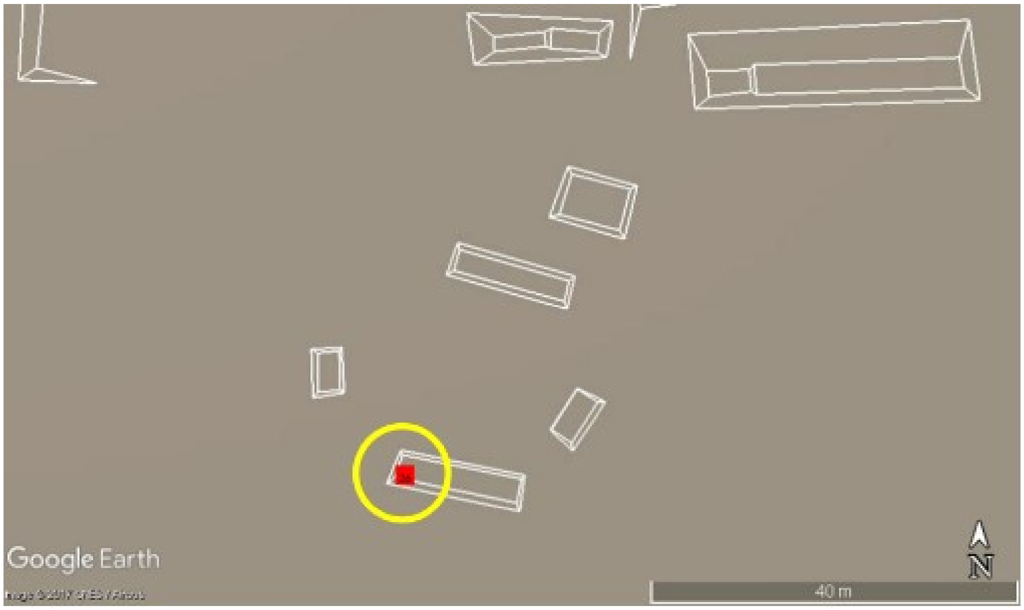

Figure 8.151 Map of Group IV (Unit 26 encircled in yellow)
(Google Earth Pro). Image Courtesy of HAP.

The osteological evaluation documented the extremely eroded dentition (Figure 8.153) and severely fragmented long bones. The teeth preserved included all four maxillary incisors, the left maxillary canine, two maxillary premolars, the right first mandibular incisor, both mandibular canines, a mandibular premolar, the left first and second mandibular molars, and the right first and second mandibular molars. Although eroded, some dental caries were visible. The observed root development allowed for

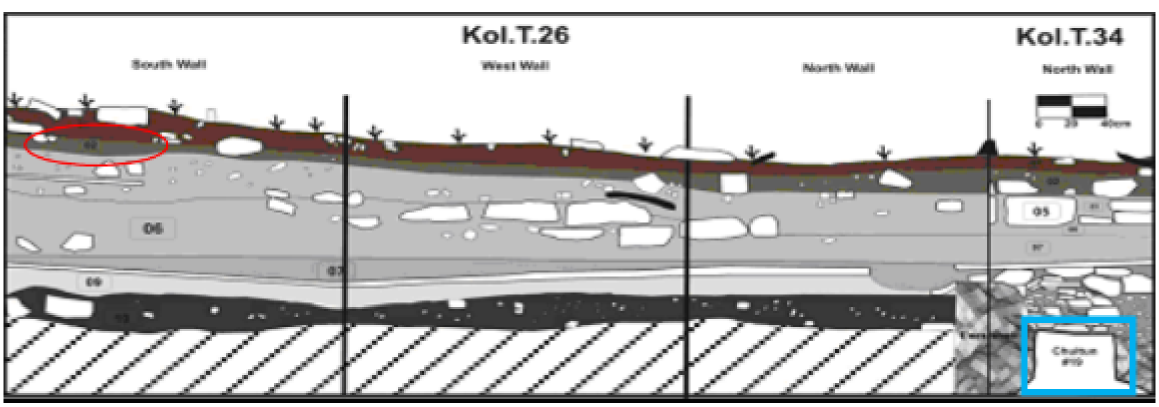

Figure 8.152 Profile drawing of KOL.T.26 and KOL.T.34.

estimations of age-at-death of 9±2 years (Ubelaker 1999; Thoma and Goldman 1960; Smith 1991).

The enamel of the left mandibular first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70797, while the $\delta^{18}O$ was -5.0 (adjusted to -5.7) and $\delta^{13}C$ was -7.1. Statistically, KOL.T.26.03.09.01 was identified as an outlier for the $^{87}Sr/^{86}Sr$ ratio result, suggesting that this individual was not local to K'o. Possible geographic origins include Piedras Negras (0.7080), Calakmul (0.707), Tonina (0.7079), Palenque (0.7079), and El Mirador (0.7079).

Figure 8.153 Dentition of KOL.T.26.03.09.01.

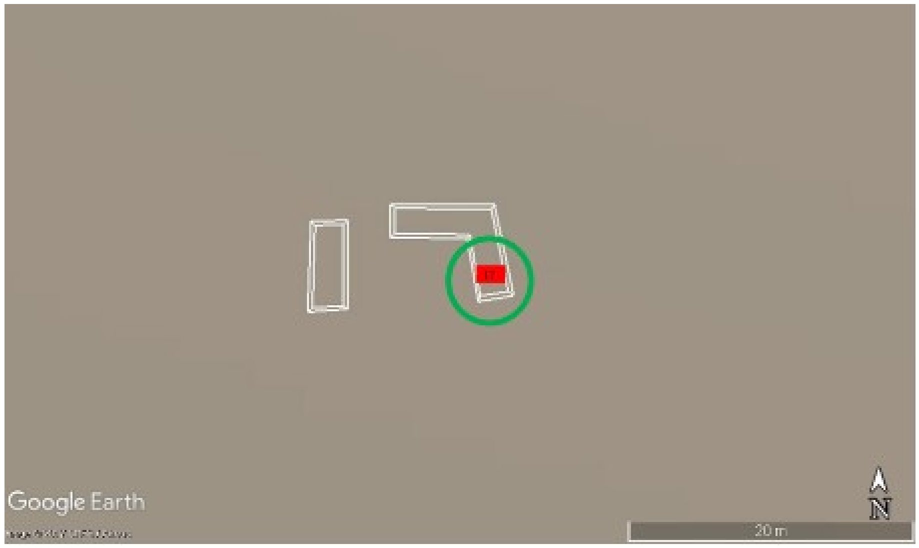

Figure 8.154 Map of Group XII (Unit 17 encircled in green) (Google Earth Pro). Image Courtesy of HAP.

KOL.T.17.01.09.01

Individual/Burial ID #:	**KOL.T.17.01.09.01/HAP Burial #32**
Laboratory ID #:	KO-15-44
Site:	K'o
Associated Period/Date:	Late/Terminal Classic (?)
Year Excavated:	2007
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul, Cival, La Sufricaya, y K'o. Informe Preliminar de la Temporada 2007*
Dentition Sampled:	Right first maxillary molar
Burial Location and Construction:	Group XII Structure 107
Burial Type, Manner, and Positioning:	Unknown-not completely excavated
Associated Artifacts:	Fragment of yellow ochre
Preservation:	? Not completely excavated
Age-at-Death Estimation:	Adult (third molar)
Biological Sex Estimation:	Indeterminate
Observations:	Occlusal Wear
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70837, $\delta^{18}O$: -4.1 (-4.8*) $\delta^{13}C$: -6.7 **local** *adjusted for weaning

Table 8.53 Individual profile of KOL.T.17.01.09.01

The skeletal remains of KOL.T.17.01.09.01 were excavated in the first context of Unit 17 of Structure 107. This structure was the eastern structure of Group XII, which is considered a lower status residential group (Tomasic 2009). Dentition and some long bone fragments were found in this first context, the humus layer, and designated Burial 32. The burial was not excavated to completion, resulting in limited mortuary context. A fragment of yellow ochre (KOL.T.17.1.14.01) was also recovered in this context, possibly an associated artifact of the burial. The ceramic sherds from this context range from the Late Preclassic through the Terminal Classic, but the excavators suppose that the burial, being so superficial, would have dated to the later periods.

The osteological evaluation documented six long bone fragments, two mandibular molars (a first and third), four mandibular incisors, the crown of a mandibular premolar, two maxillary incisors, three maxillary premolars, and one maxillary first molar (Figure 8.155). The dentition, especially the incisors and molars, has significant occlusal wear

Figure 8.155 Maxillary dentition of KOL.T.17.01.09.01.

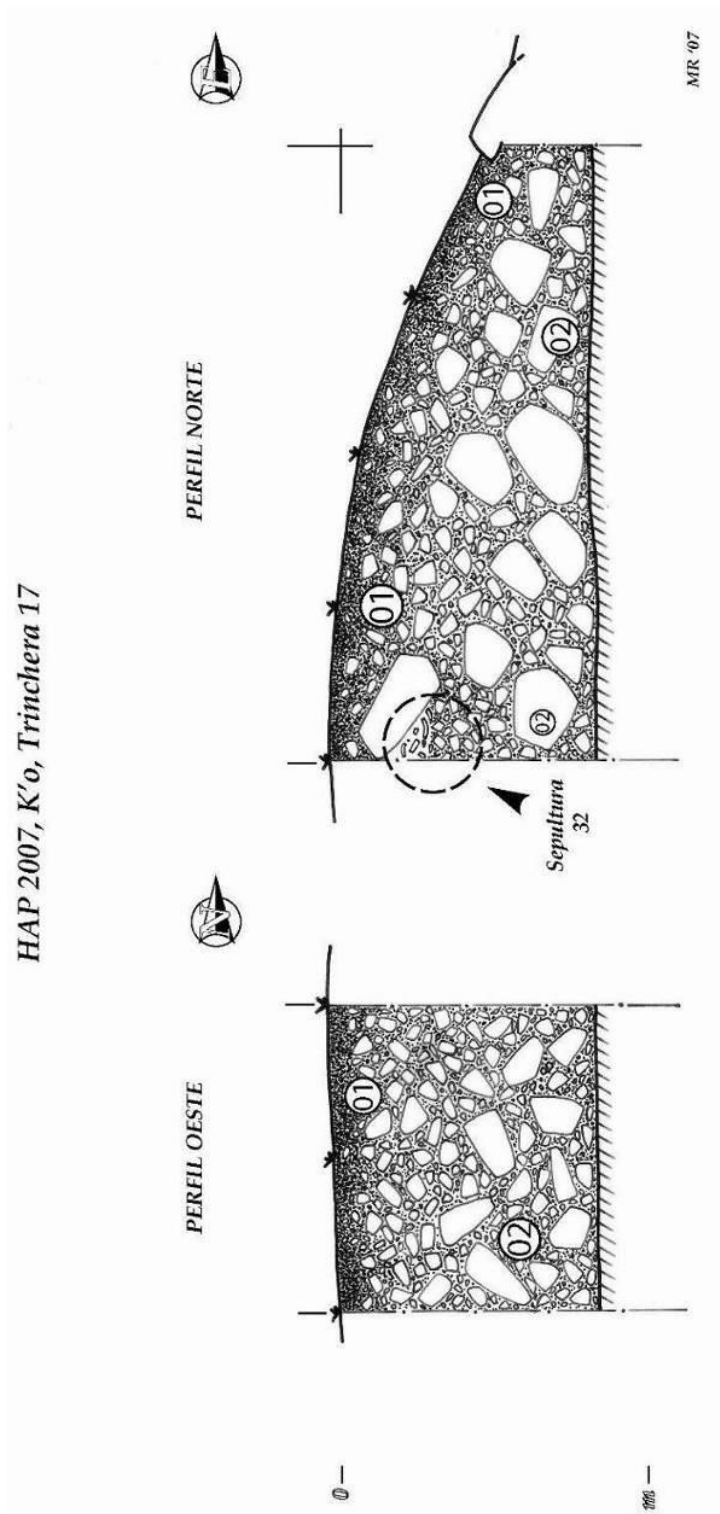

Figure 8.156 Profile of KOL.T.17. Drawing by M. Rangel (Tomasic 2009:136).

and some dental calculus. The maxillary incisors can be considered “shovel shaped incisors”. Due to the presence of the third molar and significant occlusal wear, the estimation of age-at-death is adult. The estimation of biological sex is not possible.

The enamel of the right maxillary first molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70837, while the $\delta^{18}O$ was -4.1 (adjusted to -4.8) and $\delta^{13}C$ was -6.7. Statistically, KOL.T.17.01.09.01 was not an outlier and most likely from K’o or the Holmul region.

Considering the Burials of K’o

The burials excavated at in the residential groups of K’o date to all periods of occupation, including the Late/Terminal Preclassic, Early Classic, and Late/Terminal Classic. Buried in Structure 45 of Group XXXVIII, three individuals were analyzed for stable isotope ratios that suggested their local origin. Dating to the Late/Terminal Preclassic, KOL.L.07.01.09.01 was an adult individual with dental modification, interred in an elaborate crypt that was looted of its associated artifacts. The two other individuals tested for this study date to the Terminal Early Classic, with the adult KOL.T.32.06.09.01 being buried in a capped cist or simple crypt and KOL.T.32.10.09.01 in a simple, simple grave. The later individual was buried with 23 pieces of obsidian and a small green stone, and had dental modification to their maxillary first incisors. These individuals were interred in the eastern structure of this elite residential group, suggesting its role as a mortuary shrine to those ancestors interred within. As KOL.L.07.01.09.01 was interred hundreds of years before in an elaborate crypt, it is possible that they may have been the ancestors being venerated.

KOL.L.02.00.09.01 was an Early Classic adult individual interred in a stone-lined tomb and accompanied by drilled green stone beads. The stable isotope analysis suggests they were local in origins and then buried in Structure 3 of the elite Residential Group XXXIX. Also buried in a residential group (Group XII, Structure 107), KOL.T.17.01.09.01 was a local adult buried with a fragment of yellow ochre in the Late/Terminal Classic.

Lastly, KOL.T.26.03.09.01 was interred in Structure 60 of the elite Residential Group IV during the Late Classic. This individual was 9 years ± 24 months at death with dental caries. Only one oval biface was reported as an associated artifact. The stable isotope analysis suggests that this was a non-local individual possibly interred in a cache offering. Bordering to the northeast corner of KOL.T.26, the excavation unit of KOL.T.34 revealed an elaborate *chultun* burial (KOL.T.34.15.09.01) dating to the Preclassic from the many associated ceramic vessels. Interestingly, this individual was placed extended and prone, which is unusual in the Central Maya area (and for the small spaces of *chultunes*), but quite common in the nearby Belize River Valley sites of Baking Pot and Barton Ramie (Welsh 1988). Unfortunately, this individual was not available for stable isotope analysis, but was an adult male with its head placed between two lip-to-lip vessels. KOL.T.26.03.09.01 may have been a sacrificial victim placed near the *chultun* burial in an act of ancestor veneration. Their non-local stable isotope ratio allows for the possibly that they were a captive or ward from another center in the southern lowlands and sacrificed during the Late Classic, possibly killed by the oval biface found with the skeletal remains.

K'o

HAP ID	KOL.L.07.01.09.01	KOL.T.32.06.09.01	KOL.T.32.10.09.01	KOL.L.02.00.09.01	KOL.T.26.03.09.01	KOL.T.17.01.09.01
Sample ID	KO-16-42	KO-16-45	KO-16-46	KO-16-43	KO-16-41	KO-16-44
aka				HAP Burial 24	KOL.T.26.02(a)	HAP Burial 32
Period	Late/Terminal Preclassic	Terminal Early Classic	Terminal Early Classic	Early Classic	Late Classic	Late/Terminal Classic
Location	Group XXXVIII Structure 45 Looter's Trench 12	Group XXXVIII Structure 45	Group XXXVIII Structure 45	Group XXXIX Structure 3 Looter's Trench 2	Group IV Structure 60	Group XII Structure 107
Age-at-Death	Adult?	Adult		Adult	Infans II (9yrs±24mos)	Adult?
Biological Sex					Indeterminate	
Dental Pathology	Modification: Max RI1 (D-10 and B-4), RI2 (B-1), LI2 (B-2)	Occlusal wear	Occlusal wear; dental modification maxillary LI1/RI1 (B-5)	Dental caries	Dental caries	Occlusal wear and calculus
Burial Type	Grave interment	Grave interment		Grave interment	Grave interment or Cache?	
Burial Manner		Primary				
Body Positioning	S-N				S-N	
Burial Location	Elite Residential Ceremonial Building	Elite Residential Ceremonial Building	Elite Residential Ceremonial Building	Elite Residence	Elite Residence	Residential
Grave Construction	Elaborate crypt	Capped cist or simple crypt	Simple, simple?	Stone lined tomb		

Associated Artifacts	Looted	A few eroded ceramic sherds	23 pieces of obsidian and a small green stone	Drilled green stone beads	Oval biface	Yellow ochre fragment
Tooth Sampled	RM^1	RM_1	LM^1	RM_1	LM_1	RM^1
$^{87}Sr/^{86}Sr$	0.70842	0.70845	0.70840	0.70841	0.70797	0.70837
$\delta^{18}O_{ap}$	-4.3 (-5.0*)	-6.1 (-6.8*)	-2.9 (-3.6*)	-4.0 (-4.7*)	-5.0 (-5.7*)	-4.1 (-4.8*)
$\delta^{13}C_{ap}$	-6.8	-6.9	-3.8	-5.6	-7.1	-6.7
Local or Non-Local	Local	Local	Local	Local	Non-Local?	Local

Table 8.54 Summary of the burials of K'o

Hamontun

The 2009 excavations and mapping at Hamontun revealed more than 100 residential groups, 50 structures and platforms, 35 chultuns, quarries, and stelas. Hamontun's center and the extensive settlement date to the Preclassic, with the exception of Plaza 1 which was reoccupied during the Late/Terminal Classic. Skeletal remains were found in a variety of locations, including Plaza 4 in the site center, a quarry (Group XX) just east of the Hamontun E Group, and residential groups (Figure 8.157).

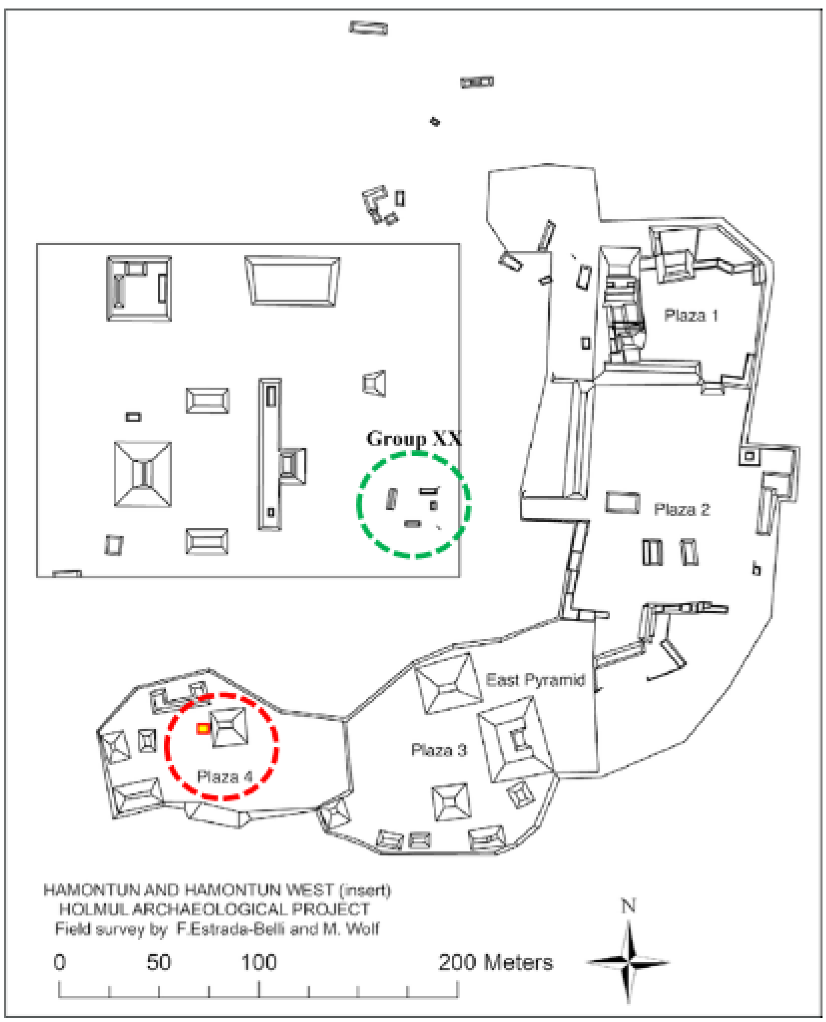

Figure 8.157 Map of Hamontun Center (Estrada-Belli 2009:120).

The Osteobiographies of Hamontun, Plaza IV

HAM.T.05.08.09.01

Individual/Burial ID #:	**HAM.T.05.08.09.01; HAM #2**
Laboratory ID #:	HA-16-48
Site:	Hamontun
Associated Period/Date:	Late Preclassic
Year Excavated:	2009
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul, y Hamontun. Informe Preliminar de la Temporada 2009*
Dentition Sampled:	Left second mandibular molar
Burial Location and Construction:	Plaza IV, simple pit
Burial Type, Manner, and Positioning:	Secondary, cache, skull facing west
Associated Artifacts:	Lip-to-lip ceramic Red Sierra type vessel (containing skull), 3 small jade pieces, 2 shells
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Adult (third molars)
Biological Sex Estimation:	Indeterminate
Observations:	Dental caries
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70817, $\delta^{18}O$: -4.4 (-4.7*) $\delta^{13}C$: -8.5 **local** *adjusted for weaning

Table 8.55 Individual profile of HAM.T.05.08.09.01

Excavation unit HAM.T.05 was placed in the eastern portion of Plaza IV of Hamontun. Plaza IV is classified as an open plaza with structures on the north, east, and west sides, with southern access. Within the second context, following the first of humus, a compact floor was revealed, with a cache of lip-to-lip ceramic vessels about 89 centimeters below the floor. The cut containing these vessels was labeled Context 04 and aligned with the central axis of the structure to the east.

When excavations continued, in the northeast corner of the unit, a fragmented, yet complete vessel was exposed. The unit was expanded to the east 1 meter and to the north

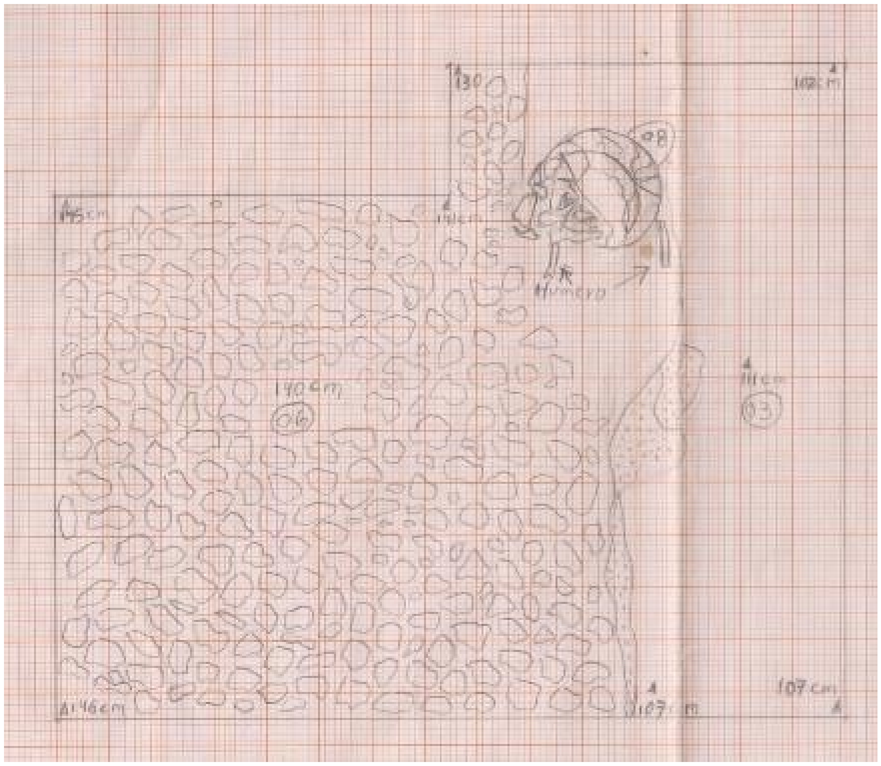

Figure 8.158 Plan Drawing of HAM.T.05.08.09.01 (Image Courtesy of HAP).

50cm intending to detect a possible mortuary context associated with the vessel. In the third context of this expansion, while looking for the floor, two tibiae and two fibulae were found. The ceramic vessel (Figure 8.159) was completely revealed to be two lip-to-lip vessels, the top plate belonging to the Red Sierra type (Estrada-Belli 2009), which corresponds to the Late Preclassic (350 BC- AD 250). The lower plate was black and was the resting space for a fragmented cranium. Two ulnae and two radii were discovered under the plate Fragments of the humeri were also found. The human remains were labeled HAM Burial #2 or HAM.T.05.08.09.01, with Context 08 being the burial context. The skull was positioned on its right side, facing west. Artifacts were found inside the skull, including three small jade pieces and two shells. They may have been placed in the mouth of the deceased.

Context 07 (HAM.T.05.07) corresponds to the burial cut for HAM.T.05.08.09.01, which is 1.2 meters long by 60cm wide. The depth was of this simple pit construction was 21 cm and it was oriented in a north-south direction. The size of the pit is too small for an extended burial, and since no vertebrae, hand or foot bones, or ribs were found, it is likely that this is a secondary burial. The location in the plaza suggests that this burial had the function of an offering or cache, and ritual activity occurring in this space.

Figure 8.159 Insitu photo of HAM.T.05.08.09.01 Estrada-Belli 2009: 150).

Figure 8.160 Molar of
HAM.T.05.08.09.01.

The skeletal remains of HAM.T.05.08.09.01 is fragmentary, probably due to the secondary manner of the burial. Cranial fragments and long bone fragments were recovered and available for osteological analysis, as well as a fragment of the first cervical vertebra. The dentition was nearly complete, although very eroded. The dentition preserved included two mandibular premolars, the left first, second, and third mandibular molars, the right first and second mandibular molars, both maxillary central incisors, three maxillary premolars, the left first, second, and third maxillary molars, and the right first, second, and third maxillary molars. Due to the presence of the third molars, the age-at-death estimation of this individual is adult. The estimation of biological sex is not possible. The dentition was very eroded, but it is probable that there are dental caries on numerous teeth (Figure 8.160).

The enamel of the left second mandibular molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70817, while the $\delta^{18}O$ was -4.4 (adjusted to -4.7 for weaning) and $\delta^{13}C$ was -8.5. Statistically, HAM.T.05.08.09.01 was not an outlier and most likely from Hamontun or the Holmul region.

The Osteobiographies of Hamontun, Residential Groups

HAM.T.07.08.09.01

Individual/Burial ID #:	**HAM.T.07.08.09.01; HAM #1**
Laboratory ID #:	HA-16-47
Site:	Hamontun
Associated Period/Date:	Preclassic?
Year Excavated:	2009
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul, y Hamontun. Informe Preliminar de la Temporada 2009*
Dentition Sampled:	Left first maxillary molar
Burial Location and Construction:	Group XX, Quarry
Burial Type, Manner, and Positioning:	Secondary, offering on bedrock carved into cross, skull facing northeast
Associated Artifacts:	Obsidian, burned limestone
Preservation:	Fragmentary (0-25%)
Age-at-Death Estimation:	Infans II (5-7 yrs)
Biological Sex Estimation:	Indeterminate
Observations:	Dental caries on deciduous molars
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70806, $\delta^{18}O$: -5.9 (-6.6*), $\delta^{13}C$: -5.8 **local** *adjusted for weaning

Table 8.56 Individual profile of HAM.T.07.08.09.01

The excavation unit HAM.T.07 was placed with the intention of finding a midden within the residential Group XX (Figures 8.161 and 8.162). During excavation, the unit was expanded from its initial 2x2m to 8x5m to explore a probable quarry identified. HAM.T.07.06 corresponds with the cuts into the bedrock (HAM.T.07.08) that form the quarry. Context HAM.T.07.08.09.01 contained human remains (also referred to as Context 09), fragments of burned limestone, and a fragment of obsidian (HAM.T.07.08.05.01). The field notes remark that a human skull, facing the northeast, was placed on a cross-shaped support carved into the bedrock (Estrada-Belli 2009). Further skeletal remains, mostly long bone fragments, were found nearby, possibly from

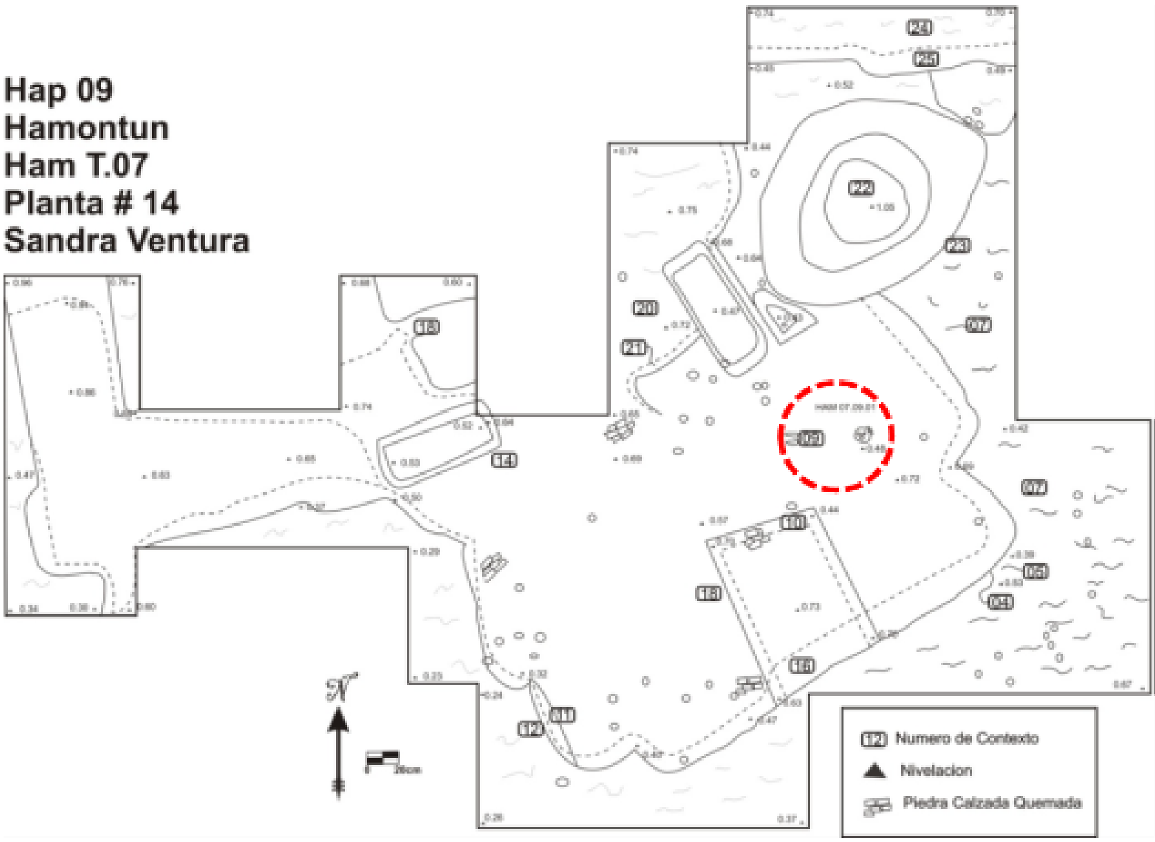

Figure 8.161 Plan drawing of HAM.T.07. Location of HAM.T.07.08.09.01 in red. (Estrada-Belli 2009:173).

the same individual. The placement of the skull and long bone fragments suggests a secondary burial serving as an offering at some sort of ceremony occurring at the quarry.

The skeletal remains of HAM.T.07.08.09.01 are fragmentary, due to the sole presence of cranial fragments and dentition. Both deciduous and permanent dentition was preserved. The mandibular deciduous dentition includes: the left first and second incisor, right second incisor, left canine, and two second molars. The maxillary deciduous dentition includes: all four incisors, both canines, and all four molars. The mandibular permanent dentition includes: all four incisors, both canines, all four premolars, both first molars, and both second molars. The maxillary permanent dentition includes: both first incisors, both canines, three premolars, both first molars, and both second molars. The deciduous dentition has dental caries, while the permanent dentition does not have visible pathology, due to the continued development.

The presence of deciduous dentition and partially developed permanent dentition indicate that this is a juvenile (Figure 8.163). Using the Ubelaker (1999) dentition chart, the development coincides with the image for 5±1.5yrs. Following the Smith (1991) permanent tooth formation stages, the first mandibular molar has 25% root development and the second mandibular molar has 75% crown formation, suggesting an age estimation of 4.8-6.1 years. Considering the enamel completion ages reported by Thoma and Goldman (1960) and the fact that the enamel of the canines has completed forming, while

Figure 8.162 Photo of HAM.T. 07. Location of HAM.T.07.08.09.01 in red. (Image Courtesy of HAP).

the mandibular first premolar's enamel had not finished, the age is estimated to be around 6 years. To allow for variability, an estimation can be posited of 5-7 years of age-at-death. An estimation of biological sex is not possible for a non-adult.

The enamel of the left first maxillary molar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70806, while the $\delta^{18}O$ was -5.9 (adjusted to -6.6) and $\delta^{13}C$ was -5.8. Statistically, HAM.T.07.08.09.01 was not an outlier and most likely from Hamontun or the Holmul region.

Figure 8.163 Dentition of HAM.T.07.08.09.01.

HAM.T.28.02.14.01

Individual/Burial ID #:	**HAM.T.28.02.14.01**
Laboratory ID #:	HA-16-50
Site:	Hamontun
Associated Period/Date:	Preclassic?
Year Excavated:	2009
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul, y Hamontun. Informe Preliminar de la Temporada 2009*
Dentition Sampled:	Left maxillary first (?) premolar
Burial Location and Construction:	Group XXXV Residential Group-midden?
Burial Type, Manner, and Positioning:	?
Associated Artifacts:	?
Preservation:	1 tooth
Age-at-Death Estimation:	Indeterminate
Biological Sex Estimation:	Indeterminate
Observations:	Occlusal wear
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70835, $\delta^{18}O$: -5.2 (-5.6*) $\delta^{13}C$: -3.8 **local** *adjusted for weaning

Table 8.57 Individual profile of HAM.T.28.02.14.01

HAM.T.28 was a 2x3 meters excavation (Figure 8.194) unit placed within Group XXXV, aiming to find a midden associated with a residential structure. The second context, following that of the humus layer, contained various artifacts that can be associated with a midden: large amounts of ceramic sherds, flint pieces, fragments of shell, charcoal, animal teeth, and fragments of obsidian (Estrada-Belli 2009). Also in this context, one human premolar was found, lacking any mortuary context. This left maxillary premolar, probably the first, was complete with some occlusal wear (Figure 8.165). Due to the singular skeletal element recovered, it is not possible to estimate age-at-death or biological sex for this individual.

The enamel of the left mandibular first premolar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70835, while the $\delta^{18}O$ was -5.2 (adjusted to -5.6 for weaning) and $\delta^{13}C$ was -3.8. Statistically, HAM.T.28.02.14.01 was not an outlier and most likely from Hamontun or the Holmul region.

Figure 8.164 Photo of HAM.T.28 (Estrada-Belli 2009: 205).

Figure 8.165 Premolar of HAM.T.28.02.14.01.

HAM.LT.30.01.09.01

Individual/Burial ID #:	**HAM.LT.30.01.09.01**
Laboratory ID #:	HA-16-49
Site:	Hamontun
Associated Period/Date:	Preclassic?
Year Excavated:	2009
Archaeological Reports:	*Investigaciones Arqueológicas en la Región de Holmul, Petén: Holmul, y Hamontun. Informe Preliminar de la Temporada 2009*
Dentition Sampled:	Right first (?) maxillary premolar
Burial Location and Construction:	Group XXXIV- looter's trench
Burial Type, Manner, and Positioning:	?
Associated Artifacts:	?
Preservation:	1 Tooth
Age-at-Death Estimation:	?
Biological Sex Estimation:	?
Observations:	None observed
Stable Isotope Results:	$^{87}Sr/^{86}Sr$: 0.70814, $\delta^{18}O$: -4.9 (-5.3*) $\delta^{13}C$: -4.3 **local** *adjusted for weaning

Table 8.58 Individual profile of HAM.LT.30.01.09.01

HAM.LT.30 aimed to explore a looter's trench into a residential structure within Group XXXIV of Hamontun (Figure 8.166). This group consisted of three structures, each on a cardinal direction (east, north, and south), a chultun, and a terrace. The eastern structure contained the looter's trench, which revealed four phases of construction (Estrada-Belli 2009). The cleaning of the looter's trench (context 1) produced ceramic sherds, lithic fragments, animal bones, and one human tooth. This right maxillary premolar, probably the first, lacks all mortuary and stratigraphic context (Figure 8.167). The tooth shows no wear, and it is possible that the root apex has not been completed. Unfortunately, this lack of context and further skeletal remains results in no estimation of age-at-death or biological sex.

The enamel of the right maxillary first premolar was tested for $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ result was 0.70814, while the $\delta^{18}O$ was -4.9 (adjusted to -5.3 for weaning) and $\delta^{13}C$ was -4.3. Statistically, HAM.LT.30.01.09.01 was not an outlier and most likely from Hamontun or the Holmul region.

Figure 8.166 Looter's Trench HAM.LT.30 (Estrada-Belli 2009: 136).

Figure 8.167 Premolar of HAM.LT.30.01.09.01.

Considering the Burials of Hamontun

The preservation of the Preclassic Hamontun individuals is very poor, in part because of taphonomic processes, but mostly due to the burial context. Two of the individuals were interred as caches or offerings in open spaces, one as an adult and one between the ages of 5 and 7 years. The skull of the adult (HAM.T.05.08.09.01) was interred within a lip-to-lip ceramic vessel of the Red Sierra type, along with three small jade pieces and two shells. This cache was cut into a plaza floor in a simple pit. The skull and fragmented first cervical vertebra placed in between two ceramic vessels might suggest the decapitation of the individual, although no cut marks were observed on the very fragmented cervical vertebra. It is more likely, due to the presence of long bone fragments, and the absence small bones such as rib fragments or carpals/tarsals, that this was a secondary burial and HAM.T.05.08.09.01 was originally interred elsewhere, with the skull and long bones being moved during this ritual offering.

The skull of HAM.T.07.08.09.01, aged between 5 and 7 years at death, was placed on a cross-shaped support carved into the bedrock surface of a quarry. Again, only the skull and long bone fragments were present, suggesting a secondary burial context. However, it is more probable that this was a sacrifice, as charred limestone and a fragment of obsidian were recovered with the remains. The location, upon a cross-shaped support in a quarry, evokes associations with reservoir imagery and quatrefoils (Scarborough 1998), suggesting that this was an offering deposited during a water ritual. Both possibly sacrificed individuals were dated to the Preclassic and had local $^{87}Sr/^{86}Sr$

ratios, suggesting that both adults and juveniles, local to the Holmul region, were sacrificed and deposited as caches during some type of ritual activity.

The remaining two individuals were represented by only one premolar each, most likely because of their tenuous burial contexts. Both were found in Preclassic residential contexts, with HAM.T.28.02.14.01 excavated from a midden and HAM.LT.30.01.09.01 from a looter's trench into an eastern structure. The latter individual was most likely, at one time, a primary burial interred in an eastern structure in a residential plaza. Little can be deduced from the osteological remains of one premolar each; however, the $^{87}Sr/^{86}Sr$ results for each suggest that they were both individuals local to the Holmul region.

Hamontun

HAP ID	HAM.T.05.08.09.01	HAM.T.07.08.09.01	HAM.T.28.02.14.01	HAM.LT.30.01.09.01
Sample ID	HA-16-48	HA-16-47	HA-16-50	HA-16-49
aka	HAM 2	HAM 1		
Period	Late Preclassic	Preclassic?	Preclassic?	Preclassic?
Location	Plaza IV	Group XX?	Group XXXV	Group XXXIV
Age-at-Death	Adult	Infans II (5-7years)		
Biological Sex		Indeterminate		
Dental Pathology	Caries	Caries on deciduous molars	Occlusal wear	
Burial Type	Cache	Cache		
Burial Manner	Secondary?	Secondary?		
Body Positioning	facing west	facing northeast		
Burial Location	Plaza	Quarry/ Residential	Residential Area	Elite Residential Area
Grave Construction	Simple pit cut into plaza floor	Simple, simple/chultun? placed on bedrock		

Associated Artifacts	Lip-to-lip ceramic vessel Red Sierra type (containing skull), 3 small jade pieces and 2 shells (found in skull)	1 obsidian fragment, burned limestone		
Tooth Sampled	LM_2	LM^1	LPM^1(?)	RPM^1 (?)
$^{87}Sr/^{86}Sr$	0.70817	0.70806	0.70835	0.70814
$\delta^{18}O_{ap}$	-4.4 (-4.7*)	-5.9 (-6.6*)	-5.2 (-5.6*)	-4.9 (-5.3*)
$\delta^{13}C_{ap}$	-8.5	-5.8	-3.8	-4.2
Local or Non-Local	Local	Local	Local	Local

Table 8.59 Summary of the burials of Hamontun

CHAPTER 9: DISCUSSION AND CONCLUSIONS

Bioarchaeological methods and theory elucidate the intersectionality inherent in the formation, physical manifestation, and manipulation of identity. Typically, dimensions of identity are considered separately, with Meskell (2001:188) calling for scholars to "break the boundaries of identity categories themselves, blurring the crucial domains of identity…". Using multiple lines of evidence (social theory, osteology, archaeology, mortuary analysis, ethnohistory, and ethnographic data), bioarchaeology presents human remains as active populations and as social beings with complex and intersectional identities. Due to the restrictions of poor preservation, this study focuses on the intersectionality between the identities of regional origin, biological sex, biological and cultural age, political role, social status, and religious purpose.

Identities of the Holmul Region

The Elite Females of Holmul

Due to poor preservation, biological sex could be estimated for only twelve out of the 52 individuals sampled (23%). Of these twelve, four were estimated to be female. Three of the four females were found at the site of Holmul (Table 9.1), with two dating to the Early Classic (specifically AD 550-600) and one from the Late Classic. The osteobiographies of these females prove intriguing, as they reveal interesting elements of elite Maya socio-cultural identities and mortuary practices.

The Females of Holmul

HAP ID	HOL.L.20.15.09.01	HOL.T.78.42.09.01	HOL.T.30.20.09.01
Sample ID	HO-16-11	HO-16-14	HO-16-4
aka			HAP 9
Location	Holmul, Group II, Building A	Holmul, Group II, Building A	Holmul, South Group I, Structure 101
Period	Early Classic (AD 550-600)	Early Classic (AD 550-600)	Late Classic
Age-at-Death	Adult (30s-40s)	Adult (late 40s)	Adult (20-33yrs)
Biological Sex	Female	Female	Female
Dental Pathology	Dental caries, jade and pyrite inlays	Incision on labial surface of tooth, alveolar resorption	LEH, dental modification, dental calculus, resorbed mandibular sockets
Pathology	Fronto-occipital shaping, osteophyte addition to vertebral bodies, woven bone lesions	osteophyte addition to vertebral bodies, woven bone lesions	osteophyte addition to vertebral bodies
Burial Type	Grave interment	Grave interment	Grave interment
Burial Manner	Primary, single	Primary, single	Primary, single
Body Positioning	Flexed, left side, S-N, facing W	Flexed, left side, N-S, facing E	Flexed, left side, S-N, facing N
Burial Location	Religious/ Ceremonial (Temple-Pyramid),	Religious/ Ceremonial (Temple-Pyramid)	Elite residential
Grave Construction	Simple, pit, under stairs	Cist, capped	simple, pit, placed in floor
Associated Artifacts	Ceramic vessel, bone needle, flint projectile tip	2 jade ear flares	Bone with drill hole
Tooth Sampled	RM_1	LC^1	LM^1
$^{87}Sr/^{86}Sr$	0.70823	0.70815	0.70847
$\delta^{18}O_{ap}$	-6.0 (-6.7)	-3.4 (-4.1*)	-4.3 (-5.0*)
$\delta^{13}C_{ap}$	-5.1	-3.1	-5.4
Local or Non-Local	Local	Local	Non-local?

Table 9.1 Individual profiles of the females of Holmul.

Two female individuals were buried between AD 550 and AD 600 in Building A of Group II at Holmul. HOL.L.20.15.09.01 was in her 30s or 40s, while HOL.T.78.42.09.01 was in her late 40s. Both individuals were buried flexed on their left side in this ceremonial, temple-pyramid structure. The skeletons of both individuals presented with osteophytic addition to the vertebral bodies, as well as some minor woven bone lesions. Both of these observations are expected for individuals past young adulthood. HOL.T.78.42.09.01 experienced tooth loss during life, with her mandible experiencing complete alveolar resorption. Only one tooth, a maxillary canine, was recovered. Further paleopathological evaluations revealed that both individuals experienced cultural body modification, with HOL.L.20.15.09.01 having undergone fronto-occipital shaping, as well as jade and pyrite dental inlays. HOL.T.78.42.09.01 had incisions on the labial surface of the canine recovered.

HOL.L.20.15.09.01 was buried in a simple pit burial under the stairs of Building A during the same construction phase as Tzahb Chan Yopaat's (HOL.L.20.21.09.01) burial. While a relatively simple burial construction compared to his adorned tomb within his frieze-dedicated temple, she had similar dental inlays as Tzahb Chan Yopaat, and was accompanied by a ceramic vessel, bone needle, and flint projectile tip. It is probable that she was an elite female, possibly a member of the royal family.

In contrast, HOL.T.78.42.09.01, slightly older than HOL.L.20.15.09.01, was interred inside the structure during the same period, although definitely after the interment of Tzahb Chan Yopaat. While also an intrusive burial, the grave construction was that of a capped cist and she was accompanied only by a pair of jade ear flares. The positioning of a constructed grave within this ceremonial structure, as well as the presence of the personal adornments made of jade, suggest her royal status and perhaps familial connection with Tzahb Chan Yopaat. She may have had a stronger royal connection or higher status to have been buried in a constructed cist within the building, as compared to the simple pit burial under the stairs of HOL.L.20.15.09.01. However, this simple burial construction may have been merely a consequence of an unexpected death and rapid burial of a royal individual.

Both royal females were of local origin, according to their stable isotope ratios, as was Tzahb Chan Yopaat. The local origin of the royal family is not unexpected, as the Maya drew political and religious power from familial ties to consecrated locales. Royal individuals would be least likely to relocate from their place of birth, thus severing their connection to the ceremonial and political power of the city center.

In contrast, the remaining female of Holmul, HOL.T.30.20.09.01, was possibly of non-local origin, as suggested by the stable isotope ratio results. She was between 20 and 33 years of age-at-death and was interred in an elite residential structure during the Late Classic. She was placed flexed on her left in a simple pit burial in the floor of the residence accompanied by a single object, a bone with a drill hole. She also experienced osteophytic addition to her vertebral bodies and had dental modification to her anterior dentition. Further, she had linear enamel hypoplasia, dental modification, dental calculus, and resorbed mandibular sockets. HOL.T.30.20.09.01 was most likely an elite individual but not a member of the royal family, as she was interred in a large residential group close to the center of Holmul, but placed in the floor of a room and not entombed in a ceremonial structure. It is likely that this elite female from outside the Holmul region represents an instance of patrilocal residence, with a female relocating to the familial residence of the male.

The familial relation remains unclear between the two females buried in Building A of Group II and Tzahb Chan Yopaat, but it remains significant that two middle-adult females were interred in the ceremonial structure dedicated to the ruler of Holmul at the time. Further, while hindered drastically by sample size, the origins of these individuals suggest that royal Early Classic females were local and tied to their familial residence, while non-royal elite Late Classic females in the Maya region may have been more likely to relocate during their life. While an extremely small sample of female elites, the three intriguing osteobiographies of the Holmul populace demonstrate their utility in revealing complex identities and socio-cultural practices of the Classic period Maya.

The Sacrificial (?) Children of the Holmul Region

Of the 52 individuals of this study, 29 were estimated to have been an adult at time of death, with ten being between birth and 14 years, and 13 of indeterminate age-at-death. There were no juveniles in the sample (between 15 and around 22). Further, nine individuals were between five and 14 (Infans II), while only one individual was younger than four years (Infans I). While these age estimations are derived from skeletal biology, they correspond loosely to the Maya age categories before adulthood. The Maya were weaned around ages three or four, before which their soul was susceptible, and they were protected by their mother. Around nine years of age, they separated based on gender and begin to learn their gendered roles, until 12 or 13, when they transitioned to accept adult levels of responsibility and form separate identities (Ardren 2011). As mentioned above, nine of the ten individuals in the sample were between the ages of four and 14, approximately, which corresponds with the Maya period of childhood that occurred following weaning but before assuming adult responsibilities.

Considering Storey's (1992) paleodemographic study of the mortuary population of Copan, where the highest mortality was between ages one and four, the prevalence of individuals between four and 14 in this sample suggests that they might have been sacrificial victims. Children served a significant role in the social and ceremonial events of the Maya and within greater Mesoamerica. Arnold describes how the "bodies of children served as food for the *tlalocs* (earth lords)" (1991:226), emphasizing the role Aztec children might have played as sacrificial offerings, as sustenance for the earth. For the Maya, Landa (1998:48) observed in the sixteenth century that the elites offered the children as sacrifices "out of devotion". The high prevalence of children in the Cenote of Sacrifice at Chichén Itzá (de Anda Alanis 2007) and the Midnight Terror Cave in Belize

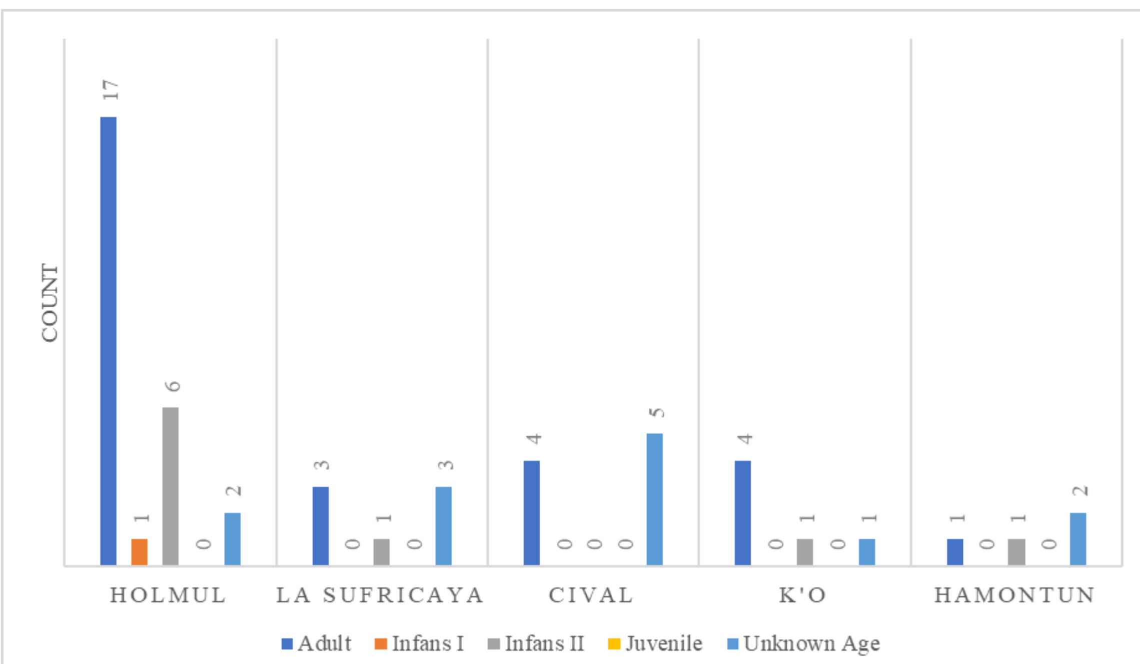

Figure 9.1 Age distribution by site in the Holmul region.

(Prout and Brady 2017) demonstrate how these individuals of a particular social age identity held a significant role or purpose in Maya sacrifice rituals and practices.

Landa (1998) also remarked that after the death of both parents, the children of slaves, orphans, or offspring were sacrificed and placed with the deceased in their grave. Welsh (1988) labeled these “adult and child burials”, while also describing how children (and adults) would be present in multiple individual burials to accompany an elite in death. Further, some infants (and the skulls of adults) were offered as cache offerings, sometimes in ceramic vessels, in dedication to construction of an altar or building (Welsh 1988).

Welsh (1988) also remarked on the prevalence of burials in association with benches in residential or palace structures, and their role as dedicatory caches to ancestors. At Holmul, all four of the individuals excavated from the Late Classic palace (Building B) of Group III were between the ages of four and 14 years, and likely of local origin. Three of these individuals were included in this study, although stable isotope analysis of HOL.T.50.27.09.01 had great error and will need to be re-run. The three individuals with concrete mortuary context (excepting 58618.0.1) were positioned flexed on their left oriented east-west. All four of the burials were associated with benches or cut into the floor of rooms with benches, and had accompanying artifacts of ceramic figurines and perforated shells. Textile impressions on plaster from the burial of HOL.T.06.09.01) suggest it was a bundle burial or that there was a “textile-lined wooden mask placed in front of the face” (Estrada-Belli 2001:7–8). While the fragmented remains limited the evaluation for trauma, it is possible that these individuals were acting as dedicatory cache burials at the benches, which were acting as altars, for the elite and the ancestors. It is also possible that these individuals were the children of the elites that were interred following their death in their own benches, while the adults were interred in ceremonial structures. It seems more likely that these children were sacrificed as offerings at these altars in the palace of the ancestors.

Two other burials at Holmul may represent child sacrifice. HOL.T.98.04.09.01 is the number for the individual buried in the Late Classic stone-lined tomb of Group II, Building A. The tomb was filled with five ceramic vessels, a carved jade pendant, incised bone, and much more. From the photographs and field notes, the tomb contained an individual in extended supine position oriented north-south. The osteological analysis is forthcoming, but the tooth selected for export and stable isotope analysis was that of an approximately three-year-old. It is more likely that this three-year-old was an additional individual within the tomb, probably sacrificed and serving as a burial offering. The osteological evaluation of the excavated remains may be able to answer more questions regarding the individuals interred and their social roles.

Individual 58622.0.1 was labeled Skeleton 2 of Ruin X by Merwin. This Late Classic individual was 12 years ± 30 months, interred flexed on their left at the south end of the simple crypt, and was of local origin. Further, this individual was placed on the torso of the adult individual (Merwin's Skeleton 1), suggesting that this multiple individual burial consisted of an adult and a child, representative of that type of sacrificial burial. Ruin X was the eastern structure of the palace (Building B) of Group III where HOL.T.100.03.09.01 was interred during the end of the Early Classic, perhaps around the rule of Tzahb Chan Yopaat. It is possible that the later burials of Skeleton 1, 2, and 3 in Ruin X were some type of veneration to the earlier, elaborate burial of HOL.T.100.03.09.01, with Skeleton 2 being a possible child sacrifice.

The Children of Holmul

HAP/Harvard ID	HOL.T.06.09 .01	HOL.T.50.27 .09.01	58618.0.1	HOL.T.98.04 .09.01	58622.0.1
Sample ID	HO-16-1	HO-16-9	HO-16-22	HO-16-70	HO-16-24
aka	HAP 1	HAP 23			**Skel 2; X2**
Location	Holmul, Group III, Bld B	Holmul, Group III, Bld B	Holmul, Group III, Bld B	Holmul, Group II, Bld A	Holmul, Ruin X
Period	Late Classic	Late/Terminal Classic?	Late Classic?	Late Classic (AD 650-750)	**Late Classic AD 650-750**
Age-at-Death	Infans II (4-8 yrs)	Infans II (8-13 yrs)	Infans II (12yrs±30mo or 11-18 yrs)	Infans I? (3years?)	Infans II (12yrs ± 30mo or 11-18yrs)
Burial Type	Grave interment	Grave interment	Grave interment	Grave interment	Grave interment
Burial Manner	Primary, single	Primary, single	Primary, single	Primary, single?	Primary, multiple?
Body Positioning	Flexed, left side, W-E, facing E	Flexed, left side, W-E, facing N	unknown	Extended?, supine? N-S	***Flexed on left side, S-N***
Burial Location	Palace, placed in bench 4, str. 43	Palace, Merwin Rm 1, str. 59	Palace, ***on bench*** (?)	Religious/ Ceremonial (Temple-Pyramid)	Religious/Ceremonial
Grave Construction	simple, pit	Simple, pit	**Simple, blocked-up room**	Tomb, stone-lined	**Simple crypt; household shrine; *south end of vault***
Associated Artifacts	None (possible textile impressions in plaster)	6 figurines (2 flutes, 4 ocarinas), 30 Pomacea shells	***30 ceramic sherds***	5 ceramic vessels carved jade pendant, incised bone, and much more	***Worked bird bone found among upper ribs; flint knife or spear point found near toe bones; textile***

Tooth Sampled	RM²	LM²	RM₁	LM₁	RM₁
$^{87}Sr/^{86}Sr$	0.70812		0.70828	0.70807	0.70821
$\delta^{18}O_{ap}$	-3.5 (-3.9*)	-6.8 (-7.1*)	-3.5 (-4.2*)	-4.8 (-5.5*)	-5.5 (-6.2*)
$\delta^{13}C_{ap}$	-3.3	-2.5	-2.1	-2.7	-5.8
Local or Non-Local	Local		Local	Local	Local
Possible Sacrificial Type	Dedicatory Burial Cache	Dedicatory Burial Cache	Dedicatory Burial Cache	Adult and Child?	Adult and Child

Table 9.2 Individual profiles of the children buried at Holmul.
Sources: **Welsh 1988; Gerry 1993;** ***Merwin and Vaillant 1932***

Unfortunately, little contextual information is available for two addition Infans II aged individuals from Holmul, 58599.02 and HOL.T.24.23.07.01.01, the former being from the Early Classic and the latter from the Late Classic. The stable isotope analyses of both suggest local origins. The Early Classic burial at La Sufricaya of SUF.ST.09.02.09.03.01 also has limited contextual information, but also was an Infans II aged individual with local origins. This was the only child burial in the sample from the Early Classic.

Two additional interred individuals of Infans II ages-at-death at the sites of K'o and Hamontun were intriguing. KOL.T.26.03.09.01 was an individual interred in an elite residential area during the Late Classic accompanied by an oval biface. Adjacent to this burial, was a Preclassic *chultun* burial, suggesting that KOL.T.26.03.09.01 may have been a sacrificial victim placed near the *chultun* burial in an act of ancestor veneration. The stable isotope analysis suggests that this child was a non-local individual, allowing for the possibility that they were a captive or ward from another center in the southern lowlands and sacrificed in an act of ancestor veneration during the Late Classic.

HAM.T.07.08.09.01 was the only Preclassic child burial in the study sample. Most of the children date to the Late Classic. This individual, aged five to seven years, was slightly younger than most of the children of the sample who were between 10 and 14 years. This individual's skull was placed on a cross-shaped support carved into the bedrock surface of a quarry. Either the skull represents sacrifice through decapitation, or it may be a secondary burial context, relocating just the skull from the individual's original burial context. The presence of charred limestone and fragment of obsidian at this location evokes associations with reservoir imagery and quatrefoils suggesting that this individual was a sacrificial offering deposited during a water ritual, similar perhaps to those at the Cenote of Sacrifice at Chichén Itzá and the Midnight Terror Cave in Belize.

While it is possible that the children buried in the Holmul region were not sacrificial offerings, the context suggests that they may have had an important social and ceremonial identity linked to their biological age and social age, one that served and preserved the earth and venerated their ancestors. Most were local individuals interred with objects typical in child burials, such as ceramic figurines and birds, while the one non-local was accompanied by an oval biface. The presence of this potential weapon suggests that this non-local may have been a captive sacrificed, while the locals were cache offerings or acts of ancestor veneration.

The Children of La Sufricaya, K'o, and Hamontun			
HAP/Harvard ID	SUF.ST.09.02.09 .03.01	KOL.T.26.03.09. 01	HAM.T.07.08.09 .01
Sample ID	SU-16-26	KO-16-41	HA-16-47
aka	HAP 6	KOL.T.26.02(a)	HAM 1
Location	La Sufricaya Group I, Str. 1	K'o, Group IV Structure 60	Hamontun, Group XX?
Period	Early Classic	Late Classic	Preclassic?
Age-at-Death	Infans II (11±2.5yrs)	Infans II (9yrs±24mos)	Infans II (5-7years)
Dental Pathology	calculus, possible filing	Dental caries	Caries on deciduous molars
Burial Type		Grave interment or Cache?	Cache
Burial Manner			Secondary?
Body Positioning		S-N	facing northeast
Burial Location	Elite Residence?	Elite Residence	Quarry/ Residential
Grave Construction			Simple, simple/chultun? placed on bedrock
Associated Artifacts	?	Oval biface	1 obsidian fragment, burned limestone
Tooth Sampled	M^1	LM_1	LM^1
$^{87}Sr/^{86}Sr$	0.70842	0.70797	0.70806
$\delta^{18}O_{ap}$	-5.1 (-5.8*)	-5.0 (-5.7*)	-5.9 (-6.6*)
$\delta^{13}C_{ap}$	-6.9	-7.1	-5.8
Local or Non-Local	Local	Non-Local?	Local
Possible Sacrificial Type	?	Captive Sacrifice?	Cache Burial/Offering

Table 9.3 Individual profiles of the children buried at La Sufricaya, K'o, and Hamontun.

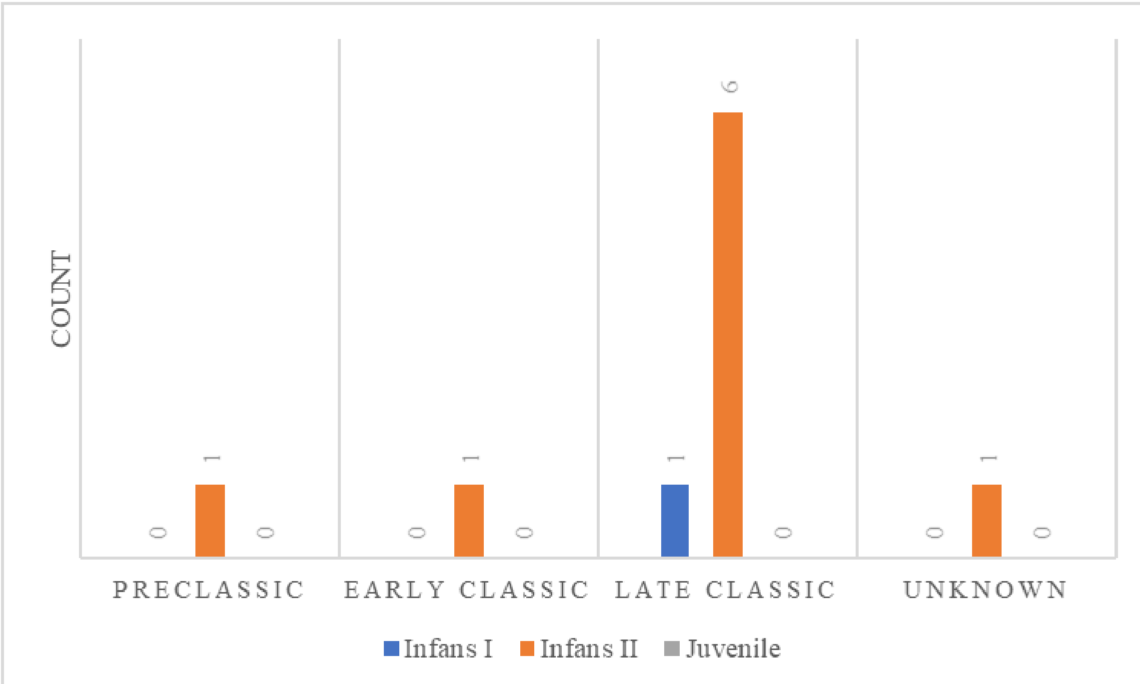

Figure 9.2 Age distribution by period in the Holmul region.

Non-Local Individuals

Two individuals within the sample were identified as most likely non-local by the $^{87}Sr/^{86}Sr$ stable isotope analysis, 58596.0.2 from Holmul and KOL.T.26.03.09.01 from K'o (discussed in-depth above). SUF.T.23.54.09.01 from La Sufricaya was also identified as non-local from the $^{87}Sr/^{86}Sr$ stable isotope analysis, but only when the box-and-whisker plot was calculated with the median included. Two additional individuals from Holmul, HOL.T.37.09.01 and HOL.T.30.20.09.01, were suggested as non-local when the $^{87}Sr/^{86}Sr$ and $\delta^{13}C$ ratio results were visualized by bagplot in the bivariate analysis. While the $^{87}Sr/^{86}Sr$ statistical analysis alone did not identify these two as statistical outliers, they were the individuals with the highest $^{87}Sr/^{86}Sr$ ratios within the Holmul dataset, and thus it corresponds that when using bivariate analysis, they may be presented as possible outliers. Finally, while the $^{87}Sr/^{86}Sr$ analysis was inconclusive due to high error for the Holmul individual HOL.T.50.27.09.01, this same individual was a statistical outlier (when unadjusted for weaning) for the $\delta^{18}O$ ratio results. Because this individual was one of the children interred in the Late Classic palace (Group III, Building B), it is of high priority to re-run the $^{87}Sr/^{86}Sr$ analysis to confirm or deny their possible geographic origin.

For Holmul, while all three possible non-local individuals were adults, most of their similarities end there. The individual 58586.0.2 interred during the Early Classic period in the ceremonial structure Building B of Group II with lavish grave goods. In the Late Classic, a female individual, HOL.T.30.20.09.01, was placed in a simple pit burial in the floor of an elite residential structure in South Group I with one artifact, a bone with a drill hole (discussed in-depth above). HOL.T.37.09.01 was interred during the Terminal Classic into the floor of a house structure also South Group I with no associated artifacts.

Individual 58596.0.2 (Merwin's Skeleton 1) was interred within a multiple individual primary burial, along with 58599.0.02 and 58599.0.1 (Skeletons 2 and 6), both of whom were of probable local origin. While 58596.0.2 (Skeleton 1) was positioned partially flexed on their left side, the other two were extended supine. All three of the individuals were accompanied by extensive amounts of grave goods, although a few specific ceramic vessels are unusual and reconsidered here as they accompanied Individual 58596.0.2 who was most likely non-local in origin. Vessel 9, associated with 58596.0.2 (Skeleton 1), may have been a local imitation of the Tzakol 3 ceramic sphere, which were influenced by central Mexico after AD 378 (Callaghan 2013). Vessel 11 was rare for the Holmul region and considered an import by Challaghan (2013). The different body positioning (flexed) and the presence of these possible non-local or foreign-influenced vessels reinforce the non-local status of 58596.0.2 (Skeleton 1).

As an interesting comparison, HOL.T.84.14.09.01 was also interred in Holmul's center during the Early Classic with non-local ceramic vessels. In this case, the Teotihuacano style tripod vessels (not yet chemically or petrographically sourced) were interred with an adult with a local $^{87}Sr/^{86}Sr$ ratio in temple-pyramid ceremonial structure (Building D) in Group I. The instance of non-local or foreign-style ceramics as associated artifacts in a burial of a local individual demonstrates how stable isotope analysis can help elucidate the identity of the individual. Both individuals may have been considered possibly non-local through the analysis of the artifacts alone, but the integration of stable isotope analysis clarifies the identities of the deceased and demonstrates the necessity of the complete, holistic bioarchaeological approach to studying human remains.

The remaining two non-local individuals, SUF.T.23.54.09.01 from La Sufricaya and HOL.T.37.09.01 from Holmul, were both interred in residential contexts during the Late Classic and Terminal Classic periods, respectively. These two add to the other Late Classic non-local individuals buried in residential structures, HOL.T.30.20.09.01 and KOL.T.26.03.09.01. 58596.0.2 was the only non-local individual interred in a ceremonial structure, and it was during the earlier period of the Early Classic.

While HOL.T.37.09.01 was interred in a South Group I, the residential structure was of a significantly different architectural design and construction than the other primary structures in the group. The excavators posited that this was a later, hastily reoccupation of the group from the lack of cardinal alignment, narrow doorways, and thin plaster floors. It is plausible that during the Terminal Classic, individuals from elsewhere in the lowlands settled at this location and were buried there.

Similarly, at La Sufricaya Group I during the Late Classic, two low platforms were constructed, possibly supporting perishable residential structures. Three individuals were buried in the platform at that time: SUF.T.23.56.09.01, SUF.T.23.54.09.01, and SUF.T.23.66.09.01. Stable isotope analysis of SUF.T.23.54.09.01 and SUF.T.23.66.09.01 revealed non-local and local regions of origin, respectively. As the Late Classic was a time of instability, it can be expected that a non-local individual may be buried in a residential structure constructed on a former ceremonial structure. The subsequent intrusive burial of SUF.T.23.56.09.01 (Burial #18) may have been placed in an act of ancestor veneration to SUF.T.23.54.09.01, who originated elsewhere but may have been one of the first of the family to settle at La Sufricaya. It is also possible that this non-local individual traveled to La Sufricaya from elsewhere in the lowlands to marry into the local family (perhaps the local SUF.T.23.66.09.01), similarly to the hypothesis for HOL.T.30.20.09.01, also buried in a residential structure during the Late Classic.

The Non-Locals Individuals of the Holmul Region

HAP ID	58596.0.2	HOL.T.37.09 .01	HOL.T.30.20 .09.01	SUF.T.23.54. 09.01	KOL.T.26.03 .09.01
Sample ID	HO-16-15	HO-16-5	HO-16-4	SU-16-28	KO-16-41
aka	**Skel 1**	HAP 12	HAP 9	HAP 19	KOL.T.26.02 (a)
Location	**Holmul, Group II, Building B**	Holmul, South Group I	Holmul, South Group I	La Sufricaya, Group I, Str. 146	K'o, Group IV Structure 60
Period	**Early Classic AD 200-600**	Terminal Classic	Late Classic	Late Classic	Late Classic
Age-at-Death	Adult (***young adult)***	Adult?	Adult (20-33yrs)	Indeterminate	Infans II (9yrs±24mos)
Biological Sex	**?**	Indeterminate	Female	Indeterminate	Indeterminate
Dental Pathology		Mandibular alveolar resorption	LEH, dental modification, dental calculus, resorbed mandibular sockets,	occlusal wear	Dental caries
Pathology	osteophytic lipping on distal foot phalanges		osteophyte addition to vertebral bodies		
Burial Type	Grave interment	Grave interment	Grave interment	Grave interment	Grave interment or Cache?
Burial Manner	Primary, multiple	Primary, single	Primary, single	Primary, single	
Body Positioning	***Flexed on left side, S-N, facing W***	Right side, S-N	Flexed, left side, S-N, facing N		S-N
Burial Location	Religious/ Ceremonial	Housemound or house platform	Elite residential, placed in floor SE corner of room	Residence?	Elite Residence
Grave Construction	**Simple, blocked-up room**	unclassifiable (simple, simple?)	simple, pit	crypt, simple	

Artifacts	***19 ceramic pots, including*** **1 polychrome; 1 jade ear flare; 1 jade ornament; 2 shells; 1 shell ornament; 1 stingray *barb*, 1 clay disc, 1 bone ring, 1 painted slate, green paint fragment**	None	Bone with drill hole	Shell pendant and ceramic vessel	Oval biface
Tooth Sampled	LM^1	LC_1	LM^1	M_1	LM_1
$^{87}Sr/^{86}Sr$	0.70780	0.70853	0.70847	0.70809	0.70797
$\delta^{18}O_{ap}$	-4.9 (-5.6*)	-4.4 (-5.1*)	-4.3 (-5.0*)	-4.9 (-5.6*)	-5.0 (-5.7*)
$\delta^{13}C_{ap}$	-3.5	-8.2	-5.4	-4.8	-7.1
Local or Non-Local	Non-Local	Non-local?	Non-local?	Non-Local?	Non-Local

Table 9.4 The non-local individuals from the Holmul region.
Sources: **Welsh 1988; Gerry 1993; Merwin and Vaillant 1932**

Conclusions

An integrated approach to Maya bioarchaeology offers the benefits of contextualizing the biographical narratives of individuals to more fully understand the intersectional identities of the past, as well as past experiences of life and death. Bioarchaeology employs multiple lines of evidence, methodology, and theory to reanimate the skeletal remains, extracting them from a collection or saving them from an appendix, and to convey the unique life histories they represent. Through the integration of skeletal analysis, mortuary analysis, bone chemistry, material culture, inscriptions, and monumental architecture, this study presents the intersectional identities of regional origin, biological sex, biological and cultural age, political role, social status, and religious purpose of the ancient Maya.

Local $^{87}Sr/^{86}Sr$ Ratios and Origins of the Outliers

The stable isotope analysis of the complete dataset suggests that all of the $^{87}Sr/^{86}Sr$ ratios fall within the ranges for the Maya lowlands, with no migrant individuals from elsewhere in the Maya region or greater Mesoamerica. With the removal of the statistical outlier individual from Holmul (58596.0.2) identified by the box-and-whisker plot, the mean (and median) $^{87}Sr/^{86}Sr$ for Holmul is 0.70825, with an IQR (50%) of 0.70815-0.70834. With the outlier from K'o (KOL.T.26.03.09.01) removed, the mean (and median) is 0.70848, with an IQR (50%) of 0.70836-0.70851. There were no statistically suggested outliers from the box-and-whisker plots for the Cival dataset, and so the mean remains 0.70804 with the median 0.70793 and the IQR (50%) of 0.70783-0.70818. The Hamontun mean (although not statistically different from the other site means) is 0.70818, with the median of 0.70816 and the IQR (50%) of 0.7080-0.70831.

To elaborate further on the outliers' status as "non-local," the various isotope analyses were combined in bagplots, bivariate box-and-whisker plots, visualizing characteristics of bivariate distribution. For the complete dataset, the bagplots of $^{87}Sr/^{86}Sr$ and $\delta^{18}O$, $^{87}Sr/^{86}Sr$ and $\delta^{13}C$, and $\delta^{13}C$ and $\delta^{18}O$ suggested no outliers. For the Holmul site dataset, 58596.0.2 was the only Holmul outlier suggested by the $^{87}Sr/^{86}Sr$ box-and-whisker plot, and now is identified again in the bagplots of the $^{87}Sr/^{86}Sr$ ratio plotted against both $\delta^{18}O$ and $\delta^{13}C$ ratios. HOL.T.37.09.01 was an outlier for the Holmul site

$\delta^{13}C$ box-and-whisker plots including the median, which has contributed to this indivdual's identification as an outlier in the bagplot. The $^{87}Sr/^{86}Sr$ ratio for HOL.T.37.09.01 was the largest in the dataset at 0.70853. While not statistically an outlier in the box-and-whisker plot of the $^{87}Sr/^{86}Sr$ ratios, when plotted with the $\delta^{13}C$ ratios in the bagplot, this individual's status as a possible non-local can be suggested. Similarly, HOL.T.30.20.09.01 was the second highest $^{87}Sr/^{86}Sr$ ratio for the Holmul dataset. While not suggested as an outlier for any of the box-and-whisker plots, when the $^{87}Sr/^{86}Sr$ and $\delta^{13}C$ ratio datasets were combined, this individual is presented as an outlier, and thus can be considered a possible non-local person.

Lastly for the Holmul site, the $\delta^{18}O$ ratio (unadjusted for weaning) box-and-whisker plot suggested that HOL.T.50.27.09.01 may be an outlier. Unfortunately, this cannot be corroborated through an $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ bagplot, as the $^{87}Sr/^{86}Sr$ test was inconclusive and needs to be re-run. HOL.T.28.04.09.01 was also identified as an outlier in the $\delta^{18}O$ ratio, unadjusted for weaning (inclusive and exclusive median), as well as when adjusted for weaning and including the median. Neither the bagplot of $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ ratios, nor that of $\delta^{18}O$ and $\delta^{13}C$ ratios concurred with its identification as an outlier. It is more likely that the low $\delta^{18}O$ ratio for the individual was a result of diet variation or sample processing error.

Unfortunately, the sample sizes for the other sites within the Holmul region limited the ability to create their site-specific bagplots. As the individuals KOL.T.26.03.09.01 and SUF.T.23.54.09.01 were suggested as outliers by the $^{87}Sr/^{86}Sr$ ratio box-and-whisker plots, it is more likely that they are non-locals than

CIV.T.01.04.09.01 and KOL.T.32.10.09.01, which were suggested as outliers by the $\delta^{13}C$ ratio plots. $\delta^{13}C$ ratios are highly variable and rarely used to suggest geographic origin. Thus, I would not consider CIV.T.01.04.09.01 and KOL.T.32.10.09.01 to be possible non-local individuals. Future statistical testing may be able to confirm the status of these four individuals.

Both the Holmul $^{87}Sr/^{86}Sr$ outlier (58596.0.2) and the K'o $^{87}Sr/^{86}Sr$ outlier (KOL.T.26.03.09.01) are most likely from elsewhere in the southern lowlands (based on geological data) or central Maya area (skeletal data). Comparable site $^{87}Sr/^{86}Sr$ ratio means based on skeletal sampling include every reported site in the southern lowlands: Piedras Negras (0.7080), Calakmul (0.7077), Tonina (0.7079), Palenque (0.7079), El Mirador (0.7079), and Yaxha (0.7070). For the tentative outliers of La Sufricaya, SUF.T.23.54.09.01 also is lower than the Holmul region mean and the La Sufricaya mean, suggesting a similar geographical origin elsewhere in the southern lowlands. HOL.T.37.09.01, and HOL.T.30.20.09.01, identified as outliers by the bagplots, had higher $^{87}Sr/^{86}Sr$ ratios than the site mean, suggesting possible geographical origins of the Belize River valley, the Gulf coast, or the northern lowlands.

Osteobiographies and Intersecting Identities

Through the combination of osteology, stable isotope analysis, archaeology, mortuary analysis, ethnohistory, and ethnographic data, the osteobiographies of these Maya individuals reveal social beings with complex and intersectional identities. The stable isotope analysis of this sample suggests that most elite individuals were local to the Holmul region, with the few outliers originating from elsewhere in the Maya lowlands, but not from greater Mesoamerica. These elite individuals most likely remained local to conform to the Maya elite ideologies of establishing lineages and reinforcing power through ancestor veneration.

From the site of Holmul, the osteobiographies of 26 individuals were constructed, from both the 20th century excavations by Merwin and the 21st century excavations by the Holmul Archaeological Project. In the civic and ceremonial center of Holmul, multiple individuals were found interred in lavish mortuary contexts, suggesting royal status. Two individuals were studied from Group I Structure D, a palace. During the Early Classic, an elite adult individual (HOL.T.84.14.09.1) was interred in an intrusive crypt grave between AD 400-500, based on the ceramic types. The associated artifacts of this burial include three tripod vessels of Teotihuacano style, although the stable isotope analysis suggests that this individual was local to Holmul or the Holmul region, and not born in Teotihuacan or Tikal. HOL.T.93.27.09.01, another local elite adult, was buried in an elite crypt burial in Building D.

In Group II Building A, four elite individuals were buried in a palace that was modified to become a ceremonial structure between AD 550 and 600. HOL.L.20.21.09.01, an adult male, was found within an intrusive tomb constructed through the floor of the vaulted room of the palace structure. The mortuary analysis suggests a royal burial, as the construction of the grave was that of a tomb, the most elaborate construction found in the Holmul center. Further, the burial was accompanied by 28 ceramic vessels, two quatrefoil jade ear flares, and the remains of a wooden mask, all suggesting a royal personage. The principal figure of the frieze on the structure above the palace is the ruler Tzahb Chan Yopaat, suggesting that the tomb of HOL.L.20.21.09.01 is in fact that of a royal tomb of Tzahb Chan Yopaat. Two elite adult females were found also buried in Building A: HOL.L.20.15.09.01 interred under the stairway of the palace structure with a ceramic vessel and a bone needle; and HOL.T.78.42.09.01 interred in a capped cist with a set of jade ear flares. Both individuals were local to Holmul and may have been members of the royal family of Tzahb Chan Yopaat. The fourth individual of Building A was recently excavated from an elaborate tomb dating to the Late Classic. The burial construction, positioning, and associated artifacts suggest the designation of an elite individual's grave. The evaluation of this tomb is forthcoming.

Many individuals were excavated from Holmul's Group II Building B by Merwin in the 20th century and by the HAP in the 21st century. Building B was most likely a burial structure and site of ancestor veneration as early as AD 150. For example, in Room 8, the "bunched" individuals and the probably re-entering or re-organization of the space suggest that this space was acting as a loci of ancestor veneration during the Late Preclassic period. The intention of ancestor veneration is corroborated with the stable isotope analysis of Skeleton 17, which resulted in signatures that suggest the local origin of this individual. These individuals were most likely local elites, venerated by their descendants during the Late Preclassic, resulting in clusters of disorganized human remains. Skeleton "12 or 5" is another noteworthy local individual interred in Building B, who was accompanied by a stingray spine with the inscription of the title Chak-Tok-Wayab, suggesting his or her high political position in the region during the Early Classic period. In Room 1, the non-local 58596.0.2 (Merwin's Skeleton 1) was interred within a multiple individual primary burial, along with 58599.0.02 and 58599.0.1 (Skeletons 2 and 6), both of whom were of probable local origin. The different body positioning between local and non-local individuals and the presence of possible non-local or foreign-influenced vessels reinforce the non-local status of 58596.0.2 (Skeleton 1). Lastly, it appears that the mortuary function of Building B changed from crypts for active ancestor veneration practices to individuals buried in blocked up rooms of a vaulted temple structure. This contrast suggests a shift in accessibility of the elites following their death, possibly suggesting that the Early Classic elites were important individuals, perhaps even members of the royal family.

The burials excavated from Group III, Court B of Holmul have many significant similarities, including age-at-death (between 4 and 14 years), likely local origin, flexed postitioning, and an association with benches within this palace structure. The associated artifacts range from ceramic figurines (HOL.T.50.27.09.01), which are common in burials of children (Welsh 1988:217), to perforated shells (HOL.T.58.16.09.01) to textile impressions in plaster (HOL.T.06.09.01). It is possible that the young individuals buried in the palace of Holmul were sacrificial or dedicatory in nature, although no direct skeletal evidence confirms this hypothesis.

In Ruin X of Holmul, Merwin excavated three individuals from the Late Classic, including Skeletons 1 and 2, which may represent the adult and child type of sacrificial burial. HOL.T.100.03.09.01 was interred later, and similarly to the primary burial of Group II Building A, the possible ruler, Tzahb Chan Yopaat. It is possible that the later burials of Skeleton 1, 2, and 3 in Ruin X were some type of veneration to the earlier, elaborate burial of HOL.T.100.03.09.01, with Skeleton 2 being a possible child sacrifice.

Outside of the center of Holmul, Late Classic burials were excavated from the elite, residential, South Group I. Most were simple pit burials cut into the floors of residential structures, including the female individual (HOL.T.30.20.09.01) in Room 2 who had a possible non-local origin, suggesting patrilocal residency. During the Terminal Classic, HOL.T.37.09.01 was interred in a mound with different architectural design and construction. The stable isotope analyses suggested the non-local origin of the individual, which is interesting considering the differing architectural design of the mound. This may be a late occupation of this residential group at Holmul by newcomers to the region from elsewhere in the lowlands.

For La Sufricaya, the osteobiographies of seven individuals were considered in this study. Two Early Classic individuals were found buried in Structure 1 of Group 1, which may have been a palace at the time. One of the individuals (SUF.ST.09.02.09.03.01) was estimated to have been 11±2.5 years of age-at-death, of local origin and buried in a palace context, suggesting their identity as a sacrificial victim. In Structure 146, the intrusive burial of SUF.T.23.56.09.01 (Burial #18) may have been placed in an act of ancestor veneration to SUF.T.23.54.09.01, who originated elsewhere but may have been one of the first of the family to settle at La Sufricaya. The disturbance of all three of the burials of the residential Structure 146 may indicate acts of ancestor veneration or the consequences of continued building construction. Also, SUF.T.11.06.09.01, a probable adult male was of local origin and his burial in a vaulted residential building near the site core suggests he was an elite individual.

All of the individuals studied from Cival date to the Middle or Late Preclassic period, during Cival's rise and florescence and before the power shifted back to Holmul for the Classic period. Of particular note, CIV.T.28.11.09.01 was a young adult male with dental caries buried in a multi-chambered chultun. Radiocarbon analysis dated the individual to 840-880 BC (calibrated), and the stable isotope analysis suggests that he was local to Cival. The *chultun* may have acted as a ritual locale or symbolic cave, with the human remains acting as offerings. At Cival, additional individuals were interred in a variety of locations, including middens, construction fill, looter's tunnels into ceremonial structures, and residential structures.

The burials excavated at in the residential groups of K'o date to all periods of occupation, including the Late/Terminal Preclassic, Early Classic, and Late/Terminal Classic. Buried in Structure 45 of Group XXXVIII, three individuals were analyzed for stable isotope ratios that suggested their local origin. These individuals were interred in the eastern structure of this elite residential group, suggesting its role as a mortuary shrine to those ancestors interred within. Two other local adult individuals were found interred in Structure 3 of the elite Residential Group XXXIX and Group XII, Structure 107. Lastly, KOL.T.26.03.09.01, estimated to have been 9 years ± 24 months at death, was interred in Structure 60 of the elite Residential Group IV. The stable isotope analysis suggests that this was a non-local individual possibly sacrificed and interred in a cache offering to an elaborate Preclassic *chultun* burial.

Of the four Hamontun individuals analyzed, two were interred as caches or offerings in open spaces during the Preclassic, one as an adult and one between the ages of 5 and 7 years, both with local $^{87}Sr/^{86}Sr$ ratios. The skull of the child (HAM.T.07.08.09.01) was placed on a cross-shaped support carved into the bedrock surface of a quarry. This location evokes associations with reservoir imagery and quatrefoils, suggesting that this was an offering deposited during a water ritual. The remaining two individuals were represented by only one premolar each, due to their tenuous burial contexts (midden and looter's trench), but were both found to be local to the Holmul region.

Broader Impacts and Future Directions

This research supports the use of the isotopic analysis of human remains as an essential tool for approaching complex archaeological questions and hypotheses, previously addressed primarily using architectural, iconographic, and artifactual evidence. An important contribution of this study was the estimation of an $^{87}Sr/^{86}Sr$ baseline for the site of Holmul and the Holmul region, and to use this to argue that all or a large number of the individuals in the sample were born locally. This local $^{87}Sr/^{86}Sr$ ratio signature of the Holmul region is comparable to other archaeological sites in the southern Maya lowlands and can be used by future scholars to clarify geographical origins of migrant individuals from other datasets. A further refinement of the $\delta^{13}C$ and $\delta^{18}O$ results will help elucidate these geographic identities, with a deeper understanding of the implications of an imported diet. Further, this study demonstrates the benefit of the isotopic analysis of dental enamel, especially in the Maya region and other global environments where difficult excavation conditions and the poor preservation of human remains previously dissuaded scholars.

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1997 Biological Perspectives on the Collapse of the Pasión Maya. *Ancient Mesoamerica* 8(02): 267–273.
2005a In Search of Yax Nuun Ayiin I: Revisiting the Tikal Project's Burial 10. *Ancient Mesoamerica* 16(01): 89–100.
2005b Identifying Immigrants to Tikal, Guatemala: Defining Local Variability in Strontium Isotope Ratios of Human Tooth Enamel. *Journal of Archaeological Science* 32(4): 555–566.
2006 *Diet, Health, and Status among the Pasión Maya: A Reappraisal of the Collapse*. Vanderbilt Univ. Press, Nashville, TN.
2012 Immigration to Tikal, Guatemala: Evidence from Stable Strontium and Oxygen Isotopes. *Journal of Anthropological Archaeology* 31(3): 334–352.

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1998 Porotic Hyperostosis and Paleoepidemiology: A Forensic Perspective on Anemia Among the Ancient Maya. *American Anthropologist* 100(4): 924–939.

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1998 Stable Carbon and Oxygen Isotopes in Human Tooth Enamel: Identifying Breastfeeding and Weaning in Prehistory. *American Journal of Physical Anthropology* 106(1): 1–18.

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2010 The Children of Kaminaljuyu: Isotopic Insight into Diet and Long Distance Interaction in Mesoamerica. *Journal of Anthropological Archaeology* 29(2): 155–178.

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1996 Human Biology in the Classic Maya Collapse: Evidence from Paleopathology and Paleodiet. *Journal of World Prehistory* 10(2): 147–198.

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2017 From E-Group to Funerary Pyramid: Mortuary Cults and Ancestor Veneration in the Maya Centre of Nakum, Petén, Guatemala. *Cambridge Archaeological Journal*: 1–28.

Zvelebil, M., and P. Pettitt
2013 Biosocial Archaeology of the Early Neolithic: Synthetic Analyses Of A Human Skeletal Population from the LBK cemetery of Vedrovice, Czech Republic. *Journal of Anthropological Archaeology* 32(3): 313–329.

Zvelebil, Marek, and Andrzej W. Weber
2013 Human Bioarchaeology: Group Identity And Individual Life Histories – Introduction. *Journal of Anthropological Archaeology* 32(3): 275–279.

CURRICULUM VITAE

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EDUCATION

Ph.D. Department of Archaeology, Boston University, 2018
Dissertation: "Maya Osteobiographies of the Holmul Region, Guatemala: Curating Life Histories Through Bioarchaeology and Stable Isotope Analysis"
Committee: David Carballo (chair), John M. Marston, Jonathan Bethard, Jane Buikstra

M.A. Department of Archaeology, Boston University, 2015

B.A. Department of Anthropology, Brandeis University, 2009

PUBLICATIONS

Peer Reviewed Journal Articles

2017 **Cormier, Aviva A.**, Jane E. Buikstra, and Anna Osterholtz. "Combined Genetic Skeletal Dysplasia of a Middle Woodland Individual: A Case Study," *International Journal of Paleopathology*, 18: 98-107. https://doi.org/10.1016/j.ijpp.2017.06.001

Peer Reviewed Book Chapters

2017 **Cormier, Aviva A.**, and Jane E. Buikstra, "Impairment, Disability, and Identity in the Middle Woodland Period: Life at the Juncture of Achondroplasia, Pregnancy, and Infection," In *Bioarchaeology of Impairment and Disability: Theoretical, Ethnohistorical, and Methodological Perspectives*, Jennifer Byrnes and Jennifer Muller, eds. Bioarchaeology and Social Theory. Springer International Publishing. https://doi.org/10.1007/978-3-319-56949-9_12

Archaeological Reports

2012 "Evaluación Petrográfica de 10 Tiestos de Cerámica de Los Sitios San Bartolo y Xultun, Guatemala." In *Proyecto Arqueológico Regional San Bartolo-Xultun: Informe de Resultados de Investigaciones Temporada de Campo No. 11*, Patricia Rivera Castillo y William Saturno, eds. Guatemala City: IDAEH, 535-560.

2012 Rossi, Franco and **Aviva A. Cormier.** "El Grupo Taaj: El Contexto Del Cuarto de los Murales y Las Excavaciones de una Residencia Elite." In *Proyecto Arqueológico Regional San Bartolo-Xultun: Informe de Resultados de Investigaciones Temporada de Campo No. 11*, Patricia Rivera Castillo y William Saturno, eds. Guatemala City: IDAEH, 97-166.

2010 Saturno, W., L. Romero, R. Beltran, **A. Cormier**, M. de Leon, D. Del Cid, P. Castillo-Rivera, F. Rossi, J. Ruane, A. Runggaldier, and J. Wildt. "Del Preclasico Tardio al Clasico: Cambios, Continuidades, y Nuevos Hallazgos en la Region San Bartolo-Xultun." In *XXIV Simposio de Investigaciones Arqueologicas en Guatemala*. B. Arroyo, H. Escobedo and H. Mejia, eds. Instituto de Antropologia e Historia, Guatemala City.

FELLOWSHIPS & AWARDS

2017, 2016	Graduate Writing Fellowship, College of Arts & Sciences Writing Program, Boston University
2017, 2014	Graduate Award, Department of Archaeology, Boston University
2016	Travel Grant, Boston University Graduate Student Organization
2015, 2014	Summer Research Fellowship, Boston University Graduate School of Arts & Sciences
2014	Graduate Research Abroad Fellowship, Boston University Graduate School of Arts & Sciences
2012, 2010	Teaching Fellowship, Department of Archaeology, Boston University

CONFERENCE ACTIVITY

Papers Presented

2017 "Regional Diversity and Population Migration of the Classic Maya: Stable Isotope Analysis of Individuals from the Holmul Region, Guatemala." Society for American Archaeology, Vancouver, March 30.

2016 "Dwarfism, Disability, and Identity during the Middle Woodland Period: A Case Study from the Elizabeth Site (11PK512)." Annual UCLA Interdisciplinary Archaeology Research Conference "Fitting In or Opting Out: Understanding Identity and Personhood in the Past," February 6.

2012 "Indigenous Revolts and Rebellions in Northern New Spain: Shifting Strategies and Changing Community Identities within Frontier Resistance." The Massachusetts Archaeology Month Graduate Research Conference, Brandeis University, October 26.

Posters Presented

2017 "Cementochronology to the rescue: Osteobiography of a Middle Woodland woman with a combined skeletal dysplasia." American Association of Physical Anthropologists, New Orleans, April 20.

2016 "A Case Study of Skeletal Dysplasia Inheritance and Maternal/Fetal Health from a Middle Woodland Context at the Elizabeth Site (11PK512), Illinois." American Association of Physical Anthropologists, Atlanta, April 15.

2015	"Population Dynamics, Migration, and the Rise of Classic Maya Civilization: A Biogeochemical Approach." Society for American Archaeology in San Francisco, April 15.
2015	"Disability, Care, and Identity in the Middle Woodland Period: Life at the Juncture of Achondroplasia, Pregnancy, and Treponematosis." American Association of Physical Anthropologists, St. Louis, March 25.

DEPARTMENTAL TALKS

2016	"The Bioarchaeology of Impairment and Disability: Skeletal Dysplasia during the Middle Woodland Period in the Lower Illinois Valley." Boston University Archaeology Brown Bag Lecture Series, February 10.

TEACHING EXPERIENCE

Boston University

College of Arts & Sciences Writing Program, Sole Instructor
Writing Seminar: Perceptions of Disability (Fall 2015 & 2016)
Writing & Research Seminar: Perceptions of Disability (Spring 2016 & 2017, Fall 2017)

Department of Archaeology, Sole Instructor
Great Discoveries in Archaeology (Summer 2016)

School of Medicine, Forensic Anthropology Program, Laboratory Teaching Assistant
Advanced Human Osteology (Fall 2013, 2014, & 2015)

Department of Archaeology, Teaching Assistant
Archaeological Field Research in Guatemala (Spring 2012)
Studies in Mesoamerican Archaeology (Spring 2012)
Archaeological Field Methods: Survey and Excavation (Spring 2012)
Great Discoveries in Archaeology (Fall 2010)

RESEARCH EXPERIENCE

2013-present	Project Bioarchaeologist, Holmul Archaeological Project, Guatemala, PI: Francisco Estrada-Belli
2014	Arizona State University Field School, Advanced Bioarchaeology and Human Osteology, Kampsville, Illinois, Director: Jane Buikstra
2012	Archaeologist, Proyecto San Bartolo-Xultun, Guatemala, PI: William Saturno
2009	Junior Staff Archaeologist, The Programme for Belize Archaeological Project (BfBAP), Belize, PI: Fred Valdez

PROFESSIONAL SERVICE

Grant Proposal Reviewer, Graduate Women in Science National Fellowship Program, 2013

UNIVERSITY SERVICE

Faculty Seminar Leader, "Disability, Accommodation, and Universal Design," Boston University Arts & Sciences Writing Program, 2017

Treasurer, Boston University Graduate Student Organization, 2016-2017

Department Representative, Boston University Graduate Student Organization, 2015-2017

Member, Grant Committee, Boston University Graduate Student Organization, 2016-2017

Member, Constitutional Reform Committee, Boston University Graduate Student Organization, 2016-2017

Member, Boston University Archaeology Graduate Student Association, 2009-2017

Member, Education and Outreach Committee, 2013-2017

Member, Lecture Committee, 2009-2013

NON-ACADEMIC WORK

Publications Assistant & Membership Specialist, American Schools of Oriental Research (ASOR), Boston MA, 2011-present

LANGUAGES

English (Fluent)
Spanish (Proficient)
French (Reading Proficient)

PROFESSIONAL MEMBERSHIPS

Society for American Archaeology (SAA), 2010-present
American Association of Physical Anthropologists (AAPA), 2014-present
Paleopathology Association (PPA), 2015-present
American Schools of Oriental Research (ASOR), 2012-present