THE RELATIONSHIP BETWEEN SOCIOPOLITICAL TRANSITIONS AND MORTUARY BEHAVIOR AMONG THE MAYA IN NORTHERN BELIZE

A Dissertation

by

KRISTIN KEIR HOFFMEISTER

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Chair of Committee,	Lori Wright
Committee Members,	Sheela Athreya
	Ethan Grossman
	Anna Linderholm
Head of Department,	Cynthia Werner

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ABSTRACT

The Preclassic (1000 BC-250 AD) and Terminal Classic (800-900 AD) periods were dynamic eras of profound change for the lowland Maya of Central America. In particular, dramatic changes in social structures appear to be reflected in shifting mortuary patterns at sites throughout modern-day northern Belize. This study uses stable carbon, oxygen, and strontium isotope data in conjunction with bioarchaeological and mortuary data in order to investigate diet, mobility, and oral health patterns during the social and political transformations experienced by the Preclassic and Terminal Classic Maya at two sites in northern Belize, Cuello and Colha. The data generated by these analyses provide substantial insight in how rising elites gained and controlled power during the Preclassic period; rather than universal patterns in diet, mobility, and health during the rise of social inequality in the Preclassic period, there are subtle differences between groups thought to be comprised of rising elite individuals. In addition, an unusual Terminal Classic mortuary deposit, the Colha Skull Pit, is comprised of primarily local individuals with a distinct diet, lending further insight into the origins and significance of these people. The isotopic and mortuary variability during these time periods further illustrates the challenges of interpreting complex mortuary deposits during broad sociopolitical changes in the past.

DEDICATION

For my parents.

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Chapter 2 was completed in collaboration with Dr. Norman Hammond, Dr. Frank Saul, and Julie Saul. In addition, Chapter 3 was completed with Dr. Lori Wright and uses some of her mortuary data in the analyses. None of the research would have been possible without the long term research projects at Colha and Cuello, directed by Dr. Tom Hester and Dr. Fred Valdez (Colha) and Dr. Norman Hammond (Cuello).

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1. INTRODUCTION

The Preclassic (1000 BC-250 AD) and Terminal Classic (800-900 AD) periods were extraordinarily dynamic eras for the lowland Maya of Central America. Mortuary data and skeletal remains represent important lines of evidence for investigating the sociopolitical transitions occurring during these time periods. Based on recent archaeological research, it is clear that the roots of the iconic Maya writing system, social structures, architecture, and material culture date to the Preclassic period (Blake et al. 1992; Hammond 1992, 2015; Inomata et al. 2013, 2015; Inomata and Henderson 2016; Joyce 2004a, 2004b; Love 1999; Saturno et al. 2006). Paramount among the changes that occurred during the Preclassic was the emergence of complex, stratified society. The exact nature of this sociopolitical transition is debated (Blake and Clark 1999; Inomata et al. 2013; Joyce 1999; Lesure and Blake 2002; Pool 2007). Furthermore, there was a clear shift in mortuary behavior during the Late Preclassic that was contemporaneous with other significant changes in architecture, site organization, social structure, and material culture at sites throughout the Maya area (Hammond 2015; Hansen 1998; Inomata et al. 2013, 2015; Love 1999; Sanders and Price 1968; Valdez 1987).

In northern Belize, these shifts have been documented at sites such as K'axob, Cuello, and Colha in the form of "clusters" of burials in public spaces that eventually became the main plazas at these sites (Hammond 1992, 1999, 2015; McAnany 1995, 2010, 2014;

McAnany et al. 1999; Wright 1989). These burials (sometimes called "mass burials") are characterized by one or more primary, articulated skeletons buried with disarticulated, secondary remains and surrounded by a cluster of other burials. They have been variably interpreted as the result of sacrifice and conflict during a highly transitional time (Hammond 1999, 2015; Robin 1989) or the establishment of hereditary sources of power via ancestor veneration (Joyce 2003; McAnany 1995, 2010; McAnany et al. 1999; Storey 2004; Weiss-Krejci 2003, 2011). In order to avoid preconceived notions and interpretive implications about these mortuary features, they are defined here as "clustered burials." Regardless of the terminology used to describe them, serious questions remain about the significance of these burials, the identities and social roles of the individuals interred in them, and the relationship of these individuals to broader sociopolitical transformations during the Preclassic.

In addition, the Terminal Classic period (800-900 AD) was also a time of dramatic change for the Maya. The Terminal Classic is characterized by increased conflict, population decline, and the abandonment of most major urban centers in the Maya lowlands, a series of events often summarized as the Classic Maya "collapse." As with the Preclassic transitions, unusual mortuary deposits appear contemporaneous with broader Terminal Classic social changes in northern Belize. At Colha, the "Skull Pit" feature (Op. 2011) represents a deposit of disarticulated individuals represented only by skulls. These remains have been linked to human sacrifice, local insurrection, and warfare; however, the origins and possible identities of these individuals remain unclear

(Barrett and Scherer 2005; Berryman 2007; Buttles and Valdez 2016; Massey 1989; Mock 1994).

Therefore, the purpose of this study is to use archaeological, isotopic, and skeletal health data to examine individuals in different mortuary contexts in northern Belize to evaluate the identities, social roles, and social functions of skeletal remains among the ancient Maya. In order to evaluate mortuary behavior in northern Belize, I test three primary hypotheses in the four articles of this dissertation:

1. The individuals in Preclassic clustered burials at Cuello and Colha and the Terminal Classic Skull Pit were derived from the local population.
2. These individuals had a distinct diet compared to individuals in residential mortuary contexts.
3. The individuals in the Preclassic clustered contexts had relatively better dental health than individuals in residential contexts.

I employ a multi-component archaeological analysis to evaluate these hypotheses by combining contextual data with skeletal data from Cuello and Colha, two sites in northern Belize with large Preclassic skeletal populations. In addition to residential mortuary contexts, Cuello has two unusual Preclassic clusters of burials, and Colha has one such feature. Colha additionally has a complex mortuary feature (the Skull Pit) dating to the Terminal Classic period that will similarly be investigated. I will examine patterning among individuals buried in these contexts in terms of geographic origins, childhood diet, childhood health, and adult dental health. Specifically, I will measure stable strontium, oxygen, and carbon isotopes from tooth enamel, as well as record dental caries and enamel hypoplasias.

The proposed research generates new isotopic and health data to examine how mortuary behavior relates to social stratification and change among the Maya. This research contributes to ongoing discourse about studying complicated mortuary contexts and the interpretive barriers associated with such contexts. This project also evaluates the social partitioning of mortuary deposits and examines diet, mobility, and health at small, peripheral sites that have historically been less emphasized in Maya archaeology.

1.1. Archaeological Background

1.1.1. Preclassic Period

The earliest inhabitants of the Maya area date to the preceramic Paleoindian (~15,000-7000 BC) and Archaic (7000-2500 BC) periods and were highly mobile groups (Table 1-1). Over time, these people adopted maize agriculture and sedentism, and the first definitive occurrence of Maya artifacts appears with the introduction of ceramics in the Preclassic period (Lohse 2010; Lohse et al. 2006; Pohl et al. 1996; Rosenswig et al. 2015). The earliest Middle Preclassic Maya communities likely exhibited little social or economic differentiation and practiced small-scale maize agriculture (Joyce 1999). During the latter half of the Middle Preclassic, however, many of the hallmark features of Classic Maya society began developing throughout the Maya region (Hammond 1992, 2015; Hansen 1992; Hester et al. 1996; Inomata et al. 2013, 2015; Inomata and Henderson 2016; McAnany et al. 1999; Willey 1990), with substantial elaboration occurring throughout the Late Preclassic (400 BC-250 AD).

Table 1-1. Maya chronology

Culture Period		Chronological Dates
Paleoindian		~15,000 - 7,000 BC
Archaic		7,000 - 2500 BC
Preclassic	Early	2500 - 1000 BC
	Middle	1000 - 400 BC
	Late	400 BC - 250 AD
Classic	Early	250 - 600 AD
	Late	600 - 900 AD
	Terminal	900 - 1000 AD
Postclassic		1000 - 1500 AD

Development occurred in site size, site organization, architecture, epigraphy, material culture, mortuary behavior, and many other aspects of everyday life. Beginning in the Middle Preclassic, astronomically aligned architecture (E-groups) appeared across the Maya Lowlands (Aimers and Rice 2006; Aveni et al. 2003; Doyle 2012); many sites were reorganized (Hansen 1992; Inomata et al. 2013); monumental architecture was raised (Freidel and Schele 1988; Hansen 1998; Inomata et al. 2013; Joyce 2004b; Munson 2012); and central, public plazas were constructed (Hansen 1998; Inomata et al. 2015). This period was also associated with changes in material culture, including lithics

(Aoyama et al. 2016; Brown et al. 2004), ceramics (Kosakowsky 1987; Rice 2015; Valdez 1987) and other luxury items (Love 1999; Rice 2015). Although the appearance of writing once heralded the boundary between the Preclassic and Classic periods, it is now clear that the origins of Maya writing date to the Preclassic (Saturno et al. 2006). Complex mortuary behavior developed throughout the Late Preclassic as well (Hammond 1992, 2015; Geller 2014; Joyce 2003; McAnany 1995, 2014; McAnany et al. 1999).

This Preclassic transformation was a complex, multifaceted shift that affected almost all aspects of society and is clearly reflected in the archaeological record. However, the exact origins and mechanisms of the establishment and consolidation of sociopolitical power have been debated. Beyond the polemical "Mother Culture" debate on the origins of Maya "civilization," a key question is exactly how burgeoning elite groups rose to power (Blake and Clark 1999; Inomata et al. 2013; Lesure et al. 2006; Pool 2007). Blake and Clark (1999) developed a model for the emergence of social hierarchy in Mesoamerica involving self-motivated actors competing for prestige ("aggrandizers"). Over time, these individuals became community leaders based on achieved prestige and were subsequently institutionalized as leading authority figures. Although still unclear, the legitimization of an elite class was accretional and likely included the social and political manipulation of the dead.

1.1.2. Terminal Classic Period

The end of the Classic period has been extensively studied by archaeologists to better understand the events and circumstances surrounding the Classic Maya collapse, during which many of the large southern lowland centers, including Palenque, Copan, and Tikal, experienced significant decline and were ultimately abandoned around 800-900 AD. A variety of explanations have been proposed to explain these dramatic changes (Aimers 2007; Aimers and Hodell 2011; Wright 1997a, 2006; Golitko et al. 2012; Iannone 2014). Regardless of the exact causes for the collapse, it is clear that the Maya populations during the Terminal Classic experienced profound changes that manifested in changing site organization, lithics, ceramics production, and mortuary behavior.

1.1.3. Previous Approaches to Complex Mortuary Deposits in the Maya Area

Burials are a unique form of archaeological data in their ability to shed light on the range of social variability and mortuary rituals involved in treating the dead (Binford 1971; Goldstein 1976; Saxe 1970). As a result, burial data can provide insight into broader scale sociocultural shifts such as those documented with increasing social complexity among the Preclassic Maya.

In his survey of Classic Maya lowland burials, Welsh (1988) interpreted multiple burials and secondary interments as forms of human sacrifice. Robin (1989) and Hammond (1999) followed suit and identified two Late Preclassic “mass burials” at Cuello in northern Belize as sacrificial in nature based on the large amount of disarticulated human remains. Saul and Saul (1991, 1997) provided systematic osteological analysis of these remains, and Hammond (1999) suggested that the disarticulated, excarnated individuals in these mass burials no longer had individual identities and were essentially just elaborate grave goods used for the mortuary treatments of others to gain and control sociopolitical status at Cuello (Hammond 1999, 2015).

Such interpretations of complex mortuary behavior have been successfully challenged (Cucina and Tiesler 2008; Geller 2005, 2014; Hendon 1999; Joyce 1999, 2003; McAnany 1995, 2014; McAnany et al. 1999; Storey 2004; Weiss-Krejci 2003). McAnany (1995) examined the Preclassic and Early Classic mortuary evidence at K'axob, Belize. Here, burials exhibited substantial changes over time in skeletal position, number of individuals per grave, presence of secondary remains, and grave goods. Drawing on theory from mortuary archaeology (Binford 1971; Braun 1981; Goldstein 1976; Hodder 1982; Saxe 1970), McAnany (1995) argued that the appearance of complex burials involving secondary interments in the Late Preclassic indicates protracted treatment of ancestral remains, rather than human sacrifice. Similarly, the presence of these burials in public, ceremonial spaces suggests greater visibility than for burials in residential areas, suggesting different social meanings (Joyce 1999). As a result, these clustered burials in public spaces have been linked to the establishment and consolidation of sociopolitical power and identity via the generation of ancestors (McAnany 1995).

Building on these critiques, there has been a move towards understanding the social, political, and ritual meanings of the dead among the Maya. McAnany's (1995) exploration of ancestor veneration in northern Belize has been further elaborated and applied to elsewhere in the Maya area to describe the process of ancestralizing and creating ownership of space (Geller 2005, 2011a, 2011b, 2012; McAnany 1995, 2010). A key component of ancestralization is the creation and reproduction of social memory and identity (Ashmore 2015; Buikstra and Scott 2009; Chase and Chase 2011; Cucina and Tiesler 2014; Geller 2014; Gillespie 2001, 2010; Joyce 2001; King 2010; Novotny 2013). Fitzsimmons (2011) and Weiss-Krejci (2003, 2011) further note that the dead were politically valued and used during times of sociopolitical establishment and negotiation, such as during the development of social stratification during the Preclassic period.

As a result of these new approaches and the difficulties inherent in mortuary interpretation, there is a growing body of research on complex mortuary features (Ashmore 2015; Duncan 2005; Knudson and Stojanowski 2008; Osterholtz et al. 2014; Scherer 2015; Tiesler 2007; Tiesler et al. 2017; Wrobel 2014) and consensus that archaeological interpretations of mortuary behavior must be based on multiple lines of evidence, including taphonomic, osteological, archaeological, and bioarchaeological data, in order to better understand the complex behaviors involved in the funerary process. This conjunctive approach has allowed for successful investigations of multiple burials, secondary interments, and other complicated mortuary behavior throughout the

Maya area (Duncan 2005, 2011; Freiwald 2011; Geller 2014; Olsen et al. 2014; Price et al. 2007; Scherer et al. 2014; Tiesler 2007; Tiesler et al. 2017). The proposed project will therefore employ multiple lines of archaeological and bioarchaeological evidence to evaluate emerging sociopolitical complexity in northern Belize.

1.1.4. Clustered Burials in Northern Belize

I will collect isotopic and dental health data from skeletal samples excavated at Cuello and Colha (Figure 1-1). These sites are ideal to answer questions about the nature of ancient Maya mortuary behavior and its relationship to broader sociopolitical shifts for several reasons. First, both sites have lengthy, overlapping occupation histories that extend throughout the Preclassic period. Although their occupations overlap, the economic context for each site differs, allowing for a broader look at mortuary behavior during the Preclassic social transitions. Second, large skeletal series are available from a variety of mortuary contexts, including the presence of Late Preclassic clustered burials. Third, both sites exhibit clear changes in mortuary behavior during the Late Preclassic that remain poorly understood. Fourth, the skeletal population of Colha also includes the Skull Pit deposit, which is a similarly unusual multiple burial that dates to the Terminal Classic period.

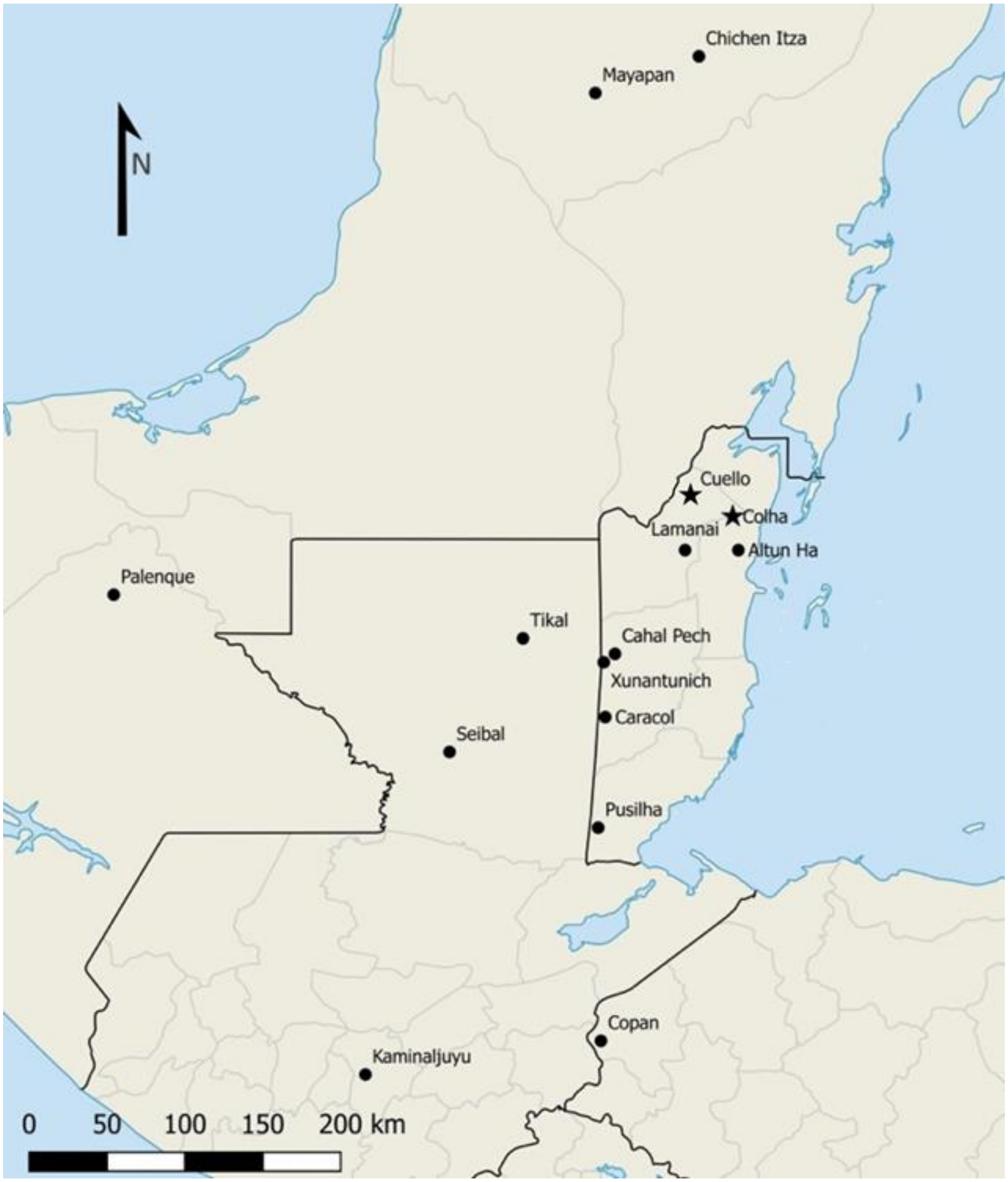

Figure 1-1. Regional map of the Maya area

1.2. Cuello

The site of Cuello is located between the Río Hondo and Río Nuevo in northern Belize, where it sits atop a limestone ridge (Hammond et al. 1991). Excavations at Cuello focused on Platform 34, a raised platform area in the site's core. Intermittent occupation at the site began during the pre-ceramic Archaic period, with permanent residences established during the Preclassic, between 1400 and 1200 BC (Hammond 2015). Cuello was continuously occupied throughout the Preclassic and at its height in the Early Classic, was a small farming community with an estimated population of 3400 inhabitants (Hammond 1999). Due to the small size and population density of the site, Hammond (1999) argues that Cuello was never a major political power. Although the site was small, the presence of foreign goods indicates that Cuello's inhabitants were active members of a broader trade network (Hammond et al. 1991).

Excavations at Cuello yielded one of the largest Preclassic skeletal collections (n= 166) in the Maya region. This sample contains individuals dating to both the Middle Preclassic and Late Preclassic. Most Middle Preclassic burials at Cuello occurred in residential contexts, typically within houses or ancillary residential structures (Hammond 1999). Both sexes and all ages are represented and primary burials were most common (Saul and Saul 1991, 1997). In the residential areas of Platform 34, primary burials remained the dominant form of mortuary behavior in the Late Preclassic. During the Late Preclassic, however, the central part of Platform 34 transformed into a public, ceremonial plaza space (Hammond et al. 1991). Sequential construction phases of this public space were accompanied by two clustered burials containing central, primary individuals and surrounding human remains in varying states of disarticulation (Figure 1-2) (Hammond 1999; Robin 1989).

Cuello's large Preclassic sample has been the focus of much investigation that builds the foundation for the current analysis. Robin (1989) provides an analysis of the Preclassic mortuary sample at Cuello with burial descriptions. Saul and Saul (1991, 1997) further provide a systematic analysis of paleopathological conditions observed in the Cuello sample. Carroll (2015) further examines the issue of war trophies and ancestor veneration at Cuello and K'axob using contextual data and finds evidence for both practices at Cuello. Hammond (1999, 2015) has also examined the mortuary information over time and its relationship to social stratification, noting the increasing complexity of mortuary behavior as social roles were established and negotiated over the course of the Preclassic. Previous isotopic work has also been done on some of the skeletal remains to investigate diet, which found some variation in maize consumption based on mortuary context (Tykot et al. 1996; van der Merwe et al. 2000; Young 2002).

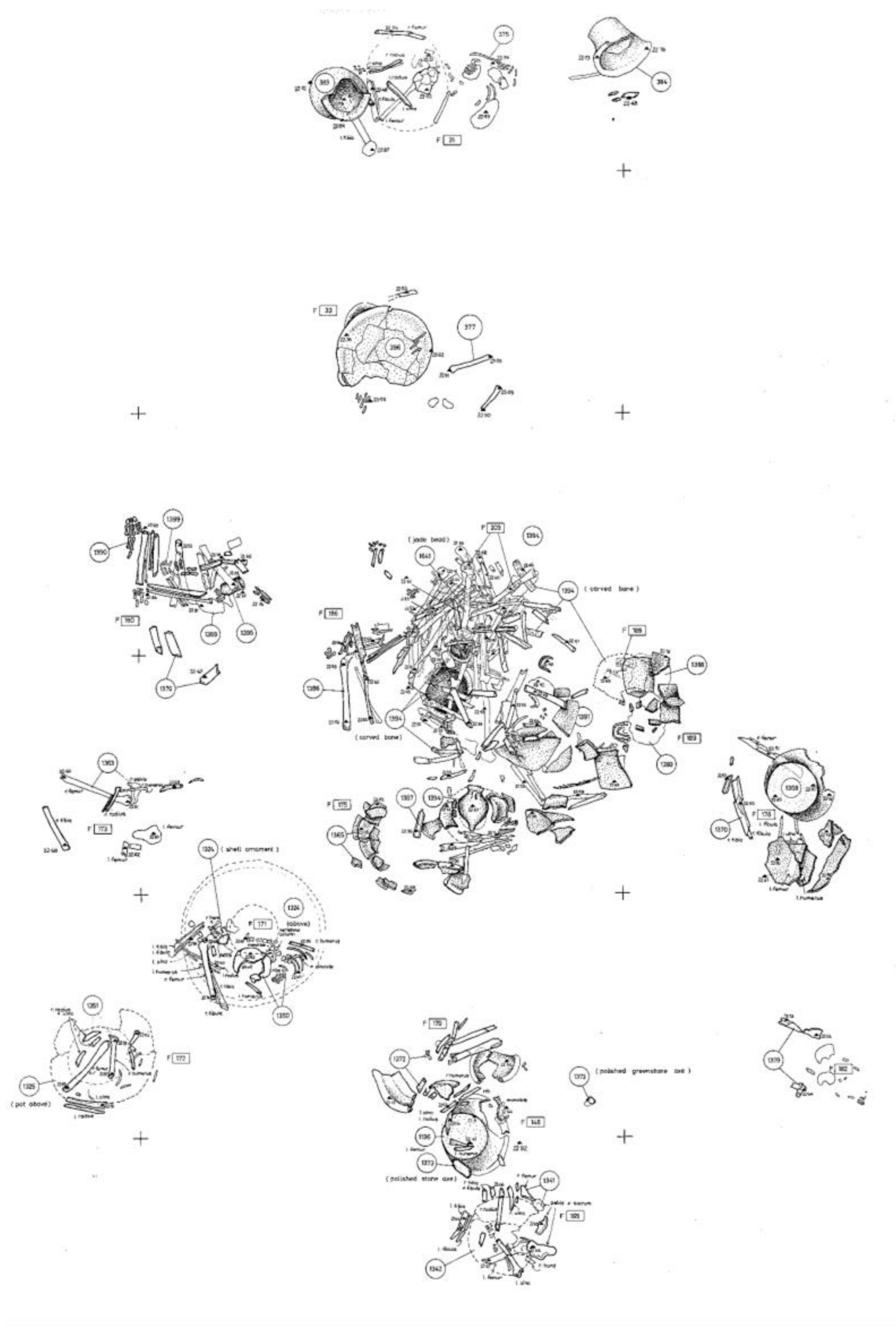

Figure 1-2. Plan of Cuello Mass Burial 1 (Hammond 1991)

1.3. Colha

Colha is located approximately 53 km northwest of Belize City and positioned atop Eocene and Miocene limestone deposits that contain chert, which became important for the development and economic success of the site (Hester et al. 1980). Colha was discovered during a regional survey performed by the Corozal Project in 1973-1974, and the site was excavated throughout the 1970s-1990s (Buttles 2002; Hester et al. 1980). The emphasis of most archaeological work at Colha has been on the extensive lithics production workshops scattered throughout the site (Hammond and Sidrys 1981; Hester et al. 1980; Shafer and Hester 1983) and its ceramic sequence (Iceland 1997; Valdez 1987).

Based on pollen data from the adjacent Cobweb Swamp, transient site occupation began during the preceramic Archaic period (Jones 1994). The first permanent settlements are Middle Preclassic and are comprised of small groupings of households (Buttles 2002). By the end of this time period, these households increased in size and number, and the social structure has been described as a chiefdom (Buttles 2002). It was during this time of unification and expansion that the first artifacts signaling long distance trade appeared at Colha (Brown et al. 2004; Shafer and Hester 1991). With the transition to the Late Preclassic, the site's size, population, architecture, and social complexity increased dramatically (Hester and Shafer 1994). Furthermore, Colha rose to become the primary source of stone tools for the region during the Late Preclassic period (Shafer and Hester 1983). The larger size of the site, abundance of stone tools, and associated lithics paraphernalia suggests that Colha's elites controlled chert resources for the region (Buttles 2002; Shafer and Hester 1983).

Colha continued to grow and expand throughout the Classic period (King 2000); however Colha likely experienced significant upheaval toward the end of this period. The Terminal Classic period exhibits evidence for dramatic changes in site organization and lithic production (Barrett and Scherer 2005; Barrett et al. 2011; Hester 1985). Ultimately, the site was abandoned during the Terminal Classic, after which there was a century-long occupational hiatus that ended with a culturally distinct group reinhabiting Colha (Barrett et al. 2011; Eaton 1980; Shafer and Hester 1983; Valdez 1987).

The skeletal assemblage from Colha is comprised of human remains from the Middle Preclassic to the Postclassic site abandonment. From the Middle to Late Preclassic, there was a clear shift in mortuary behavior, with the introduction of a large, complex cluster of burial in the main plaza (Op. 2031; Figure 1-3). During the Late Preclassic, there is a greater prevalence of disarticulated remains as well, most of which are located in this unusual mortuary context. Op. 2031 contains several unique features, including a well-like crypt of disarticulated remains, as well as a central female individual seated upon disarticulated remains and accompanied by numerous disarticulated human remains in separate pits, a pattern that is mirrored at Cuello (Robin 1989; Wright 1989).

The skeletal remains at Colha have been the subject of bioarchaeological investigation, especially with regard to the Terminal Classic Skull Pit feature (Barrett and Scherer 2005; Berryman 2007; Buttles and Valdez 2016; Massey 1989; Mock 1994). The Preclassic skeletal sample from Op. 2031 has been described and studied for health status (Wright 1989; Young 1994). Bioarchaeological studies have also been done on Op. 2031 to investigate diagenesis (Giraldo 2012) and biological relatedness using nonmetric traits (Snowden 2013). The mortuary patterning has also been examined in literature studies of excavation reports (Obledo 2011; Thompson 2005). Isotopic research at the site has focused on faunal remains to examine patterns of deer and dog use (White et al. 2001), as well as establishing a local strontium value using deer remains (Thornton 2011). Although components of the skeletal assemblage have been examined in isolation and have been briefly described in the Colha Project's excavation reports, the entire collection has never been systematically examined as a complete unit to assess site-wide patterning.

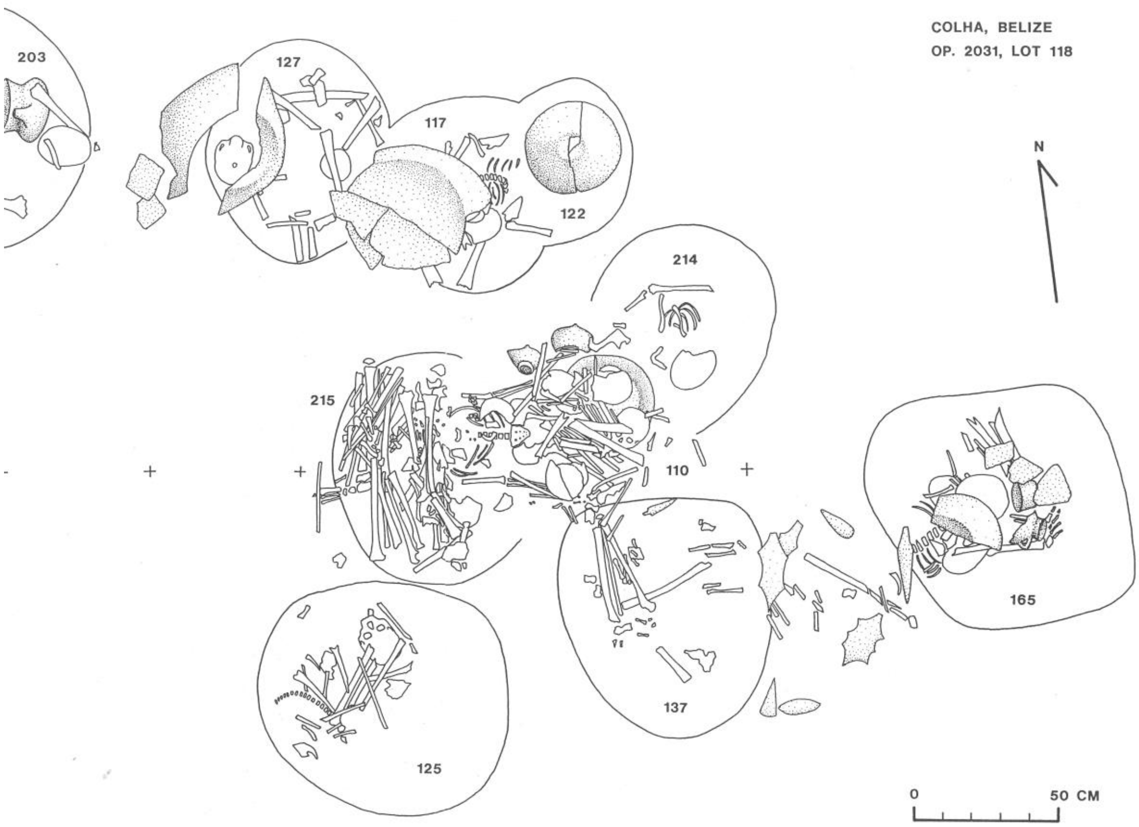

Figure 1-3. Excavation map of Colha, Operation 2031, Lot 118 upper levels (Wright personal communication)

1.4. Research Design

It is clear that the dead were not socially static among the Maya. Instead, they were part of ongoing negotiations of social and political power that were manipulated and controlled by the living, and any differences in mortuary treatment likely related to differences in social roles during life. Therefore, the **first hypothesis** I test is that individuals from Preclassic clustered burials at Cuello and Colha and the Terminal Classic Skull Pit were derived from the local population. In order to test this hypothesis, I compare the geographic origins between the individuals in these complex mortuary contexts and individuals with other mortuary treatments. I predict that individuals in the complex burial contexts were selected from the local elite groups. These individuals are therefore expected to be locals. In the case of the Preclassic burials, I predict these individuals were selected from the local population to be established and legitimized as ancestors. If this prediction is supported by the data, then this has substantial implications for the development of social status in northern Belize and the use of the dead and ancestors to legitimize claims to power. Another alternative explanation is the possibility that the social differences being navigated and negotiated during the Late Preclassic did not directly relate to differences in geographic origins. Instead, the placement of human remains during these time periods could have had broader social functions that did not manifest skeletally as differences in point of origin.

In addition, I test a **second hypothesis** that the individuals in these complex mortuary deposits had a distinct diet compared to individuals in residential mortuary contexts. I compare the childhood diet between individuals from all mortuary contexts. I predict that the remains in Preclassic clustered burials and the Terminal Classic Skull Pit consumed a different diet than other people at each site. If there are differences in diet between mortuary contexts at Cuello and Colha, it would suggest differential access to resources, which could also be an integral component of social hierarchy and political dynamics during times of significant sociopolitical transitions. Alternatively, a lack of dietary differences between groups could indicate that whatever mortuary treatment resulted in these complex deposits did not directly relate to differences in diet during life.

Finally, I test a **third hypothesis** that individuals in the Preclassic complex deposits had relatively better dental health than individuals in residential contexts. I compare the childhood and adult dental health between individuals in the complex mortuary deposits to all other mortuary contexts and time periods at each site. I predict that these individuals were a local elite group characterized by relatively better dental health. If these individuals do not exhibit differences in dental health, it could indicate a relatively stable stress load during childhood or dietary behavior during adulthood experienced by all members of society at Cuello and Colha.

1.5. Significance

In order to investigate mortuary behavior at Cuello and Colha, this research uses archaeological data in conjunction with enamel hypoplasias to measure childhood health, dental caries to document adult oral health, and strontium, oxygen, and carbon stable isotopic data to test place of origin. This research is important to our understanding of Preclassic and Terminal Classic populations in Mesoamerica and the social meaning of complex mortuary deposits. First, this project will inform archaeological theories about the broad sociopolitical transformations in the Late Preclassic. Although this transition has been examined at several Preclassic sites in the Maya area, uncertainty exists regarding the exact nature of the development of social complexity in the region. By examining the social meanings of unusual mortuary deposits at the site cores, I will be able to further elucidate the process of establishing and maintaining social roles within society. Second, although there has been debate about the social meaning and uses of unusual mortuary deposits in northern Belize during these transitional time periods, there has been no systematic, contextually sensitive archaeological analysis of Cuello and Colha using both archaeological and biological data to date. Finally, this project is broadly relevant to understanding the social meanings of complex mortuary deposits, both within Mesoamerica and abroad.

2. ISOTOPE BACKGROUND

2.1. Isotope Background

In order to examine mobility patterns at Cuello and Colha, I use radiogenic strontium and stable oxygen isotopes. I also complemented the mobility analysis with an assessment of paleodiet using stable carbon isotopes.

2.2. Strontium Isotope Background

Strontium is an alkaline earth element that has four naturally occurring isotopes: ^{84}Sr, ^{86}Sr, ^{87}Sr, ^{88}Sr. Of these isotopes, ^{87}Sr is radiogenic and forms from the radioactive decay of rubidium 87. The ratio of ^{87}Sr to ^{86}Sr ($^{87}Sr/^{86}Sr$) can be used to reconstruct mobility patterns in terrestrial mammals because this ratio varies due to differences between different geologic materials in their original ^{87}Rb content of rocks and ages (Bentley 2006; Ericson 1985; Faure and Mensing 2005). Strontium enters into the food web via erosion of underlying rocks and is subsequently incorporated into the tissues of plants, animals, and humans. In the body, strontium enters the hydroxyapatite of bones and dental enamel due to substitution for calcium (Bentley 2006; Ericson 1985). Because there is a relatively small mass difference between strontium isotopes, there is little biological fractionation as strontium is incorporated into bodily tissues. As a result, the $^{87}Sr/^{86}Sr$ of bones and teeth reflects the $^{87}Sr/^{86}Sr$ of areas where food was consumed (Bentley 2006; Ericson 1985).

2.3. Strontium Isotopes in the Maya Area

The Maya region of Central America is characterized by several broad strontium regions that allow for inferences about mobility patterns, as shown in Figure 2-1 (Hodell et al. 2004).

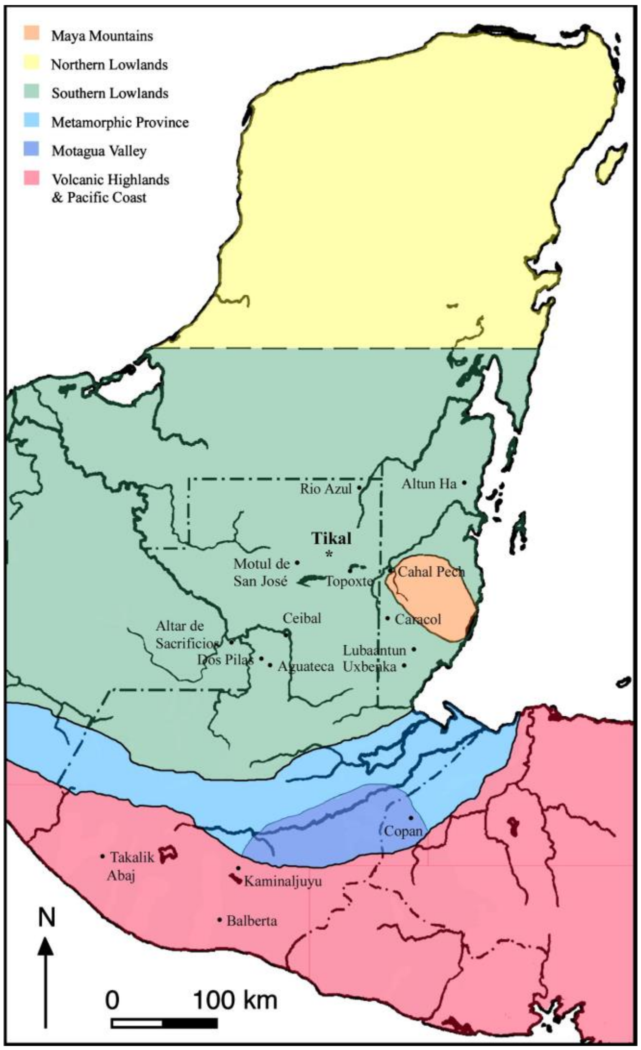

Figure 2-1. Map of strontium geology zones in the Maya area (Wright 2012)

Cuello and Colha are situated within the Southern Lowlands cluster identified by Hodell et al. (2004), which has a strontium isotopic range of 0.70718-0.70822, while the nearby Northern Lowlands are defined by values in the range of 0.70822-0.70954. The highest strontium isotope values in the area originate from the Maya Mountains of southern Belize, and the lowest values stem from the Pacific coast and volcanic highlands of Guatemala (Hodell et al. 2004). Although some overlap exists between these geochemical zones, especially at the borders, $^{87}Sr/^{86}Sr$ remains a powerful means to evaluate mobility among archaeological populations, and there has been a wealth of research on faunal (Sharpe et al. 2018; Thornton 2011) and human mobility (Freiwald 2011; Ortega-Muñoz et al. 2019; Price et al. 2002, 2010, 2012; Somerville et al. 2016; Trask et al. 2012; White et al. 2007; Wright 2005a, 2005b, 2012; Wright et al. 2010).

In terms of the geology of northern Belize, there is some heterogeneity in the region (Figure 2-2; Figure 2-3). Cuello, which is situated due west of the modern town of Orange Walk, Belize, sits atop Late Tertiary materials. In contrast, Colha, which is located to the southeast of Cuello, is in a more geologically diverse area, with Early and Late Tertiary formations in the area, as well as smaller Quaternary outcroppings.

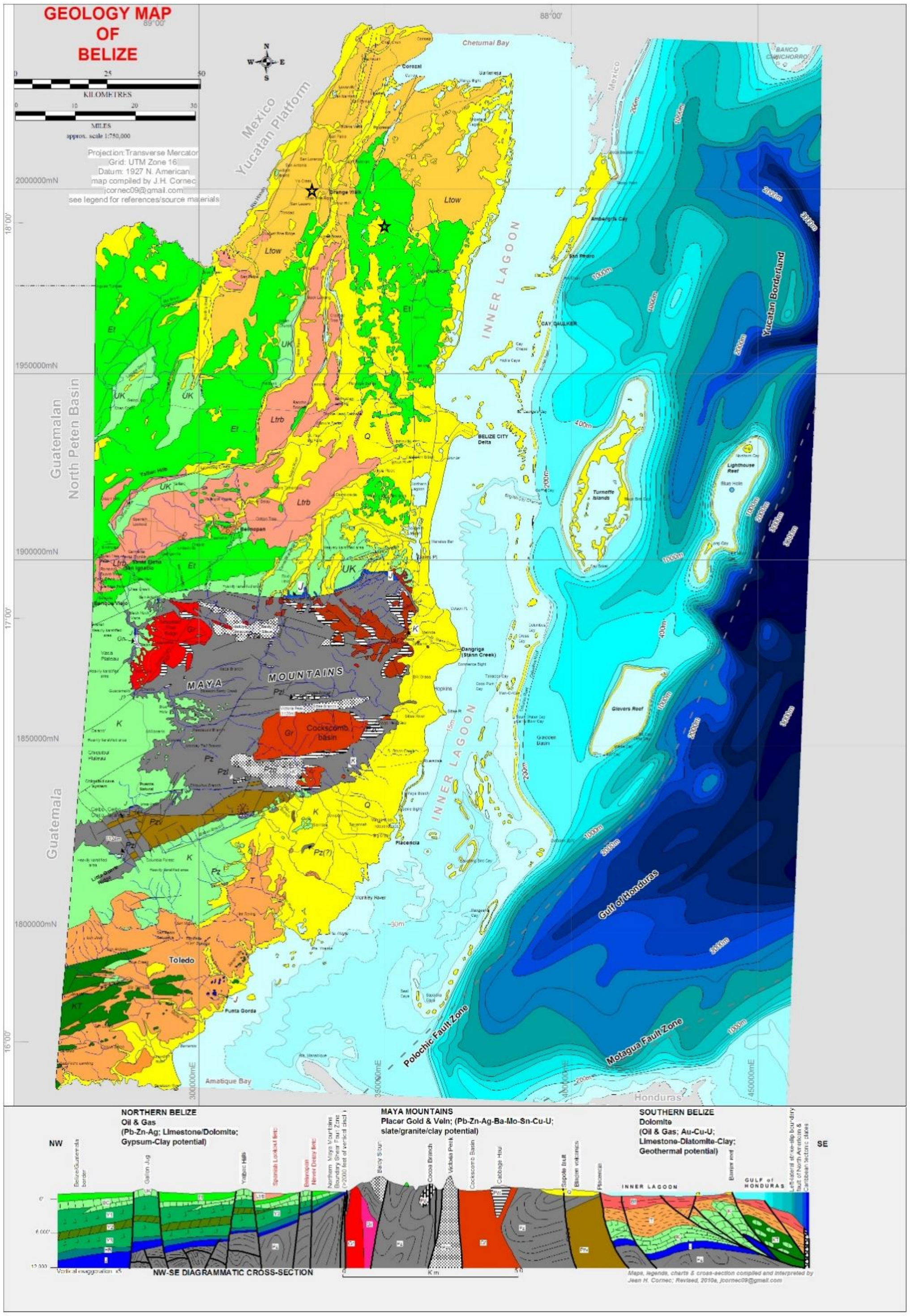

Figure 2-2. Geology map of Belize (Cornec 2008). Cuello (northwest) and Colha (southeast) marked with stars

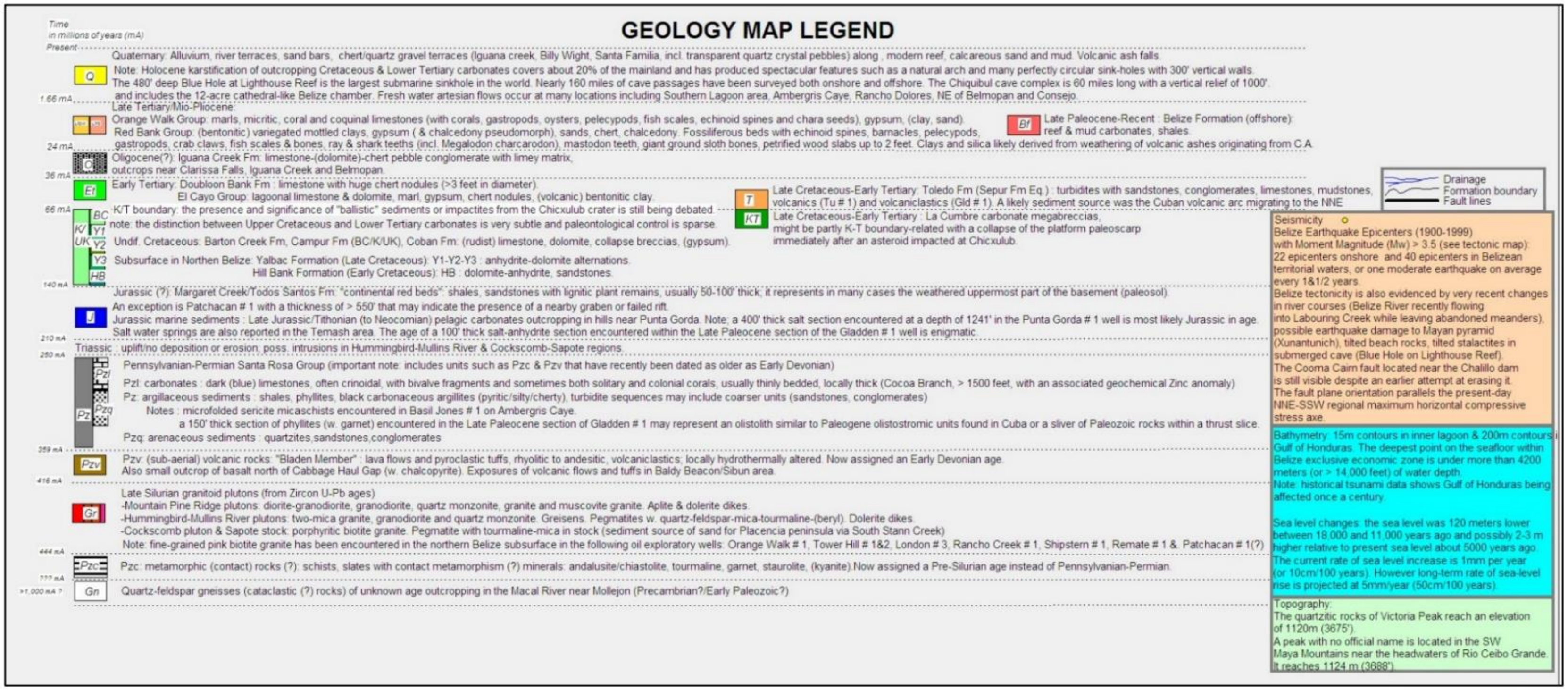

Figure 2-3. Legend for geology map of Belize (Cornec 2008)

In the Maya area, the primary determinant of an individual's $^{87}Sr/^{86}Sr$ values is likely to be local limestone due to its extensive use to process maize prior to consumption (Wright 2005a). Salt consumption and the trade of salted marine fish inland are also likely to affect skeletal $^{87}Sr/^{86}Sr$ values (Fenner and Wright 2014), albeit to a lesser degree than the alkaline processing of maize. There is ample archaeological evidence for sea salt production and trade among the Maya (McKillop 2005). In particular, Colha had ties to the coast, as well as the salt production site of Northern River Lagoon, which is located approximately 17 km east of the site, via a waterway (Valdez and Mock 1991). Although the local strontium ranges for nearby sites may overlap due to the gradual transitions in geochemical signatures across space, the zones are not entirely homogeneous, and strontium isotopes can still be used in conjunction with stable oxygen isotopes to evaluate the mobility of terrestrial vertebrates in Mesoamerica (Sharpe et al. 2018; Thornton 2011; Freiwald 2011; Price et al. 2002, 2010, 2012; Somerville et al. 2016; Trask et al. 2012; White et al. 2007; Wright 2005a, 2005b, 2012; Wright et al. 2010).

2.4. Strontium Faunal Baselines

Many approaches call for using a faunal strontium value to establish a "baseline" local strontium range for a given site (Price et al. 2002, 2010, 2012), while others demonstrate that using human values is also a viable approach (Wright 2005a, 2005b). With regard to the present study, there are no faunal strontium values yet published for the site of Cuello. However, there are two published strontium isotope faunal values for deer

(*Odocoileus virginianus*) samples from Colha, which yielded values of 0.7081 and 0.7082 (Price et al. 2010). These were referenced when establishing a local strontium range for Colha. Due to species-specific fractionation factors for stable oxygen isotopes, faunal data can only be used to help identify local strontium values.

2.5. Oxygen Isotope Background

In addition to $^{87}Sr/^{86}Sr$, stable oxygen isotopes are used to assess mobility in archaeological populations. The element oxygen has three stable isotopes (^{16}O, ^{17}O, and ^{18}O), of which the lightest and heaviest are used to reconstruct paleomobility patterns. The ratio of ^{18}O to ^{16}O is compared relative to a known standard (SMOW for bone phosphate and PDB for bone carbonate) and reported in permil (‰). Oxygen is incorporated into bodily tissues largely from consumed water, with lesser inputs from food (Longinelli 1984; Luz et al. 1984). The $\delta^{18}O$ of drinking water varies over space due to differences in the $\delta^{18}O$ of precipitation as clouds move away from the equator and toward higher latitudes and altitudes (Rozanski et al. 1993). Thus, there is a $\delta^{18}O$ rainwater gradient across geographic space that is reflected in the available drinking water in a given location, and thus the $\delta^{18}O$ of bodily tissues. Upon entering the body, oxygen is incorporated into the bony skeleton in both the phosphate and carbonate components of the bone mineral hydroxyapatite. Recent research has indicated that straightforward interpretation of $\delta^{18}O$ values can be confounded by evaporative effects due to the natural evaporation of standing bodies of water (Scherer et al. 2015) and boiling practices involved in food and beverage preparation (Tuross et al. 2017). The latter is particularly important to consider for Maya populations that relied on standing bodies of water such as lakes, aguadas, or cenotes for drinking. As a result, researchers now use $\delta^{18}O$ values as supporting evidence for strontium isotopes, rather than as independent measures of mobility themselves.

2.6. Carbon Isotope Background

Whereas strontium and oxygen isotopes are used to examine mobility patterns, stable carbon isotopes are used to infer paleodiet. For dietary studies, the ratio between carbon's two stable isotopes, ^{12}C and ^{13}C, is compared to a known standard (vPDB) and reported as $\delta^{13}C$ in permil (‰). The $\delta^{13}C$ of plant species varies depending on differences in carbon fractionation in each of the three photosynthetic pathways (DeNiro and Epstein 1978; Vogel and van der Merwe 1977). C3 plants, which include most of Earth's plant biomass, have much lighter carbon isotopic values than C4 plants, which primarily consist of grasses such as maize. CAM plants, which include succulents, have intermediate $\delta^{13}C$ values. In Mesoamerica, the primary determinant of $\delta^{13}C$ values is maize consumption due to the reliance on *Zea mays* as a staple crop. Differences in plant $\delta^{13}C$ are subsequently incorporated into bodily tissues of consumers (Vogel and van der Merwe 1977; DeNiro and Epstein 1978).

Stable carbon isotopes can also be used to infer the proportion of marine items versus terrestrial items consumed by an individual in a C3 foodweb (Schoeninger and DeNiro 1984), as well as tropical reef fish, which have carbon isotopic values that overlap with those of maize (Keegan and DeNiro 1988). This latter component is especially important at sites within an easy trade distance to the coast like Colha. In the skeleton, the $\delta^{13}C$ of collagen reflects the protein-based components of diet, while the $\delta^{13}C$ of carbonate reflects the $\delta^{13}C$ of the total diet (Ambrose and Norr 1993).

Carbon isotopes of different bodily tissues reflect different components of the total diet (Ambrose and Norr 1993). With regard to skeletal tissues, the $\delta^{13}C$ of bone collagen reflects the $\delta^{13}C$ contributions from dietary protein, while the $\delta^{13}C$ of bone apatite is a better approximation of total dietary $\delta^{13}C$ (Ambrose and Norr 1993). In addition, for sites along the coast and those that likely relied on marine resources, $\delta^{13}C$ can also be used to interpret the relative dependence on marine versus terrestrial food sources (Schoeninger and DeNiro 1984).

Stable carbon isotopes have been successfully applied to reconstruct paleodiet throughout the Americas, often in conjunction with nitrogen isotopes. In the Maya area, dietary variation has been documented at sites throughout the region, with differences in $\delta^{13}C$, and thus maize consumption, occurring across space, over time, and between mortuary contexts and demographic groups (Freiwald 2011; Gerry 1993, 1997; Henderson 1998; Piehl 2006; Rand et al. 2013; Reed 1994; Scherer et al. 2007; Tykot et al. 1996; van der Merwe et al. 2000; White et al. 1993; White, et al. 2001; Wright 2006).

2.7. Diagenesis

Diagenesis, or the postmortem chemical alteration of bone, is a significant concern when performing isotope studies, especially in regions characterized by poor preservation, such as the Maya region of Central America. In order to minimize the possible effect of diagenetic alteration on the isotope values obtained in this study, I sampled only dental enamel, which is well-documented to have greater resistance to diagenesis. Furthermore, I removed the outer layer of enamel that interfaced with the burial environment as part of my analytical methods, thereby negating the possible diagenetic effects. This approach has been used extensively in the Maya area (and beyond), and there's a wealth of isotopic research that has generated biogenic isotopic signals free from diagenesis (Sharpe et al. 2018; Thornton 2011; Freiwald 2011; Price et al. 2002, 2010, 2012; Somerville et al. 2016; Trask et al. 2012; White et al. 2007; Wright 2005a, 2005b, 2012; Wright et al. 2010).

3. PRECLASSIC DIET AND MOBILITY AT CUELLO, BELIZE

3.1. Introduction

The Preclassic period (1000 BC - AD 250) was a time of profound transformation for the lowland Maya civilization. During this time, significant sociopolitical changes occurred, ultimately resulting in a complex, stratified society characterized by institutionalized inequality and political centralization (Estrada-Belli 2011; Hammond 1991; Inomata et al. 2013, 2015; Blake and Clark 1999; Lesure and Blake 2002). As these changes were developing throughout the Preclassic period, there were also shifts in many other aspects of daily life including mortuary behavior, which has been linked to the establishment and consolidation of hereditary lines of sociopolitical power (Hammond 1999, 2015; Wright 1989; McAnany 1995).

At Cuello and several other sites in northern Belize, mortuary patterns during the Late Preclassic period continues to involve the standard Maya mortuary behavior of single burials under residential structures. In addition, Late Preclassic "mass burials," also referred to as "clustered burials" here, appear during this time period in the spaces that ultimately transformed into the primary civic-ceremonial plazas at these sites (Hammond 1991, 1999, 2015; McAnany 1995, 2010, 2014; McAnany et al. 1999; Wright 1989). These clustered burials are characterized by multiple individuals in varying states of articulation deposited over time in the same area. At Cuello, the two clustered burials include one or two primary, articulated skeletons at the center of the feature who are accompanied by disarticulated human remains in their laps, around their feet, or beneath them. These individuals also have a number of elaborate grave goods and are surrounded by contemporaneous articulated and disarticulated single and multiple burials (Hammond 1991, 1999, 2015; Wright 1989; McAnany 1995).

Due to the unusual composition and high prevalence of disarticulation in these mortuary deposits, they have been interpreted as the result of human sacrifice during sociopolitical transitions (Hammond 1999, 2015; Robin 1989) or the creation of ancestors to establish hereditary ties to power (McAnany 1995, 2010; McAnany et al. 1999; Storey 2004; Weiss-Krejci 2003, 2011; Wright 1989). When originally describing the two Late Preclassic clustered burials at Cuello, Robin and Hammond (1991) characterized the disarticulated remains in these mass burials as human grave goods that had lost their personal identities. Hammond (1999, 2010, 2015) further related the presence of these bundles of excarnate bones ("body bundles") to the establishment and consolidation of power at Cuello.

In contrast, when examining a similar deposit at nearby K'axob, McAnany (1995) suggested that these complex Late Preclassic mortuary features are not the result of human sacrifice and instead result from extracted rituals and treatment of ancestral remains. McAnany (1995) therefore suggests that the complex mortuary deposits represent establishing a "genealogy of place" during the Preclassic period in northern Belize in which kin groups used the physical placement of ancestral remains in public spaces to establish ties to sociopolitical power. McAnany (1995) therefore relates these Late Preclassic mortuary deposits in what ultimately become the public civic-ceremonial spaces at each site to the creation and veneration of ancestors as a means to establish and control sociopolitical power and identity. Thus, these burials, the identities of the individuals interred in them, and their relationship to Late Preclassic sociopolitical transformations remain unclear.

There has been a wealth of research on mortuary behavior and "unusual" mortuary deposits like those found in northern Belize during the Preclassic period (McAnany 1995; Fitzsimmons 2009, 2011; Eberl 2005; Tiesler and Cucina 2007, 2017; Gillespie 2001; Weiss-Krejci 2003; Duncan and Schwarz 2014). Among the Maya, the dead were frequently manipulated and used to establish physical ties to places, dedicate buildings, and assist in identity formation, and there is ample iconographic evidence from the later Classic period that shows the significance of ancestors and ancestral spirits interacting with the living (Fitzsimmons 2011; Mock 1998; Eberl 2005; Scherer 2015). In fact, ancestors were key social actors among the ancient Maya who were often invoked and negotiated with by the living (Fitsimmons 2011). Elaborate mortuary rituals, often involving secondary postmortem processing or treatment, were commonly applied to ancestral remains, and new rulers lacking a firm grasp on sociopolitical power were documented to have used such rituals in public spaces, or plazas, to establish and validate their status (Scherer 2015).

Furthermore, elaborate mortuary treatments and non-funerary deposits have been associated with victims of human sacrifice (Tiesler and Cucina 2007; Scherer 2015). With regard to investigating possible human sacrifice or ancestor veneration in the archaeological record, there is documented variability in terms of likely sacrificial mortuary deposits at sites throughout the Maya area (Price et al. 2008; Tiesler and Cucina 2007). Due to the complexity of possibly sacrificial deposits, identifying human sacrifice requires more than just skeletal data alone. This issue of examining complex mortuary and non-funerary deposits among the Maya has been reexamined by Tiesler (2008), who argues for a contextually sensitive taphonomic approach when attempting to identify sacrificial ritual in the archaeological record. Such a thanatological approach has been successfully applied to interpret mortuary behavior throughout the Maya region (Duncan 2011; Duncan and Schwarz 2014; Palomo et al. 2017; Tiesler et al. 2017).

The purpose of this study is to examine the Preclassic mortuary deposits at Cuello using geochemical and archaeological data in order to investigate the individuals interred in the mass burial deposits and better understand their relationship to broader sociopolitical changes during the Late Preclassic. Specifically, this study uses mortuary context data in conjunction with strontium, oxygen, and carbon isotopes of tooth enamel from 94 individuals to investigate dietary and mobility patterns. Cuello is ideally situated to investigate Preclassic mobility and mortuary patterning in northern Belize due to the extensive Preclassic occupation at the site and large associated Preclassic skeletal assemblage that includes individuals buried in the two clustered burial contexts as well as other contemporaneous mortuary contexts throughout the Middle and Late Preclassic periods (n= 166; Saul and Saul 1991, 1997).

To date, the overwhelming majority of research on Maya dietary and mobility patterns using isotopic evidence has focused on Classic period populations, which are typically represented by larger, better preserved skeletal assemblages from archaeological sites throughout the Maya region (Freiwald 2011; Price et al. 2008, 2010; Somerville et al. 2016; Scherer et al. 2007; Wright 2005, 2006, 2012; Wright et al. 2010). Preclassic isotope samples have predominantly been included in these larger studies for chronological comparisons with later isotopic data, rather than the emphasis of independent analysis. This study 1) characterizes local strontium and oxygen ranges for Cuello, and 2) examines Preclassic mobility and dietary patterns at Cuello over time and between mortuary contexts in order to better understand Preclassic sociopolitical transformations in northern Belize. Specifically, I test the hypothesis that the individuals in these complex mortuary deposits were derived from the local population and had a distinct diet.

3.2. Site Background

Excavations at Cuello have yielded a wealth of information about ancient Maya life during the Preclassic period. At its height, Cuello was never more than a small village, yet analyses of material remains from the site have revealed insights into Preclassic chronology (Hammond 1991), architectural innovation (Hammond and Gerhardt 1990), health (Saul and Saul 1991, 1997), mortuary behavior (Hammond 1999, 2015; Robin 1989), and many other facets of ancient Maya life. Cuello is located in modern day northern Belize atop an interfluvial limestone ridge between the Rio Hondo and Rio Nuevo rivers, approximately 5 km west of Orange Walk Town (Figure 3-1). The site was discovered in 1973 during a regional survey performed by the British Museum's Corozal Project and was subsequently excavated over 11 field seasons from 1975-2002 (Hammond 2005). The site core is comprised of two large plaza platforms, each with an associated pyramid. Excavations at Cuello focused on one such platform, Platform 34, with the specific focus of investigating the Preclassic period occupation (Hammond 1999, 2005).

Cuello was established as a small farming community around 1400-1200 BC based on AMS dating of bone collagen (Hammond 2015; Hammond et al. 1995). During the subsequent Early Middle Preclassic Swasey phase (1200-900 BC), the site remained a small village. The earliest burials at Cuello dating to this time period lack any substantial grave goods and are quite simple in form (Hammond 1999, 2015; Robin 1989). However, by the end of the Middle Preclassic Bladen phase (900-650 BC), there is substantial elaboration and evidence of foreign exotic grave goods at several burials at Cuello, suggesting the emergence of social inequality during the latter part of this phase (Hammond 1999, 2015).

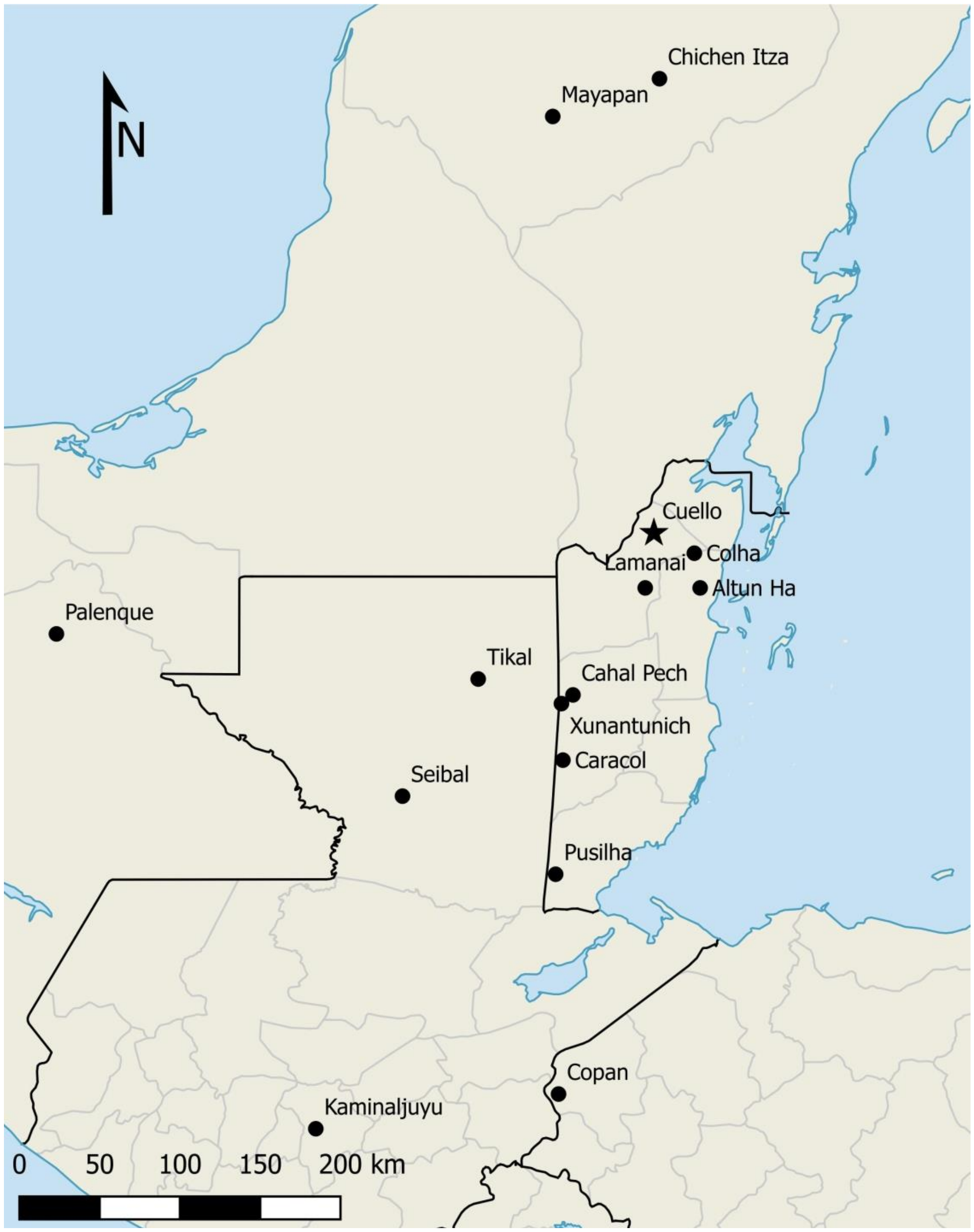

Figure 3-1. Regional map of the Maya area. Cuello is noted with a star

With the transition to the Late Middle Preclassic Lopez Mamom phase (650-400 BC), the main patio floor at Cuello shifted from a primarily domestic space to a possibly communal ritual space, and differences in grave goods and burial complexity increased dramatically (Hammond 1999, 2015). During the Late Preclassic Cocos Chicanel phase (400 BC-AD 250), Cuello experienced significant reorganization, and the original Middle Preclassic structures on Platform 34 were destroyed in favor of creating a large open central plaza for public rituals (Hammond 1999, 2015). During the Late Preclassic construction of this ceremonial space, two "mass burials," or "clustered" burials, were deposited, each with two central individuals placed with disarticulated human remains ("body bundles") and surrounded by individuals in varying states of articulation (Figure 3-2).

These mass burials are almost entirely male in composition, with only one possible female, and lack subadults, suggesting that individuals were not chosen at random for inclusion in these deposits. Mass Burial 1 consists of at least 32 adult skeletons, with 2 centrally placed male individuals (Cuello burials 50 and 51) accompanied by disarticulated "body bundles" surrounding them. These two individuals are further surrounded by 24 adult males, 1 possible female, and five adults of indeterminate sex in varying states of articulation. Similarly, the slightly later Mass Burial 2 consists of two central individuals with body bundles that were surrounded by an additional 11 adult male burials, 0 female burials, and 3 adults of indeterminate sex (MNI= 16). Due to the unusual archaeological context of these mass burials, as well as the highly skewed demographic composition, Hammond interpreted them as sacrificial in nature, although the possibility of ancestral veneration has also been suggested (Robin 1989; Saul 1991, 1997; Hammond 1999, 2015; McAnany 1995). Of the 199 human individuals excavated at Cuello, 166 date to the Preclassic period (Hammond 2015). Previous research on these skeletal remains has focused on mortuary patterning (Robin 1989; Hammond 1999, 2015) and paleopathology and health (Saul and Saul 1991, 1997).

Previous isotopic research has also been performed on the Cuello skeletal collection to investigate paleodiet using stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) of collagen and bone apatite (Tykot et al. 1996; van der Merwe et al. 2000). Based on these data, diet did not significantly change between the Middle and Late Preclassic periods at Cuello. Furthermore, as with other archaeological Maya sites in Belize, inhabitants of Cuello consumed relatively reduced amounts of maize compared to sites elsewhere in the Maya lowlands (Tykot et al. 1996; Gerry 1993, 1997; Freiwald 2011). There is also some evidence to suggest that males consumed more maize than their female counterparts and that adults consumed more animal protein than did subadults (Tykot et al. 2000). The present study expands upon this earlier isotopic work and presents new $\delta^{13}C$ data of dental enamel for an increased sample of Cuello individuals.

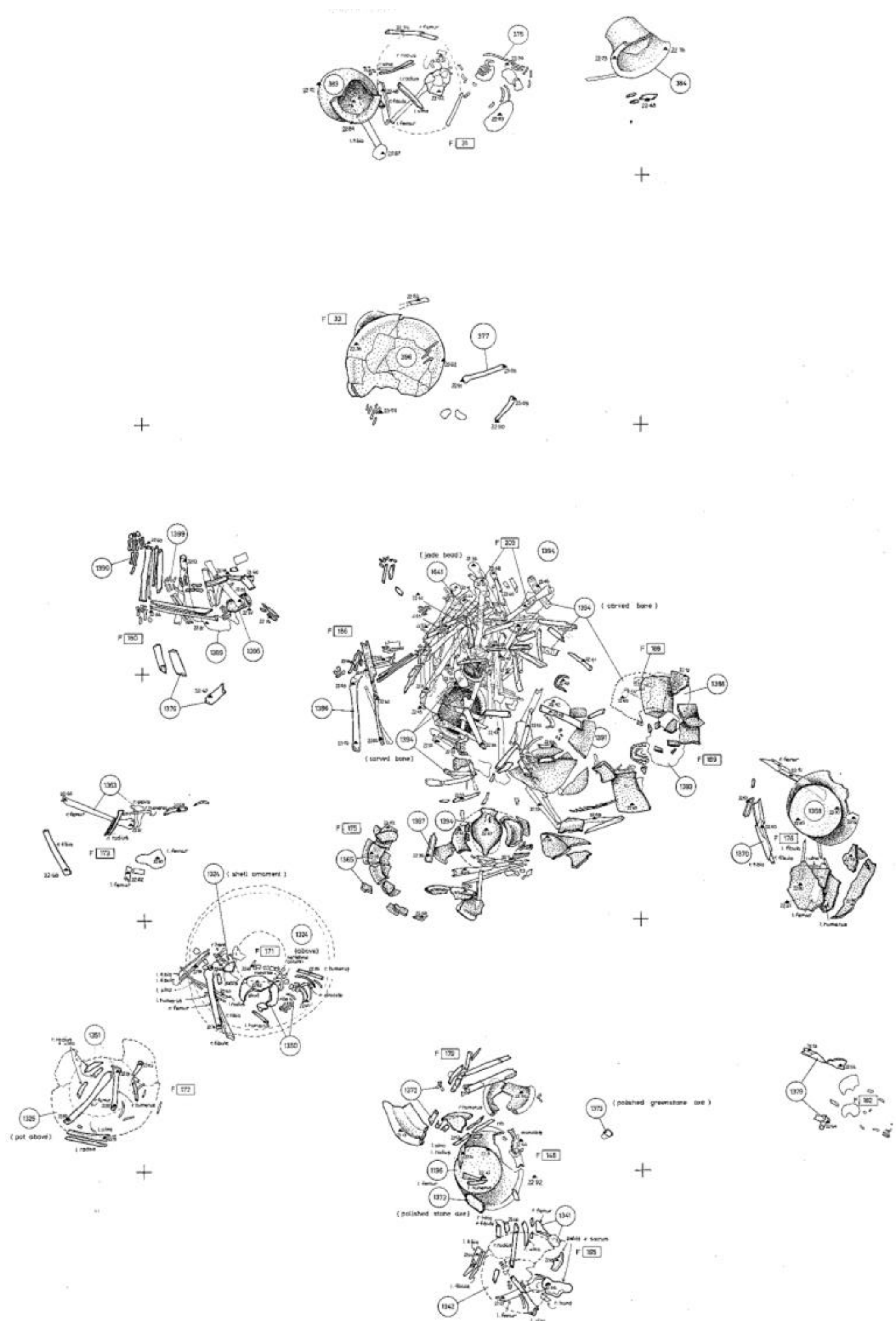

Figure 3-2. Map of Cuello Mass Burial 1 (Hammond 1991)

3.3. Analytic Methods

All age, sex, and paleopathology assessments were performed by Saul and Saul (1991, 1997). Permanent first molars were selected for isotopic analysis from the Cuello skeletal remains excavated during the 1975-1992 seasons that are curated by Dr. Frank and Julie Saul in Toledo, Ohio. Dental enamel samples were primarily selected from Preclassic period burials, with three additional samples pulled from Classic period contexts. Samples were selected from all demographic age and sex categories, as well as from a broad range of mortuary contexts at Cuello. Mortuary context variables were compiled by Robin (1989) and Hammond et al. (1991, 1992, 1995). Individuals sampled for isotopic analysis are presented in Appendix A.

Dental enamel samples for isotopic analysis (n= 94) were taken as vertical cross sections of the crown from the cemento-enamel junction to the occlusal surface of the cusp. Resulting isotopic values therefore represent an average for the duration of amelogenesis, which is roughly the first 2.5-3 years of life for permanent first molars (Reid and Dean 2006). As teeth do not remodel during the life of an individual, the resulting isotopic values represent geographic location and diet during childhood. Ten to twenty milligram samples for both light and heavy isotope analysis were taken with a Brasseler diamond drill bit, which was also used to remove dentine and abrade the enamel surface to remove any potential contaminants.

All light isotope preparation was performed in the lab of Dr. Lori Wright at Texas A&M University. Enamel samples were first rinsed with 1 ml 0.25M hydrochloric acid for one minute then rinsed three times with distilled water and dried. The enamel sections were subsequently ground with an agate mortar and pestle to a fine powder and then soaked for 48 hours in a 1.5% sodium hypochlorite solution to remove organics. Samples were then rinsed three times with distilled water and centrifuged. Finally, enamel samples were washed with 1 ml of 1M acetic acid and centrifuged for 15 minutes, then rinsed 3 times with distilled water and dried. Treated enamel samples were transferred to the Texas A&M University Stable Isotope Geosciences Facility where they were run on a Thermo Scientific Kiel IV Automated Carbonate Device coupled to a Thermo Scientific MAT 253 dual inlet isotope ratio mass spectrometer. The Stable Isotope Geosciences Facility at Texas A&M University reports a $\pm 1\sigma$ instrumental uncertainty of ±0.04‰ for $\delta^{13}C$ and ±0.06‰ for $\delta^{18}O$ based on long-term replicate analyses of PDB carbonate isotope standards NBS 19 and IAEA 603.

Strontium isotope preparation and analysis were performed at the R. Ken Williams Radiogenic Isotope Geosciences Laboratory at Texas A&M University. Enamel samples were first sonicated in 1 ml 1M acetic acid optima for 20 minutes, rinsed with distilled water, and sonicated again for 5 minutes in 1 ml 1M acetic acid optima. Cleaned samples were rinsed three times with distilled water and then dissolved overnight in 500µL 7N nitric acid. Dissolved enamel samples were dried on a hot plate at 90°C for 3 hours and then redissolved in 500µL 3N nitric acid overnight. Dissolved samples were subsequently run through columns with Eichrom SrSpec resin to isolate strontium and reduce isobaric interference. Once columns were completed, the resulting strontium sample was dried on a hotplate for ~2 hours at 90°C. One microliter of 2N HCl was used to load samples on degassed rhenium filaments, which were subsequently run on a Thermo Scientific Triton thermal ionization mass spectrometer. Over the last three years, long-term analyses in this lab have yielded an SRM 987 value of 0.7102393 ± 15.2 ppm.

In order to define a local isotopic range for Cuello, Wright's (2005) statistical method was used wherein outliers from a normal distribution are considered as likely nonlocals. The isotopic values for any migrants were further compared to published isotopic data for the Maya region to evaluate potential origins (Freiwald 2011; Ortega-Muñoz et al. 2019; Price et al. 2002, 2010, 2012; Somerville et al. 2016; Thornton 2011; Trask et al. 2012; White et al. 2007; Wright 2005a, 2005b, 2012; Wright et al. 2010). Due to the overlap between geological and hydrological zones within the Maya area, isotopic data are best used to rule out potential homelands for migrants rather than positively identify them. It is further important to note that while geochemically classifying individuals into local and nonlocal groups is one way to assess mobility patterns during the Preclassic, it may not be an accurate representation of identity and self-expression among the ancient Maya.

3.4. Results

3.4.1. Defining Local Isotopic Range

The carbon, oxygen, and strontium isotope data for each Cuello individual are presented in Appendix A. For strontium isotopes, there is no significant difference for $^{87}Sr/^{86}Sr$ by first molar position (ANOVA, F= 1.878, df= 93, p= 0.139). The descriptive statistics for the Cuello strontium isotope data are presented in Table 3-1. The mean strontium value for the total dataset is 0.70796, with a range of 0.70755-0.70814, which falls broadly within the Southern Lowlands cluster previously identified by Hodell et al. (2004).

Table 3-1. Cuello strontium isotope descriptive statistics

	Total	Trimmed	Local
Mean	0.70796	0.70800	0.70800
Standard Deviation	0.00012	0.70798	0.00007
Count	94	82	80
Minimum	0.70755	0.70781	0.70788
Maximum	0.70814	0.70814	0.70814
Variance	1.42E-08	5.32E-09	4.62E-09
Skewness (standard error)	-1.124 (0.249)	-0.084 (0.266)	0.170 (0.269)
Kurtosis (standard error)	1.215 (0.493)	-0.413 (0.526)	-0.854 (0.532)
Median	0.70798	0.70800	0.70800
Shapiro Wilk Statistic	0.912	0.983	0.97
Degrees of freedom	94	82	80
Significance	0.000*	0.364	0.570

* indicates statistical significance at 0.01 level

The distribution of the total Cuello data is not normal. It is highly skewed to the left, as seen in the histogram in Figure 3-3, with most values falling lower than the mean. This indicates the likely presence of nonlocal individuals in the Cuello assemblage.

By eliminating the likely nonlocal individuals with extreme strontium isotope values of 0.70780 and below, the data are more normally distributed. Table 3-1 provides the descriptive statistics for this subsequent “trimmed” range, which has a mean of 0.70800, standard deviation of 0.00007, and range of 0.70781-0.70814. Figure 3-3 shows the histogram of this trimmed data set compared to that of the total data set. The Shapiro-Wilk test for normality indicates that this trimmed sample approximates a normal distribution (W= 0.983, df= 82, p= 0.364), and a normal probability plot (Q-Q plot) that compares the data to the expected normal curve highlights this distribution (Figure 3-4). The remaining two individuals in the lower tail of this trimmed distribution, which are highlighted in Figure 3-4, are closer to the nonlocals than locals in terms of strontium isotope values, and they therefore warrant closer examination.

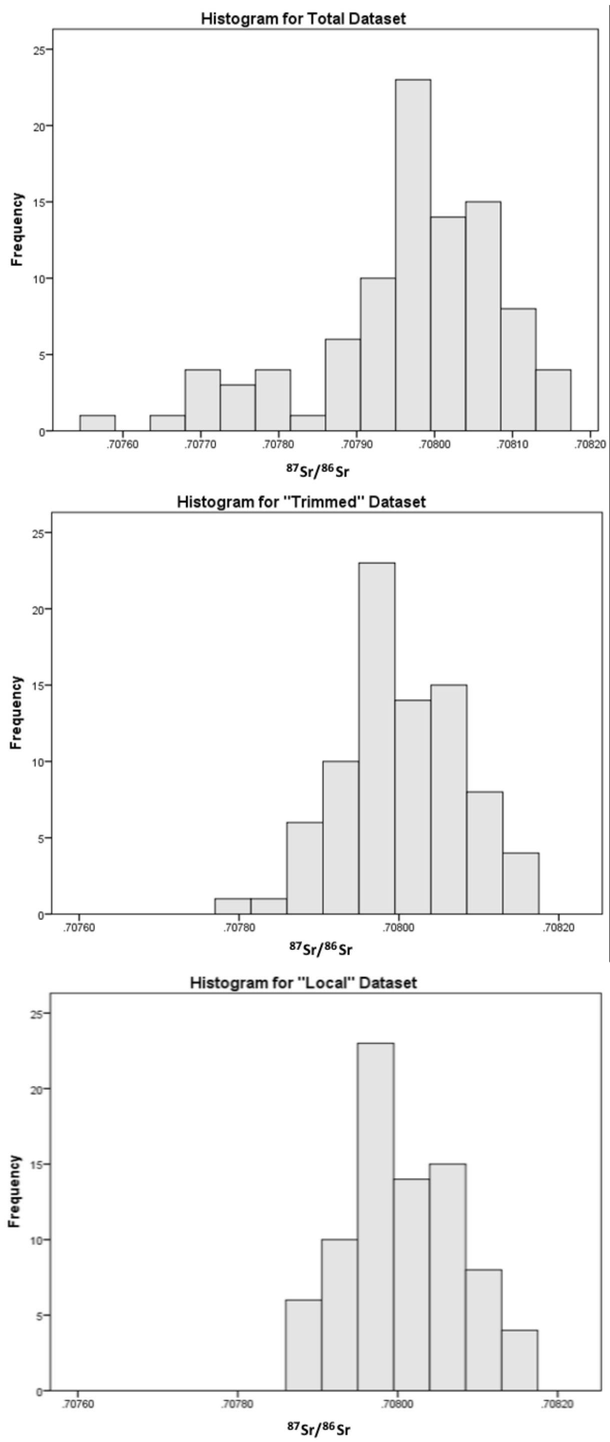

Figure 3-3. Histograms of total, trimmed, and local $^{87}Sr/^{86}Sr$ values at Cuello

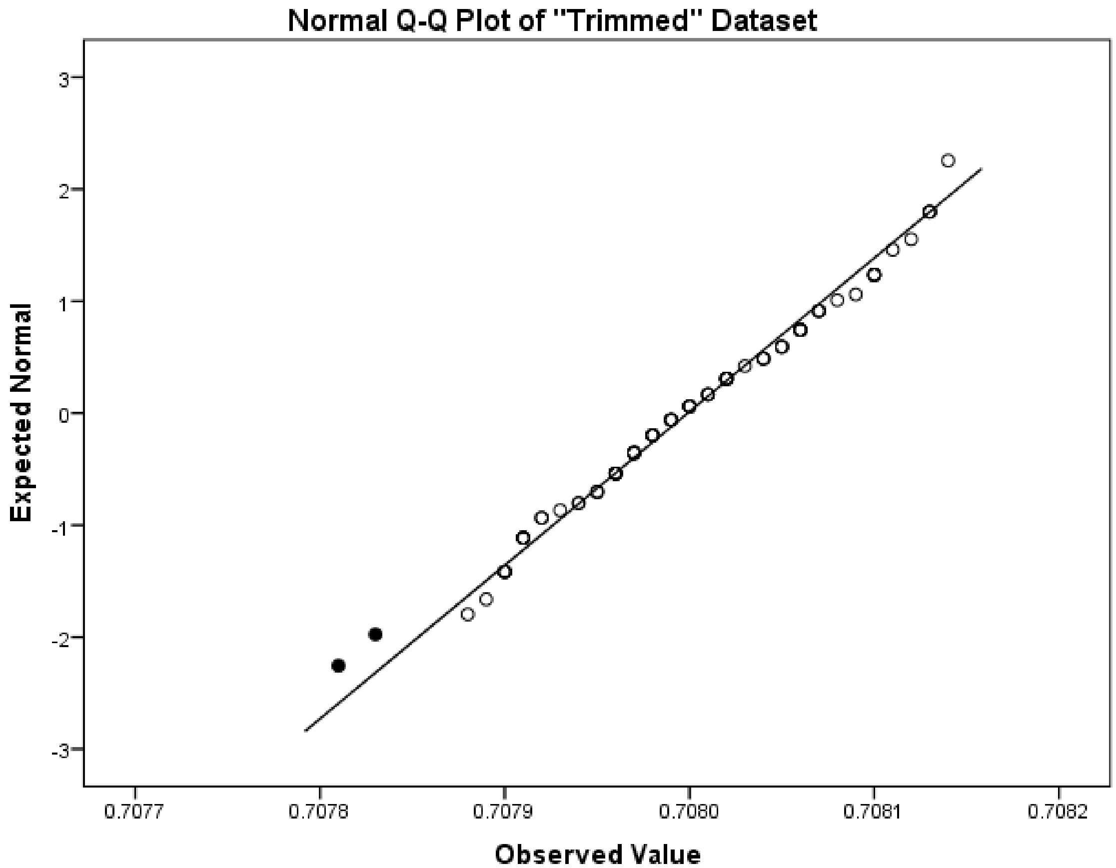

Figure 3-4. Q-Q plot of "trimmed" strontium isotope values. Two possibly nonlocal individuals highlighted in black

Removing these two individuals from the trimmed Cuello dataset results in a “local” range of 0.70788-0.70814, mean of 0.70800, and standard deviation of 0.000068, which are not markedly different from the “trimmed” dataset, as seen in Table 3-1. The Shapiro-Wilk test indicates that while this “local” range is still normally distributed, the significance value is reduced compared to the “trimmed” range, and both groups show high kurtosis. In terms of demographic data and mortuary context, these two individuals exhibit very few similarities. They are different sexes and were buried in different mortuary contexts from different parts of the Middle Preclassic period. There are both local and nonlocal individuals in the rest of the Cuello skeletal assemblage with similar characteristics.

Thus, there is no significant reason to consider these two individuals as nonlocals on the basis of contextual information in conjunction with the lower strontium isotope values. However, when reviewing the histogram of the total dataset with reference to these possibly nonlocal individuals (Figure 3-5), there appears to be two distinct groups in these data: one of local individuals and one of nonlocal individuals. Both of these groups are normally distributed and likely represent two different segments of the population, those born in the immediate vicinity of Cuello and those born outside of Cuello. Therefore, I consider the two individuals on the lower end of the “trimmed” range to be nonlocals. The resulting local strontium range for Cuello is 0.70788-0.70814. On the basis of this strontium range, there are 14 likely nonlocal individuals (14.9%) of the 94 Cuello samples.

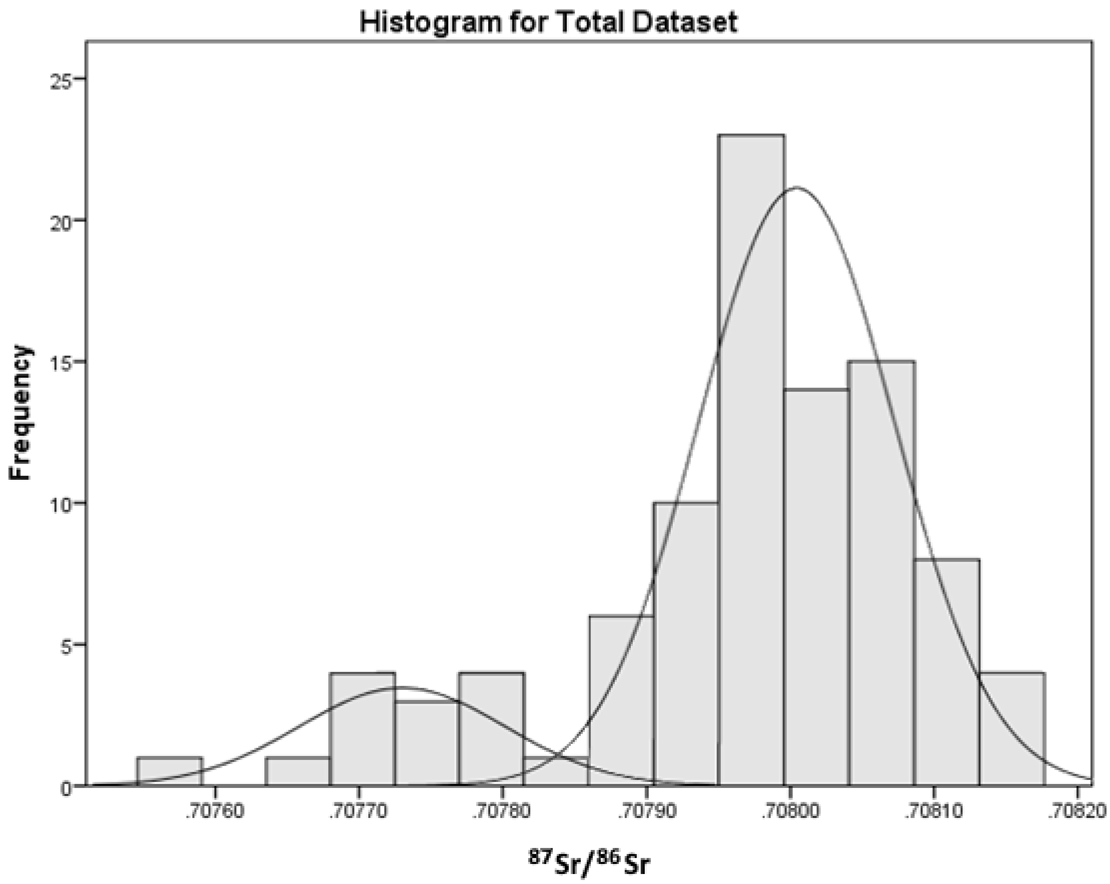

Figure 3-5. Histograms of overlapping strontium isotope distributions in Cuello data

The descriptive statistics for the Cuello oxygen data are presented in Table 3-2. The total dataset has a wide range of 3.6‰ and is highly skewed to the right. The Shapiro-Wilk test of normality indicates that the data are not normally distributed. Reviewing a histogram of these data in Figure 3-6 reveals two significant outliers of -0.3‰ and -0.4‰. One of these individuals, Cuello burial 23, is additionally a strontium outlier, further indicating that this person likely spent their early years outside of Cuello. The remaining oxygen outlier (Cuello 24) has a strontium value within the normal range.

Table 3-2. Cuello oxygen descriptive statistics

	Total	Trimmed
Mean (‰)	-2.9	-2.9
Standard Deviation (‰)	0.6	0.5
Count	94	92
Minimum (‰)	-3.9	-3.9
Maximum (‰)	-0.3	-1.5
Variance	0.4	0.3
Skewness (standard error)	1.319 (0.249)	0.308 (0.251)
Kurtosis (standard error)	3.523 (0.493)	-0.373 (0.498)
Median (‰)	-2.9	-2.9
Shapiro Wilk Statistic	0.915	0.981
Degrees of freedom	94	92
Significance	0.000*	0.212

* indicates statistical significance at 0.01 level

Removing these two individuals from the oxygen dataset to create a "trimmed" range in Table 3-2 reduces the variability in the oxygen data and creates a normal distribution. As a result, the local range for oxygen isotopes at Cuello is -1.5‰ to -3.9‰, with a mean of -2.9‰ and standard deviation of 0.5‰. Using these oxygen data, I am able to identify one additional nonlocal individual at Cuello, bringing the total number of likely nonlocals to 15 (16% of individuals sampled).

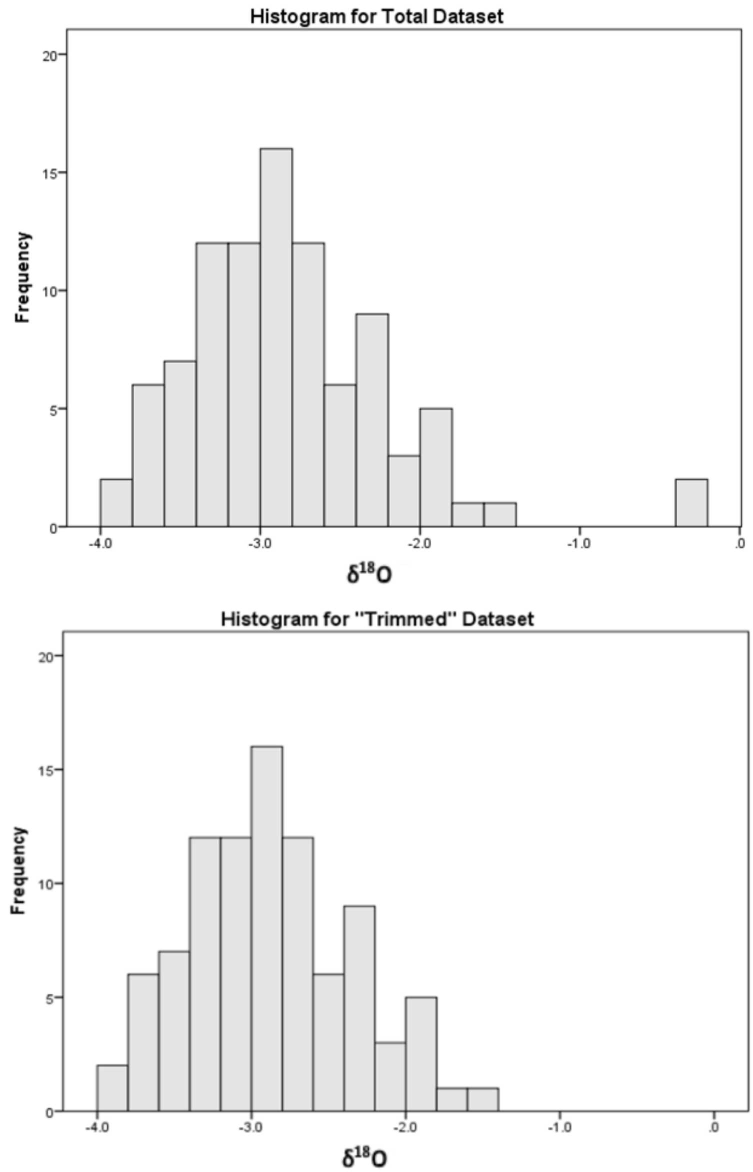

Figure 3-6. Histograms of total and "trimmed" oxygen isotope data from Cuello

3.4.2. Dietary Patterns at Cuello

In addition to strontium and oxygen isotopes, I sampled Cuello teeth for carbon isotope analysis of enamel carbonate. The descriptive statistics for the carbon data are presented in Table 3-3. These results are broadly consistent with regional dietary patterning documented in the Maya region, with Belizean ancient Maya diets exhibiting lower $\delta^{13}C$ values on average (Gerry 1993, 1997; Freiwald 2011). There are statistically significant differences for carbon isotopic values between local and nonlocal individuals ($t = 2.033$, $df = 92$, $p = 0.045$), lending further support to the identification of these individuals as nonlocals to Cuello who consumed a diet comprised of more maize than those individuals who spent their childhoods at Cuello.

Table 3-3. Cuello carbon isotope descriptive statistics

	Total
Mean (‰)	-7.7
Standard Deviation(‰)	1.3
Count	94
Minimum (‰)	-10.6
Maximum(‰)	-4.7
Variance	1.6
Skewness (standard error)	0.048 (0.249)
Kurtosis (standard error)	-0.651 (0.493)
Median (‰)	-7.7
Shapiro Wilk Statistic	0.987
Degrees of freedom	94
Significance	0.464

3.4.3. Who are the Nonlocals?

The 15 foreign individuals at Cuello were recovered from a variety of mortuary contexts. With regard to the likely origins of the nonlocals at Cuello, there is a great deal of overlap between local isotopic ranges for sites in Belize and Guatemala. The Cuello data are compared to the local ranges for other Maya sites in Figure 3-7. It is clear that most of the nonlocals buried at Cuello originated in areas not far from the site, as there are likely no migrants from distant sites such as Teotihuacan, Kaminaljuyu, or Copan. Furthermore, the Cuello data are inconsistent with an origin along the eastern Yucatan coast (Ortega-Muñoz et al. 2019). Three of the individuals could have origins somewhere in southern Belize, as the values overlap with the local range identified for Pusilha (Somerville et al. 2016) and Uxbenka in southern Belize (Trask et al. 2012). For most of the remaining nonlocals, the strontium and oxygen values are consistent with an origin somewhere in the Petén or perhaps elsewhere in northern Belize, such as at Nojol Nah (Das Neves 2017). Finally, there are no obvious nonlocals from the nearby Belize River Valley. This indicates that Preclassic inhabitants of Cuello were involved in long distance interactions with individuals primarily within the Southern Lowlands. There is no evidence for mobility from Volcanic Highlands, Maya Mountains, or Metamorphic Province regions identified by Hodell et al. (2004).

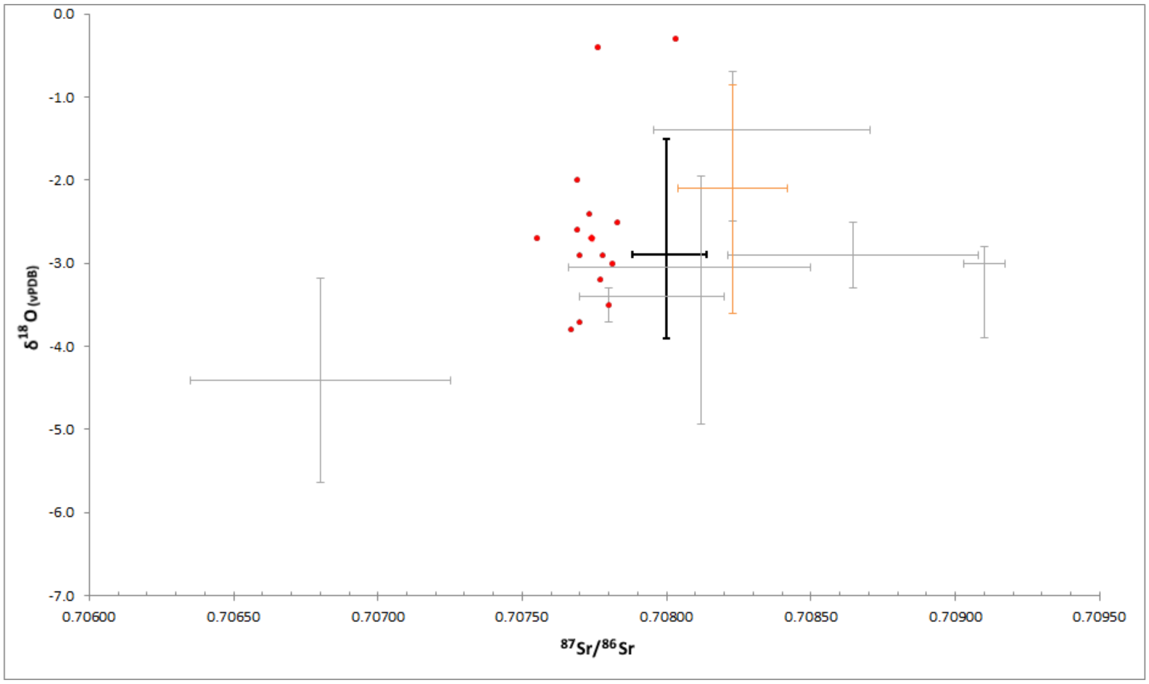

Figure 3-7. Scatter plot of $\delta^{18}O$ and $^{87}Sr/^{86}Sr$ of local ranges for sites throughout the Maya area. Cuello local range in bold black. Colha range identified in orange. Red circles are likely nonlocals in the Cuello sample

Of the nonlocal individuals buried outside of the mass burial contexts (n= 8), five date to the Middle Preclassic period. Cuello 62 is a young adult female who was buried as a primary, single occupant of a simple grave (Robin 1989), and likely originated somewhere in the Petén region of Guatemala based on strontium isotope values. Cuello 179 was a subadult in their early teens at time of death who was buried in a simple grave with a neonate individual (Cuello 180). The neonate was not sampled for isotopes in this analysis due to poorly preserved incomplete permanent tooth buds. The elder subadult in this burial (Cuello 179) likely originated in the Petén region based on overlapping strontium isotope values. Finally, Cuello 146, Cuello 154, and Cuello 161 are all young adult male individuals dating to the Middle Preclassic period. All three of these individuals were buried as primary single interments in simple graves (Hammond et al. 1991), and they likely originated in the Petén area based on strontium isotope values, although Cuello 154 could also have spent his childhood in southern Belize in the Pusilha or Uxbenka area as well. Thus, it appears that Middle Preclassic nonlocals at Cuello likely all originate in the Petén area, or possibly southern Belize for Cuello 154, and all of these individuals were all entered in primary interments in simple graves.

The remaining three nonlocals from mortuary contexts outside the mass burials date to the Late Preclassic phase. Cuello 19 is a young adult male who was buried in a simple grave in full articulation as a single interment. This individual exhibits both cranial modification (lambdoid flattening) and dental modification, and was accompanied by a Sierra Red bowl over the skull (Robin 1989). This individual likely spent their childhood in the Petén region of Guatemala based on strontium isotope values. Furthermore, Cuello 23 is a subadult individual that was approximately 6-9 years of age at death who was buried as a primary, articulated interment in a single burial with scattered pottery sherds and two metate fragments over the skull. Finally, Cuello 24 is a middle adult female individual buried in a simple grave. This individual was a single, primary interment that was very poorly preserved and is associated with an eroded bowl and small shell beads (Robin 1989). Both Cuello 23 and 24 have oxygen isotope values that are almost 1‰ higher than any other individual in the Cuello sample. These values don’t overlap with any other previously analyzed site, but the values are closest to the range of Nojol Nah (see Figure 7; Das Neves 2017).

The Late Preclassic Mass Burial 1 includes the remains of at least 32 individuals. Five of the 16 sampled for isotopic analysis are nonlocal in origin. Of the two central individuals in Mass Burial 1 (Cuello 50 and 51), Cuello 50 is nonlocal in origin. This individual is a young-middle adult male buried in a simple grave as the primary occupant, and likely originated in either the Petén region or southern Belize based on strontium isotope signatures. This individual had more grave goods than Cuello 51, which include ceramics and several elaborate bone fan handles probably made of deer bone. The remaining central individual, Cuello 51, spent his childhood at Cuello and is local in origin. However, Cuello 51, Individual 2 is a tooth sampled from extra teeth found with Cuello 51, and this tooth has a foreign isotopic signature. This sample is a permanent tooth from an individual who died in adulthood based on dental development and wear, but sex and specific age category cannot be assigned. Robin (1989) argues that these extra teeth belong with the body bundle Feature 203, which was placed in the laps of Cuello 50 and 51. This individual had similar oxygen and strontium isotope values to Cuello 50, and therefore likely originated in southern Belize or the Petén region as well. Thus, of the central feature in Mass Burial 1, there are both local and nonlocal individuals, and it is possible that the nonlocal individuals originated in a similar location.

Furthermore, three of the nonlocals were located in contexts in the periphery of Mass Burial 1. Cuello 39-40, Individual 1 is a likely male young adult individual dating to the Late Preclassic. Cuello 39 and 40 are a double burial consisting of two primary articulated individuals in a simple grave. Both individuals are reported as the same age and sex (Robin 1989) and were commingled. As a result, it is unclear which individual is nonlocal in origin, likely originated in the Petén region based on strontium isotope values, and which is local. These individuals are located just south of the two primary individuals (Cuello 50 and 51). Furthermore, Cuello 45 is a young adult male individual buried in a double burial with Cuello 46 as part of Mass Burial 1. Cuello 46 is a likely male middle adult. Both individuals are nonlocal in origin, and both likely originate from the Petén region of Guatemala. The grave type is simple in form, both individuals are articulated, and Cuello 45 exhibits dental modification. Of the three non-centrally located foreign individuals in Mass Burial 1, it seems that all spent their childhoods in the Petén area.

Two individuals sampled from the slightly later Mass Burial 2 were also nonlocal in origin. Cuello 69 is a nonlocal adult male individual buried with Cuello 68 in a simple double burial that dates to the Late Preclassic period. This double burial was located along the eastern edge of Mass Burial 2. Cuello 69 consists of completely disarticulated long bones and a partial skull that was interred with the primary occupant of the grave, Cuello 68, who is local in origin. The double burial is associated with a number of grave goods, including a jade bead, shells, and ceramics. The foreign individual in this burial likely originated in either southern Belize or the Petén region based on strontium and oxygen isotope values. Cuello 79, Individual 2 is a represented by a tooth that was found with Cuello 79, one of the central individuals in Mass Burial 2. Robin (1989) notes that the extra skeletal elements associated with Cuello 79, including this tooth, are likely part of the body bundle burials Cuello 75-78 that were placed in the lap of Cuello 79. The tooth sampled is an isolated permanent tooth from an individual who died in adulthood. Because there are no directly associated skeletal materials with the tooth, specific age and sex cannot be assigned. This individual is clearly a nonlocal based on its very low strontium value (0.70755) that does not overlap with any previously analyzed site in the Maya region. Based on the environmental strontium data presented in Hodell et al. (2004), this individual definitely spent their childhood in the southern lowlands, likely from areas with Cretaceous limestone, perhaps in Guatemala south of Tikal or Alta Verapaz.

3.4.4. Chronological Comparisons

In terms of mobility patterning based on chronology, 14.3% (5/35) Middle Preclassic individuals are nonlocal in origin, while 17.9% (10/56) of Late Preclassic individuals are likely nonlocals. Of the three Classic period burials sampled, all are local in origin. When comparing the proportion of nonlocals between the Middle and Late Preclassic periods, there are no statistically significant differences (Fisher's Exact $p= 0.868$), indicating mobility patterns did not change substantially between these two time periods. However, there are significant differences in carbon isotopes between the Middle and

Late Preclassic periods (t= -2.818, df= 89, p= 0.006), with Middle Preclassic diets exhibiting less maize consumption than Late Preclassic diets.

3.4.5. Demographic Comparisons

Age at death and sex estimation are problematic for most Maya skeletal assemblages due to poor preservation. Saul and Saul (1991, 1997) previously assigned all individuals into age categories, and there are no statistically significant differences between these groups for oxygen (F[5,88]= 1.186, p= 0.323), strontium (F[5,88]= 0.758, p= 0.583), or carbon isotopes (F[5,88]= 1.437, p= 0.219). Separating these age categories into the broader groups of adults (n= 77) and subadults (n= 17), there are additionally no significant differences in the proportion of locals and nonlocals for each category (Fisher's Exact p= 1.0). Of the 77 adults sampled for isotopic analysis at Cuello, 15 (19.5%) cannot be reliably sexed, 15 (19.5%) are likely female, and 47 (61%) are likely male (Saul and Saul 1991, 1997). Of the 11 nonlocal adults at Cuello that can be reliably sexed, nine are male while two are female, although this difference is not statistically significant (Fisher's Exact p= 1.0). Furthermore, there are no significant differences in $\delta^{13}C$ by age (t= -1.366, df= 92, p= 0.175) or sex (t= 0 .825, df= 60, p= 0.413).

3.4.6. Mortuary Context Comparisons

In terms of mortuary variables, there were no significant differences in the proportion of locals versus nonlocals for most contextual characteristics of the individual graves themselves. With regard to grave type, most of the graves are simple in form, and all of the nonlocal individuals were interred in such simple graves. Of the five individuals in cists and three individuals in crypts, all are local in origin. Furthermore, there are no significant differences in the proportion of locals by level of articulation (Fisher's Exact= 1.0), primary or secondary deposit (Fisher's Exact= 0.729), or if burials were single or multiple interments (Fisher's Exact= 0.221). There are no significant differences in the mean strontium, oxygen, or carbon isotope values between any of these groups either.

When examining the mobility patterns within the "mass burials" at Cuello, there are significantly more migrants in these contexts compared to other mortuary contexts at the site (X^2= 4.193, df= 1, p= 0.041). Of the 24 individuals sampled from the mass burials, 29.2% are nonlocal in origin. In contrast, only 11.4% of the remaining burials outside of these contexts are likely nonlocals. Thus, there is a much higher proportion of likely nonlocals buried within the mass burial contexts. Furthermore, there are also significant differences in stable oxygen isotopes between these groups (t= 2.619, df= 92, p= 0.01), lending further support to the distinct mobility patterns in these features. Finally, there are significant differences in stable carbon isotopes between the "mass burial" mortuary contexts and the rest of the Cuello skeletal assemblage (t= 2.619, df= 92, p= 0.01), indicating that individuals in these highly unusual contexts also had diets consisting of more maize during life.

3.5. Discussion

Of the 94 individuals sampled from Cuello, 15 (16%) likely spent their childhoods some distance from Cuello. Due to overlapping strontium and oxygen isotope ranges across the Maya lowlands (such as the overlap between Cuello and nearby sites like Colha), it is possible that more migrants are present in the Cuello assemblage that cannot be identified on the basis of these data alone. Of these 15 likely nonlocals, nine are males, two are females, two are adults of indeterminate sex, and two are subadults. While the difference between the sexes in terms of mobility is not statistically significant, there are more male migrants at Cuello. Female exogamy, which has been cited as a likely reason for mobility patterns among adult females among the ancient Maya (e.g., Wright 2012) does not adequately account for the mobility patterns demonstrated at Cuello. This distribution of male nonlocals at Cuello instead likely reflects more complex migration among the ancient Maya. Furthermore, the prevalence of male nonlocals in this sample likely also relates to broader patterns in mortuary behavior, as there are significantly more migrants in the mass burial contexts, which are also almost entirely male in composition (only one possible female individual was identified in these deposits).

Compared to other Maya sites that document changes in mobility patterns over time, the level of mobility didn’t significantly shift from the Middle to Late Preclassic at Cuello, indicating stability in migration practices over time at this site. However, the $\delta^{13}C$ data indicate a dietary shift from the Middle to Late Preclassic period, with Middle Preclassic diets exhibiting lighter carbon isotope values. This indicates that maize consumption increased over time at Cuello from the Middle to Late Preclassic periods, which isn't surprising given the increased emphasis on maize as a staple crop moving into the Classic period and increased productivity of maize (Miksicek 1991). Although these data indicate that there are modest increases in maize consumption over time at Cuello, the degree of maize consumption remains reduced relative to sites elsewhere in the Maya region (Gerry 1993, 1997; Freiwald 2011). In a previous study, Tykot et al. (1996) reported that the overall $\delta^{13}C$ values of collagen and apatite did not change substantially over time at Cuello; however, this initial analysis was based on a relatively small sample. The current analysis expanded the number of individuals sampled, which allowed for detection of chronological trends in the data. Tykot et al. (1996) further report stable nitrogen isotope data ($\delta^{15}N$) used to evaluate protein consumption, which the authors note consisted of a variety of C4-enriched deer and dog meat. There are small differences in the $\delta^{15}N$ values of the mass burial inhabitants compared to adults in single burials at Cuello as well, although the difference is only about one permil and sample sizes are relatively small.

The two Late Preclassic mass burials have a significantly different diet and significantly more migrants than the rest of the Cuello skeletal assemblage. Of the 16 individuals sampled from Mass Burial 1, five are likely nonlocals. These nonlocals include one of the central individuals (Cuello 50), one of the secondary "body bundles" (Cuello 51, individual 2), and three of the individuals surrounding the central deposit (Cuello 39-40, Cuello 45, Cuello 46). Interestingly, Cuello 45 and 46 are articulated individuals interred in a double burial, potentially indicating the deliberate placement of certain nonlocals together in this mortuary context. All are adult males, and all are articulated except for the body bundle.

Of the eight individuals sampled for isotopic analysis from Mass Burial 2, two are likely nonlocal in origin. One of these is a sample from the “body bundles” (Cuello 79), while the remaining is a disarticulated male individual from a double burial (Cuello 68/69) surrounding the central individual. This latter individual is likely Cuello 69 based on the advanced attrition and older age, who was completely disarticulated and placed secondarily in a grave with Cuello 68 (Robin 1989). Thus, the two nonlocals from this mass burial were both secondary disarticulated interments associated with local primary individuals.

The $\delta^{13}C$ data further indicate that the individuals in these mass burial contexts had a significantly different diet than did their contemporaries buried in residential mortuary contexts. The average $\delta^{13}C$ value for individuals in mass burials is -7.1‰, while the average $\delta^{13}C$ for the remaining Cuello assemblage is -7.9‰, and this difference is statistically significant ($t= 2.619$, $df= 92$, $p= 0.01$). The slightly higher $\delta^{13}C$ value suggests that maize was a greater component of the total diet for individuals in the mass burial contexts. This finding parallels that of Tykot et al. (1996) that individuals in the mass burials had higher $\delta^{13}C$ collagen values ($n= 3$), although enamel apatite values did not differ substantially from other contexts. These dietary differences are likely related to the prevalence of nonlocal individuals in the mass burial contexts who consumed a different diet prior to arriving at Cuello.

The high proportion of nonlocal individuals in the mass burial contexts leads to important questions about the identities of the people buried in these contexts. Previous researchers have hypothesized that mass burials represent the result of human sacrifice (Hammond 1999, 2015; Saul and Saul 1991, 1997; Robin 1989; Robin and Hammond 1991). Hammond (1999) suggests that the central individuals, who were placed first for each mass burial, likely represent the physical and social focus of the group (Hammond 1999). These individuals are located centrally and are associated with the most grave goods as well, further indicating their importance for this mortuary assemblage. The excarnate “body bundles” surrounding these individuals thus likely represent human grave goods that have lost their personal identities (Hammond 1999, 2015).

In contrast to this hypothesis, ancestor veneration has also been suggested for similarly complex mortuary deposits. At nearby K’axob, McAnany (1995) suggested that similarly complex Late Preclassic multiple burials involving secondary interments indicate protracted treatment of ancestral remains, rather than human sacrifice. McAnany’s (1995) exploration of ancestor veneration in northern Belize has been further elaborated and applied to elsewhere in the Maya area to describe the process of ancestralizing and creating ownership of space via manipulation and placement of the dead during times of sociopolitical establishment and negotiation (Geller 2005, 2011;

Fitzsimmons 2011; Weiss-Krejci 2003, 2011). Such interpretations could also apply to the Cuello mass burials.

Following the Tiesler and Cucina (2008) taphonomic approach and considering the archaeological data for the Cuello mass burials, it is clear that these deposits satisfy many of the expectations for post-sacrificial deposits. The sex and age distribution of the Cuello mass burial deposits is highly skewed, with at least 39 males, one possible female, eight adults of indeterminate sex, and zero subadults. Furthermore, the deposition of the burials during the transition of the space from primarily residential to public-ceremonial use could also possibly suggest a sacrificial origin, as does the presence of multiple, highly disarticulated excarnate remains. These individuals likely were subjected to some kind of posthumous body processing, although cut marks are not documented on their remains, possibly due to extremely poor preservation (Saul and Saul 1991, 1997). However, McAnany (1995) notes that similar deposits at nearby K'axob that reflect the creation of ancestors shift to a skewed sex distribution over time, with males becoming more prevalent moving over the Preclassic period.

The distinct diet and high prevalence of nonlocals in the mass burials could also lend support to the identification of the mass burials as sacrificial in nature. Hammond (1999) notes the possibility that not all of these individuals were indigenous to Cuello, and the isotopes corroborate this hypothesis. Furthermore, the creation of ancestors proposed by McAnany (1995) would be expected to be associated with local, self-interested aggrandizers claiming access to power and space via the deposition of the dead in public spaces.

3.6. Conclusions

These data provide a further avenue to assess Preclassic life and interactions at Cuello. Using strontium and oxygen isotopes, I was able to establish a local isotopic range for a site in northern Belize and thereby identify skeletons who originated elsewhere in the Maya region. The isotope data in conjunction with the atypical mortuary treatment in the Cuello mass burials suggests that these individuals were human sacrifices. Approximately 16% of the individuals sampled from the Cuello skeletal collection are likely nonlocal in origin. Of these likely nonlocals, a significant proportion was buried in the unusual mass burial contexts, lending further support for the identification of these contexts as likely sacrificial in origin. These individuals also had a significantly different diet as well based on stable carbon isotopes, further indicating that they were treated differently during life as well as death. Of the nonlocals at the site, much of the mobility at Cuello during the Preclassic period appears to have occurred within the southern lowlands based on the strontium and oxygen data.

4. PRECLASSIC MOBILITY AT COLHA, BELIZE

4.1. Introduction

During the Preclassic period, the archaeological site of Colha, located in modern-day northern Belize, experienced the dramatic growth from a small village to a socially stratified regional lithic production center (Figure 4-1; Shafer and Hester 1983). Settlement data suggests that from the Middle to Late Preclassic, a major transition occurred that transformed Colha from a small gathering of house structures to a site organized around a central ceremonial plaza and that had increased population, more complex architecture, and sociopolitical stratification (Hester and Shafer 1994). During the Late Preclassic, the ample evidence of lithic craft specialization at Colha suggests that it controlled chert resources for the region (Hester and Shafer 1984; Shafer and Hester 1983).

In addition to broader architectural, economic, and social changes, mortuary behavior at Colha dramatically shifted during the Preclassic as well. A large concentration of Preclassic burials (Op. 2031) was found below what became the Classic period main ritual plaza. The burials in this cluster were placed in discrete pits cut through plaza floors. The features contained a variety of broadly contemporaneous single and multiple burials that included both primarily and secondarily deposited skeletons in varying states of articulation (Wright 1989). Among these unique mortuary features was a crypt that may have served as an ossuary, as well as a burial of a Late Preclassic female individual with elaborate grave goods, including the remains of seven other individuals. Her skeleton was thoroughly dyed with red ocher, and she was buried in a seated position with a bowl of skulls and disarticulated remains in her lap. Architectural changes are associated with these mortuary deposits include the construction of a shrine and a more formal plazuela group, shifting away from the residential focus during the Middle Preclassic period (Sullivan 1991; Anthony and Black 1994).

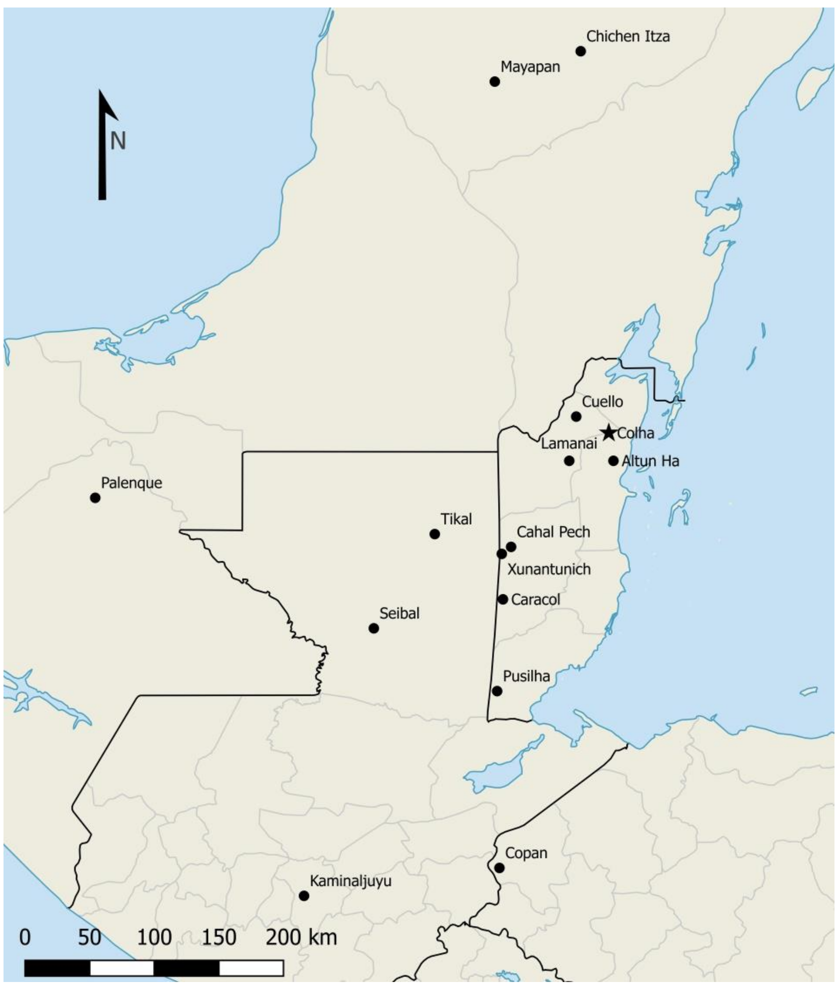

Figure 4-1. Regional map of the Maya area. Position of Colha is noted with a star

Following the deposition of these burial features, the entire area underwent massive architectural changes that culminated in the establishment of an open plaza surrounded by small temples as the main ritual focus at Colha. Such changes further coincided with higher sociopolitical complexity, site reorganization, increased population, and the expansion of stone tool production (Sullivan 1991; Buttles 2002; Eaton 1982). The number of intrusive burials in this area has led Wright (1989) to suggest that it was a bounded cemetery area that experienced extended use by the Late Preclassic Maya. This feature also has very few subadults, suggesting that individuals interred in it were specifically selected based on age, in part (Wright 1989). Based on the complexity of this mortuary feature and its deposition during the transformation of this space into the ritual focus of Colha, it has been interpreted as the result of ancestor veneration and the establishment and consolidation of sociopolitical power by emerging elites in the Late Preclassic (Wright 1989).

Similar and contemporary mortuary features have also been described that date from the Late Preclassic period at the nearby Cuello (Hammond 1991, 1999, 2015) and K'axob (McAnany 1995, 2014; McAnany et al. 1999). At Cuello, Hammond (1991, 1999, 2015) has speculated that the large, commingled deposits were "mass burials" resulting from human sacrifice. However, McAnany (1995, 2014) argued that the complicated burials at K'axob instead reflect the secondary deposition of disinterred primary burials during the process of ancestralization, rather than human sacrifice. As part of this process, secondarily deposited human remains were used to establish lineal ties to place and ultimately generate hereditary sources of sociopolitical power (Saxe 1970).

In this study, I investigate Preclassic mortuary behavior at Colha using archaeological context data in conjunction with radiogenic strontium and stable oxygen and carbon isotopes in order to better understand the relationship of these large, complex burials to broader Preclassic trends in sociopolitical stratification. I test the hypothesis that individuals interred in these complex clustered burials originated in the local population and had a distinct diet compared to individuals in residential mortuary contexts. Recent research on Maya mortuary remains have advocated for a taphonomic, contextually sensitive approach to studying complicated mortuary deposits (Tiesler 2007; Tiesler et al. 2017). While detailed archaeological data exist for the Op. 2031 burials at Colha recovered on Dr. Fred Valdez's 1989 project and documented during excavation by Wright (1989), some archaeological data from other contexts are missing. As such, detailed thanatological methods are impossible for many of the remains from the site. However, I incorporate these methods and combine mortuary, geochemical, and archaeological data to better understand the lives and livelihoods during the Preclassic period at Colha. Despite the limitations of studying previously excavated collections such as that of Colha, these data are important contributions to understanding the Preclassic sociopolitical organization of the ancient Maya.

4.2. Bioarchaeological Background

Colha is a small archaeological site located in northern Belize, approximately 53 km northwest of Belize City. The site was originally discovered by the Corozal Project's regional survey of northern Belize in 1973-1974. After initial test excavations by that project in the late 1970s, the Colha Project was formally established and conducted excavations at the site from 1979-1995, with a particular emphasis on the lithics production industry of the site. Colha consists of a monumental civic-ceremonial center with surrounding peripheral house groups, and it was occupied from the preceramic Archaic period to the Postclassic period, with one major occupational hiatus between the Terminal Classic and Postclassic periods (Figure 4-2). Colha is particularly known for its lithic production, and there are a large number of lithic workshops at the site that exploited the Eocene and Miocene limestone deposits in the area. By the Late Preclassic period, Colha emerged as the dominant lithics production center in the area, and Colha stone tools have been found throughout the Maya region, indicating that inhabitants of Colha regularly engaged in long-distance trade (Hester and Shafer 1984, 1994; Shafer and Hester 1983).

The majority of skeletal remains recovered from Colha were excavated in 1989 in Operation 2031 (Op. 2031), located in what ultimately became the main plaza area of the site (Figure 4-3; Wright 1989). The burials date to the Middle and Late Preclassic periods, and the remains of at least 54 individuals were recovered from this feature

(Wright 1989). Each burial is described here with reference to the burial and/or lot number, depending on the convention used in each field season, and excavation maps are presented in Figure 4-4.

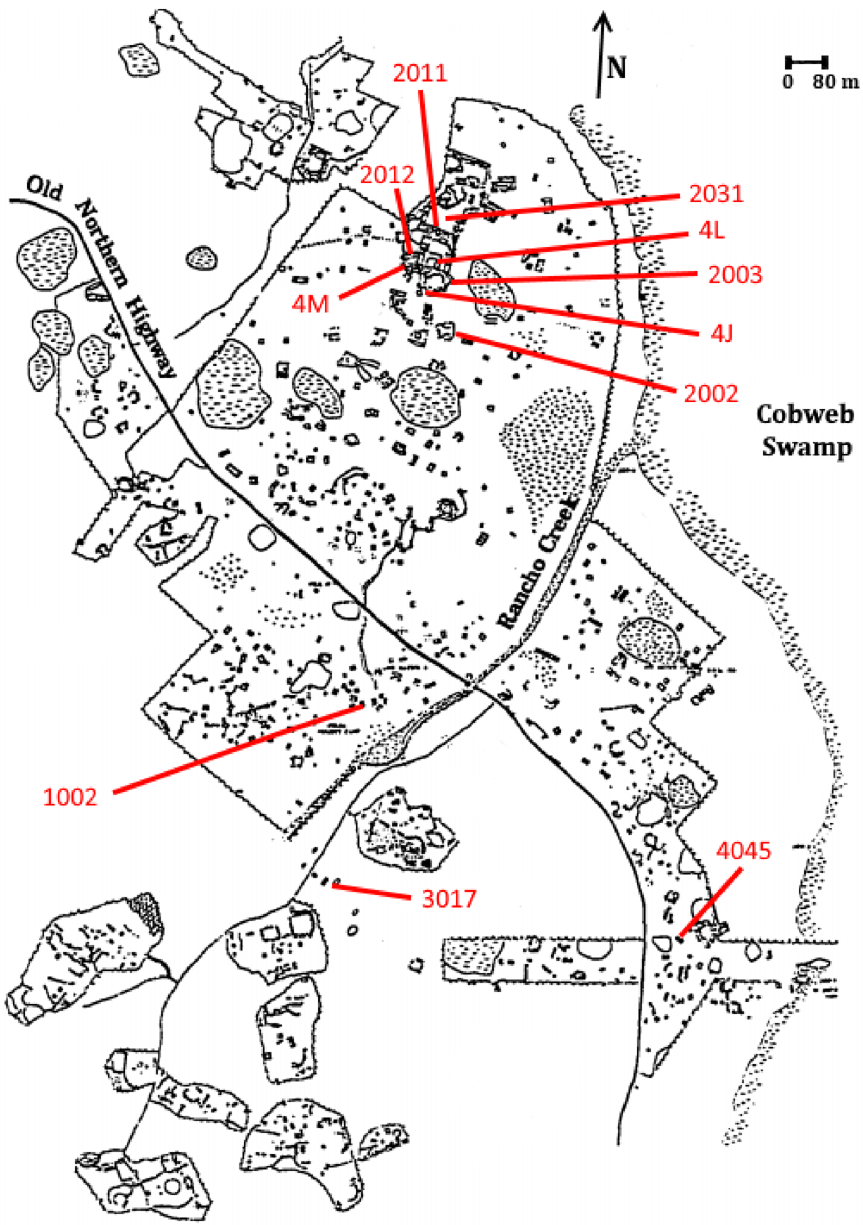

Figure 4-2. Map of Colha. Red labels indicate those excavated Operations that produced burials and are included in this study (adapted from King 2000)

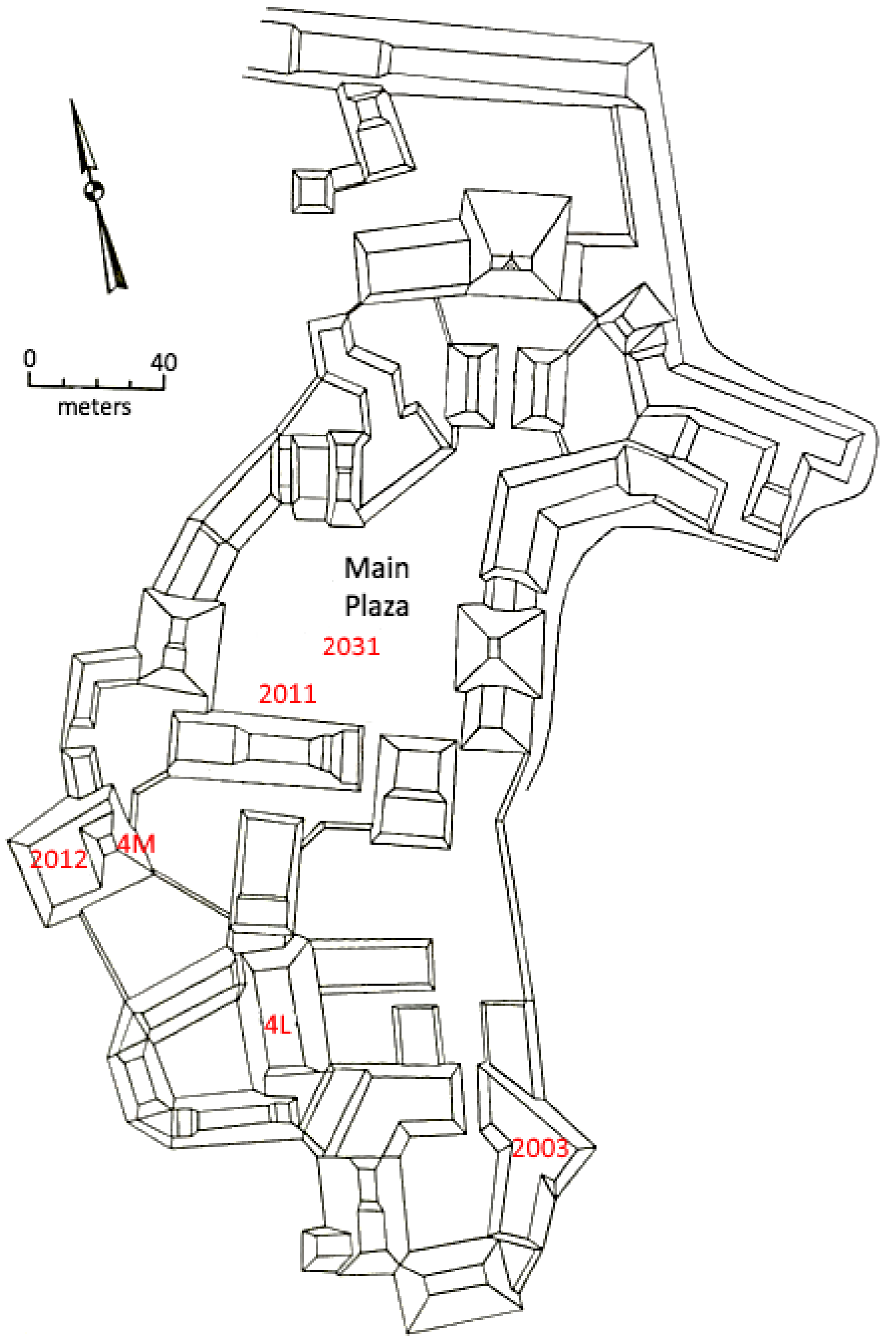

Figure 4-3. Ceremonial site core of Colha, indicating the locations of several of the excavated areas, identified by their Operation numbers (adapted from Hester et al. 1980)

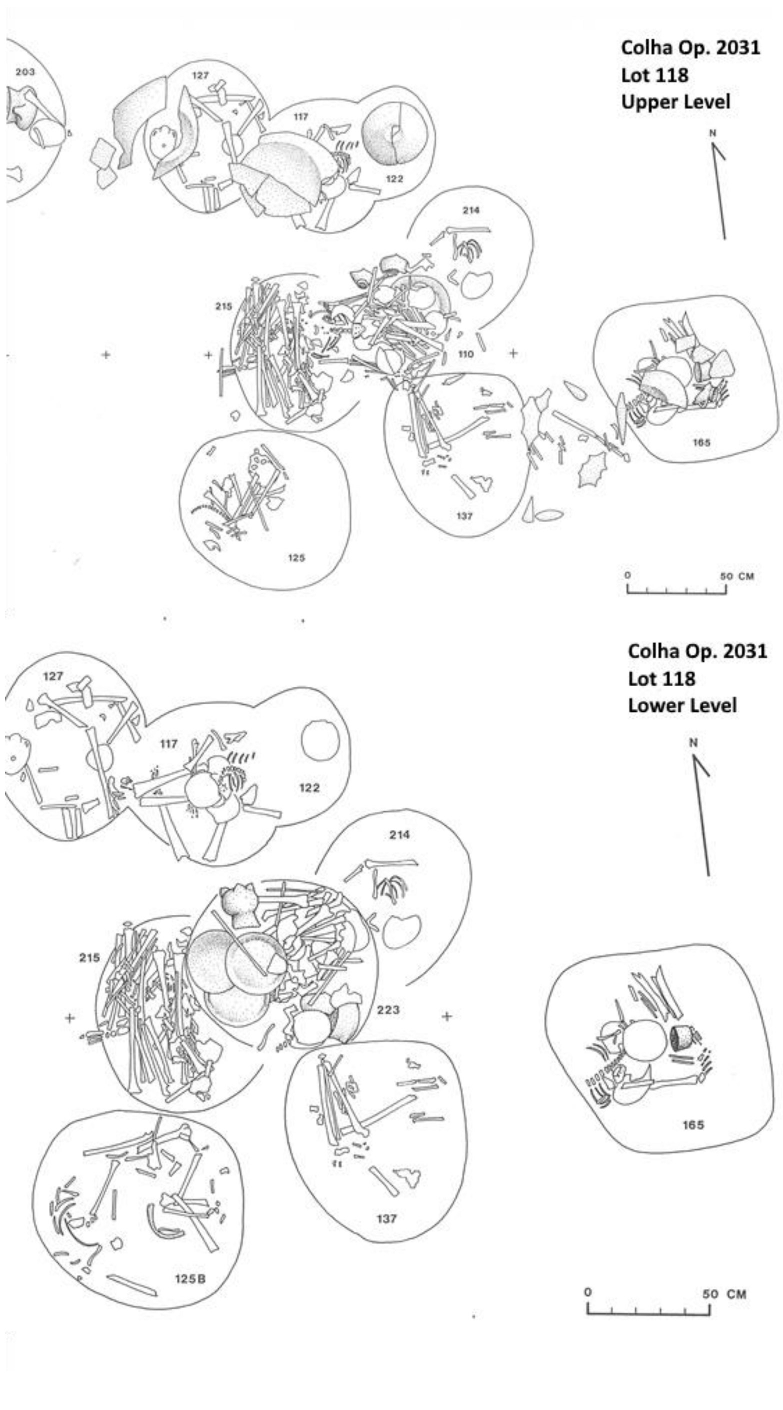

Figure 4-4. Excavation map of Colha, Operation 2031, Lot 118 upper and lower levels. Left edge represents end of the excavation unit (Wright personal communication)

4.2.1. Middle Preclassic Burials

Of the individuals excavated at Colha, seven burials date to the Middle Preclassic period, all of which were articulated, single, primary burials that were excavated in 1983 (Anthony 1987) and 1989 (Wright 1989). The first four Middle Preclassic burials excavated were all recovered from a Middle Preclassic midden (Anthony 1987). Burial 54 is an adult male that was interred as the primary individual in a simple grave. He was buried in an extended, supine position and accompanied by shell beads, a small serpentine celt, and a Consejo Red bowl placed over the cranium (Anthony 1987). Burial 57 is a subadult of 3-4 years of age, similarly buried as the single occupant of a simple grave. This individual was buried in a tightly flexed, sitting position and accompanied with no grave goods. Burial 59 is an older subadult, around 10-11 years of age, that was buried with a red Bolay-type bowl over the skull and two shells in the head area. This individual was semi-flexed and buried in a simple grave. Finally, burial 63 is that of an older adult female who was buried in an extended, supine position in a simple grave, with shell beads around the left arm and an effigy vessel atop the left femoral region (Anthony 1987).

The remaining three Middle Preclassic burials from Op. 2031 were excavated in 1989 by the Colha Project under the direction of Dr. Fred Valdez. The burials were analyzed by Wright (1989), who notes similarly simplistic burials. Lot 219 is represented by a single individual, an elderly female, who was likely interred in an extended, supine position in a simple grave with a single bead. This skeleton, like those described by Anthony (1987), was found in a midden.

The Lot 238 burial was found in a simple grave cut through a plaster floor that was subsequently resurfaced. This young adult male was buried in an extended, supine position with the hands crossed atop the body and a bowl inverted over the skull. Most of the long bones and metatarsals of this skeleton exhibited signs of periosteal reactions, indicating chronic, nonspecific infection at the time of death. Finally, Lot 218 contains a burial that likely dates to the Middle Preclassic based on its stratigraphic position, although Wright (1989) notes that its lack of ceramics makes a definitive chronological association challenging. This individual is a young adult male with healed metatarsals on the left foot. He was buried in a supine position with legs crossed and two polished bone tubes beside the left leg (Wright 1989).

4.2.2. Late Preclassic Residential Burials

The remaining burials in Op. 2031 date to the Late Preclassic period and were buried in varying states of articulation, commingling, and disposal types. Six individuals were recovered from residential contexts (Wright 1989), including burials in Lots 136, 87, 95, 142, and 184. The first of these burials, in Lot 136, was only partially excavated, so the mortuary dataset is incomplete. The skeleton was found in a simple grave in an extended and supine position. The superior half of the individual extended beyond the south wall of the excavation unit and was therefore left in situ. Based on the size and skeletal fusion of this individual, they were an adult at time of death, but the sex could not be estimated due to poor preservation.

Lot 87 is an adult female found in a tightly flexed, seated position beneath the floor of the northernmost excavated structure in Op. 2031. This woman was buried in a simple grave with a large Chicanel bowl placed over the skull that had been used extensively prior to its inclusion in this grave, based on its repaired damage. This individual was also accompanied by a rodent incisor and ceramic disc, both of which were placed inside the Chicanel ceramic. Buried in the same stratigraphic context as the Lot 87 female, the subadult in Lot 95 was around 5 years of age at death. This individual was buried in a tightly flexed fetal position in a simple grave, accompanied by a Chicanel jar and ceramic disc. Furthermore, the individual in Lot 142 was also a subadult buried in a simple grave buried in a fetal position. This individual was poorly preserved, approximately 4 years of age at death, and lacked any grave goods.

Lot 184 represents a burial of two individuals in extended, supine positions with their heads oriented south and who were found in midden fill. Individual A, located to the east of B, is a middle adult female with evidence of dental disease and periostosis. Her cranium was covered with a Chicanel bowl, and she was found with a fuschite bead. Individual B is likely an old adult male that similarly exhibited postcranial evidence of periostosis, as well as healed porotic hyperostosis and a well-healed Colle's fracture on the right ulna. In contrast to Individual A, B did not have any grave goods that could be specifically assigned to him.

4.2.3. Late Preclassic Clustered Burials

Aside from these residential burials, two components of the Late Preclassic assemblage in Op. 2031 deviate from the typical Maya mortuary pattern in which individuals were buried in simple deposits underneath houses and other structures. The first of these components is Lot 107, which includes at least 12 individuals in a “well-like” crypt structure constructed of limestone marl blocks arranged in a circular shape and topped by a marl capstone (Wright 1989). The limestone blocks were associated with two Late Preclassic plaza floors such that it would have been visible during the Late Preclassic occupation. The remains inside the crypt include skeletal elements from both the axial and appendicular skeleton, all of which were completely disarticulated and had been deposited at random, with no evident attention paid to the organization of skeletal elements. Based on the stratigraphy within the crypt itself, three rough layers of remains were present, sorted by the prevalence of skeletal elements. Wright (1989) determined the MNI based on right temporal bones and identified at least five males and two females. The overwhelming majority of elements in Lot 107 were larger bones. As a result, Wright (1989) theorizes that this crypt served as an ossuary in which bones were deposited secondarily from elsewhere. This is further supported by the lack of small bones in the crypt, suggesting the remains were moved from elsewhere and smaller elements were not retained.

By contrast, the other unusual component of the Late Preclassic mortuary deposits at Colha, the Lot 118 complex, represents a series of complicated mortuary deposits that has been compared to the "mass burials" at nearby Cuello (Wright 1989). The Lot 118 burials were placed in 10 pits cut through the same two Late Preclassic plaza floors as Lot 107. These pits were arranged in a rough semicircle around a central deposit of two superimposed multiple burials, Lot 110 and Lot 223, that differed significantly from the surrounding deposits.

Lot 110 consists of a complex burial containing a primary articulated individual, two partially disarticulated individuals, and the remains of five secondary, disarticulated skeletons. The burial had been filled with a distinct white lime matrix and was surrounded and capped with limestone blocks, thereby distinguishing it from other mortuary features in Lot 118. The primary individual (Individual A) is that of a middle-old adult female skeleton who was oriented in a seated position with a large red dish in her lap that contained the remains of the five secondary, disarticulated crania and other skeletal elements. This individual exhibited evidence of dental disease, nonspecific infection in the form of periostosis on multiple skeletal elements, healed trauma on the right foot, and mild osteoarthritis in the upper back. Individual A was further furnished with elaborate grave goods, including the remains of a jade and shell necklace, a brown incised tecomate, a small brown tapir effigy vessel, and a shell gorget (Wright 1989). She and the other individuals accompanying her were further covered in red ocher.

The disarticulated remains in the lap of Individual A include five secondary crania, noted as crania C, D, I, H, and E. Cranium C is an adult male with healed porotic hyperostosis with evidence of localized cranial trauma on the right frontal. Furthermore, Cranium D is an edentulous adult female individual with evidence of cribra orbitalia, porotic hyperostosis, and temporomandibular joint degeneration. Cranium E is an adult, possibly female, individual with well-healed porotic hyperostosis, and Cranium I is a middle adult male with evidence of cranial deformation in the form of lambdoid flattening. Finally, Cranium H is the only subadult in this deposit, and was likely around the age of 9-10 years at death, as estimated by dental development (Buikstra and Ubelaker 1994). The postcranial remains were also deposited secondarily into this deposit. There are a variety of subadult elements consistent with an individual around the age of Cranium H, so Wright (1989) suggests these are the remains of a single child that was experiencing an active infection at time of death, based on the periostosis on every long bone available. As with Lot 107, there are very few small skeletal elements in the disarticulated remains in the bowl, indicating they were secondary deposits.

Beneath Individual A and the associated vessel and its human contents, two layers of disarticulated skeletal remains were recovered, representing the remains of two other primary individuals. Individual C, who is not associated with Cranium C, is an older adult represented by both partially articulated forearms and hands, the right hip, and the right foot. Individual B was found beneath Individual C and consists of the thorax and both arms. Based on pelvic morphology, this individual was a middle adult female.

Lot 223, the other intrusive multiple burial in the center of Lot 118, was found beneath Lot 110. Unfortunately, this lot was only partially excavated due to the end of the field season in 1989. The primary individual, Cranium J, was a young adult male with tabular oblique cranial modification and evidence of healed trephination on the frontal bone. As with Lot 110, the lap of Individual J contained secondary disarticulated skeletal elements and ceramics. Two unexcavated skulls were placed on the thorax of Individual J, which were further covered by concentric stacks of cranial elements that were deposited as individual fragments based on the careful placement. Two of these individuals are adult males, and another possibly female cranium was identified in the field. An abundance of disarticulated skeletal elements was noted, including closely stacked groups of long bones, fragmentary ossa coxae, loose teeth, foot bones, and other elements, none of which were in articulation or exhibited any evidence of cut marks. Wright (1989) estimates that a minimum of five individuals were included among the disarticulated remains, most of which were left in situ.

Beyond these central features, multiple additional Late Preclassic individuals were buried in varying states of articulation and commingling. The previously described Lot 223 is intrusive into two burial lots positioned to the east and west of it. The first of these, Lot 214, was likely an articulated primary old adult female in a seated position with a red bowl positioned over the cranium. The other, Lot 215, represents a primary burial of partially disarticulated bones of at least six individuals. The long bones were generally stacked in a north-south orientation, and several groups were found in articulation. Postcranial remains also include five innominates, derived from at least two male skeletons and one adolescent. Cranial pieces from at least one adult and one adolescent were also found, in addition to fragments of a cremated skull. Several skeletal elements exhibit cut marks, and two small green stone beads were the only grave goods recovered from this burial.

An additional three burials in Lot 118 consist of primary, articulated individuals. Lot 165 is a middle adult male buried in a seated position in the westernmost pit of the 118 complex. The long bones of the legs and feet exhibited evidence of well-healed periostoses. A red bowl was held in his lap, a biface fragment was found around his hands, a macroblade fragment was in his mouth, and a red jar and ceramic sherds were placed over the skull. Furthermore, Lot 117 contained an articulated young adult male, found seated in a northern pit in Lot 118. This skeleton was associated with a Sierra Red dish over the skull, a Sierra red bucket between his feet, and a single incised jade bead in the area of the pelvis. There is slight cranial modification in the form of lambdoid flattening, and this individual exhibits signs of healed porotic hyperostosis and some pedal arthritis. Finally, Lot 122, which wasn't fully excavated, contained a primary, articulated burial that had a large Sierra Red dish over the cranium of an adult female that had been burned. Only the cranium was removed, and the other skeletal elements were left in place.

In addition, several of the pits contained burials that combined both primary and secondary deposits. Lot 125 contains a burial pit to the southwest of Lot 118, and it contained multiple individuals deposited at two separate times. The first feature, 125A, contained disarticulated remains of three skeletons. A spinal column was found in articulation and was likely associated with the majority of the remaining skeletal elements, which were of a subadult around 10-17 years of age at death. Interestingly, this individual lacks a cranium, hands, and feet, and the femur exhibits cut marks, likely indicating some kind of defleshing process prior to interment. A second individual, an old adult male, was also found in 125A, represented by a disarticulated cranium placed in the burial secondarily. A thin layer of fill, ceramics, and chert fragments separated 125A from 125B, which also contained multiple skeletons. A largely articulated old adult male is the primary occupant of this deposit, and his skull was removed secondarily based on the presence and articulation of the spinal column. Wright (1989) suggests that the old adult cranium in 125A may well have belonged to this individual, and it had been removed during the deposition of the subadult in 125A and placed with the later deposit. Additional disarticulated skeletal elements were found with 125B, and they may have been deposited secondarily.

Similarly, Lot 127 includes two individuals who were likely also buried during two separate deposits. Individual A is a subadult between 12-18 years of age at death who was buried with a large red dish over its skull. The long bones of the legs exhibit active periostosis, and Wright (1989) notes that the partial articulation and absence of smaller skeletal elements make it difficult to assess if this was a primary or secondary burial. Individual B, a middle to old adult male, was buried beneath this subadult, and the majority of this skeleton was disarticulated, likely disturbed by the later interment. This individual exhibits porotic hyperostosis, periostosis, and healed Colles fractures on both ulnae. Individual B was further associated with some grave goods, including a bowl over the skull and a bead and biface below it.

Lot 137 is located partially underneath the previously described Lot 110, slightly to the south of the central burials. This lot includes two partially articulated individuals, both of which are middle adult males missing their skulls and torsos. Wright (1989) notes that the positioning of the inferior parts of these skeletons indicates they were originally deposited in articulation and subsequently disturbed.

In contrast to the other burials in Lot 118, Lot 116 was deposited on the surface of the Late Preclassic plaza floor. The skeleton is that of an adult, but it is very poorly preserved, and Wright (1989) notes that it's impossible to determine how the bones were deposited on the floor. Notably, this individual does have modified upper central incisors. Multiple ceramic and lithic artifacts might also be associated with this individual, but their association is uncertain. Wright (1989) concludes that this individual is likely a separate, earlier feature associated with Late Preclassic residential architecture.

The final component of Lot 118, Lot 203, was incompletely excavated due to its discovery at the end of the field season. This burial, located at the west of Lot 118, included the cranium of seated middle adult female and the disarticulated remains of at least two other individuals. Wright (1989) notes that this burial extended beyond the borders of the 1989 excavations, suggesting that the Lot 118 complex is much larger than was excavated in 1989.

Based on the stratigraphy of these deposits, it is clear that some of these Late Preclassic burials were intrusive, cut down through the floor, indicating that this area experienced an extended period of use for mortuary ritual (Wright 1989). Following the deposit of these individuals, this area of Colha was transformed from a domestic space to a ritual plaza area (Wright 1989).

Additional burials were recovered from a number of contexts at Colha, including house mounds and lithic workshops, during earlier excavations (Hester and Shafer 1984; Shafer and Hester 1983; Meskill 1988; Eaton 1979; Escobedo 1979; Dreiss 1994; Scott 1980; Potter 1980). Furthermore, there are multiple burials that date to the Late and Terminal Classic periods at Colha. Many of these originate from excavations in the site core, including Operation 2012 (Op. 2012), which focused on Structures 26 and 27 in the western section of Colha's main civic-ceremonial area. The highly disarticulated, predominantly male Late-Terminal Classic component of Op. 2012 has been interpreted as the result of warfare (Barrett and Scherer 2005), as well as the nearby Op. 2011 Colha Skull Pit, which is a Terminal Classic deposit of 30 defleshed, decapitated skulls found adjacent to the main staircase of a Late Classic monumental structure to the south of the site's main plaza (Massey 1989; Barrett and Scherer 2005; Buttles and Valdez 2017). The Skull Pit deposit is the focus of a separate chapter. Thus, there are a wide variety of mortuary context at the site to compare with the unusual Preclassic treatments in Op. 2031.

4.3. Analytic Methods

Both authors independently estimated the age and sex of most individuals in the Colha skeletal assemblage following established methods, with identical assessments. A few were studied only by the first author (Appendix B; Buikstra and Ubelaker 1994; Wright 1989). Archaeological context variables were compiled with reference to published site reports and field notes curated by Dr. Thomas Hester at the Texas Archaeological Research Laboratory (TARL) at the University of Texas at Austin. Unfortunately, due to poor preservation of some of the remains and incomplete archaeological data, the exact position and burial type could not be identified for all (see Appendix B), but these individuals are still included to establish local strontium ranges and to compare mobility patterns between chronological periods and mortuary contexts.

For isotope analysis, I preferentially sampled permanent first molars from all available dentitions in the Colha skeletal collection. For the current analysis, the Skull Pit individuals (Op. 2011) were excluded, as these individuals are the focus of another chapter. Furthermore, in order to increase the sample size, I sampled permanent canines for those individuals lacking permanent first molars. Although not ideal due to the different formation times, the period of amelogenesis overlaps between these two tooth types, making the data roughly comparable. In total, I included 74 individuals in this sample. Prior to sectioning teeth for isotopic analysis, I collected all dental data following established protocols (Buikstra and Ubelaker 1994) and took high-resolution photographs using a Dino-Lite digital microscope. I further created molds and casts for all sampled teeth, prior to sectioning. Five to ten milligram samples of tooth enamel using a Brasseler diamond tipped drill bit. I took samples as longitudinal sections from the cemento-enamel junction to the crown tip, such that the resulting isotopic ratios represent the average values for the entire period of enamel formation.

I conducted all light isotope preparation in Wright's lab at Texas A&M University. Each enamel section was first rinsed with 1mL of 0.25M HCl that was left on the sample for 60 seconds, then rinsed three times in distilled water. All samples were subsequently dried overnight and then ground to a fine powder with an agate mortar and pestle. To remove residual organics, I soaked ground samples in 2mL of a ~1.5% sodium hypochlorite solution. After 48 hours had passed, samples were centrifuged, and the supernatant was removed with a pipette. I subsequently rinsed samples three times in distilled water, centrifuging each time. Finally, I exposed the ground samples to a series of diagenetic rinses. First, 1 mL of 1M acetic acid was added for 15 minutes. Samples were subsequently centrifuged for 10 minutes, then rinsed with distilled water and centrifuged again, for a total of three rinses. I then dried samples in a 70°C oven overnight until dry. Prepared samples were sent to the Texas A&M University Stable Isotope Geosciences Facility to be analyzed on a Thermo Scientific Kiel IV Automated Carbonate Device coupled to a Thermo Scientific MAT 253 dual inlet isotope ratio mass spectrometer, the uncertainty for which is reported at ±0.04‰ for $\delta^{13}C$ and ±0.06‰ for $\delta^{18}O$ based on long-term replicate analyses of PDB carbonate isotope standards NBS 19 and IAEA 603.

I conducted all heavy isotope sample preparations in the Texas A&M University R. Ken Williams Radiogenic Isotope Geosciences Laboratory. On the first day of preparation, samples were soaked in 1mL of acetic acid optima and sonicated for 20 minutes. The acetic acid was subsequently removed and replaced with fresh acetic acid optima and sonicated for 5 minutes. Samples were rinsed three times with distilled water and then soaked in 0.5 mL of 7N nitric acid overnight to dissolve. On the second day, dissolved samples were transferred into Savillex beakers and heated on a hotplate at 90°C for 2 hours until dried. Dried samples were then soaked in 0.5 mL of 3N HNO_3 overnight to redissolve. Finally, strontium was isolated using Eichrome SrSpec resin in columns. A drop of phosphoric acid was added to the separated strontium samples, which were then dried on a hotplate for ~2 hours at 90°C. Prepared samples were loaded onto degassed rhenium filaments with 1 microliter of 2N HCl. Samples were then run on a Thermo Scientific Triton thermal ionization mass spectrometer, which has yielded an SRM 987 value of 0.7102393 ± 15.2 ppm over the last three years.

In order to define a local strontium signature for Colha, I evaluated the human data following Wright's (2005) statistical method to identify outliers. This allowed us to identify likely nonlocal individuals in the Colha skeletal assemblage for both strontium and oxygen data, as well as define the local ranges for each isotope at Colha. The resulting site values are also compared to published strontium isotope faunal data for two deer (*Odocoileus virginianus*) samples from the site that yielded values of 0.7081 and 0.7082 (Price et al. 2010). Due to species-specific fractionation factors for stable oxygen isotopes, faunal data can only be used to help identify local strontium values.

4.4. Results

The statistical distribution of the strontium isotope data from Colha gives some indication of the local range, following the parsimonious assumption that most individuals will have been locally born (Wright 2005a). Descriptive statistics for the isotope data are presented in Table 4-1. The mean $^{87}Sr/^{86}Sr$ value is 0.70822 ± 0.00019, which is consistent with previously published values of 0.7082 and 0.7081 for white-tail deer samples from Colha (Price et al. 2010).

Table 4-1. Descriptive statistics for strontium, oxygen, and carbon isotope ranges at Colha

Parameter	Total Sr	Local Sr	Oxygen	Carbon
Mean	0.70822	0.70823	-2.14‰	-7.76‰
Median	0.70822	0.70822	-2.21‰	-8.06‰
Variance	3.2644E-08	5.94048E-09	0.398	4.087
Std. Deviation	0.00019	0.00008	0.63	2.02
Minimum	0.70762	0.70804	-3.55‰	-10.67‰
Maximum	0.70878	0.70842	-0.85‰	-2.3‰
Range	0.00116	0.00038	2.7	8.37
Interquartile Range	0.00012	0.00011	0.85	2.4
Skewness	-0.467	0.106	-0.197	1.057
Kurtosis	2.987	0.005	-0.604	0.896
Shapiro-Wilk	0.888*	0.985	0.977	0.911

* indicates statistical significance at 0.01 level

The Shapiro-Wilk test of normality (0.888, df= 74, p= 0.000) indicates that these data are not normally distributed, a fact that is further confirmed by the Q-Q plot in Figure 4-5. The skewness (-0.467) indicates that the data are definitely skewed, and a high kurtosis value of 2.987 indicates this distribution is leptokurtic, meaning there are more individuals in the tails of this distribution than normal. A total of 12 individuals appear to be statistical outliers 1.5 times beyond the interquartile range of this sample, as demonstrated in the box plot in Figure 4-6. These individuals, who have strontium isotope values either above 0.70850 or below 0.70789, are thus likely nonlocal individuals.

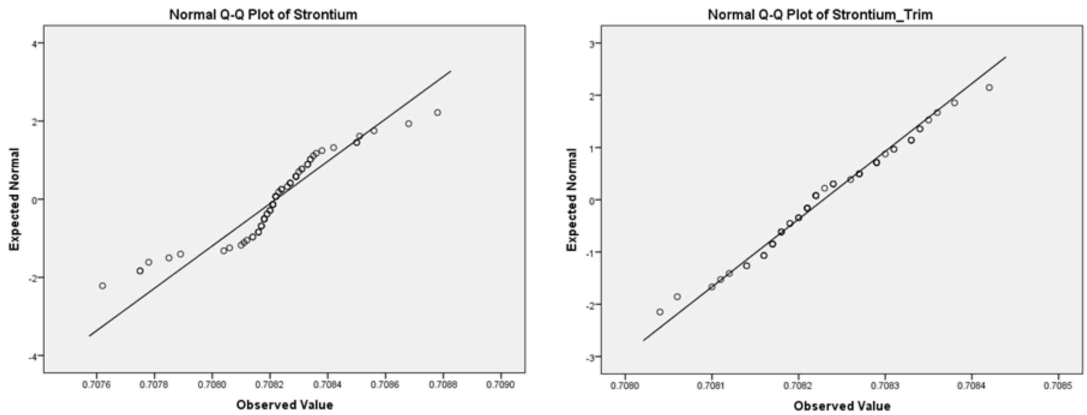

Figure 4-5. Q-Q plots of Colha strontium data. "Untrimmed" results on left and "trimmed" (local) results on right

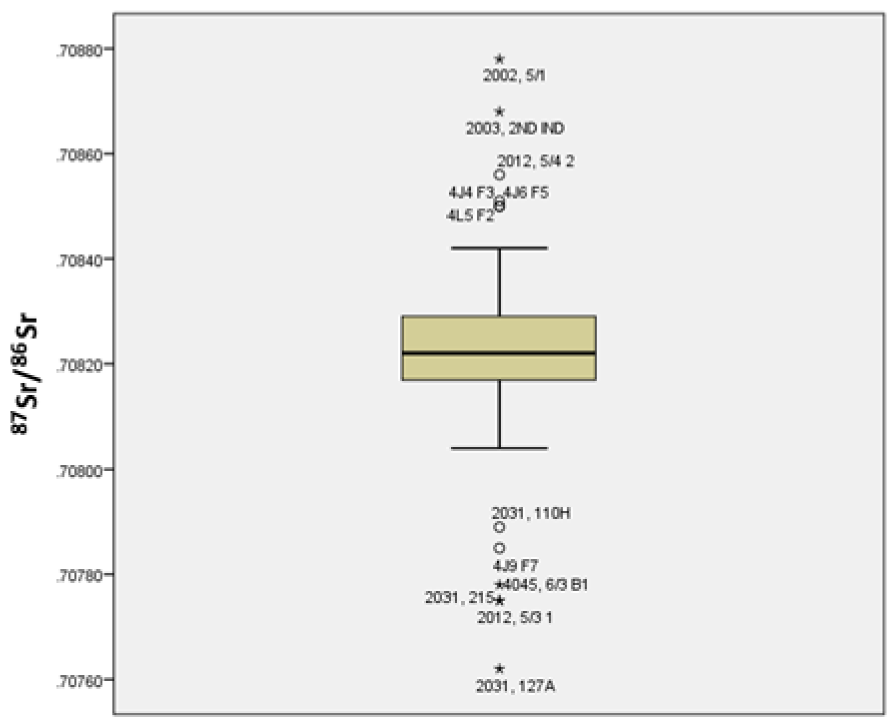

Figure 4-6. Boxplot of strontium isotope ratios at Colha. Outliers identified by mortuary context

Removing these 12 individuals from the sample yields a “trimmed” strontium dataset presented in Table 4-1. The mean of this trimmed data is 0.70823, the median is 0.70822, and the standard deviation is 0.00008. The Shapiro-Wilk test of normality (0.985, df 62, p= 0.628) indicates these data are normally distributed, and the Q-Q plot confirms this observation in Figure 4-5. Furthermore, the skewness and kurtosis are close to 0, and no additional outliers are detectable beyond 1.5 times the interquartile range. As a result, this “trimmed’ strontium isotope data are likely comprised of individuals who were born locally at Colha or in a region with very similar geology. Thus, the local strontium range for Colha is defined here as 0.70804-0.70842. The nonlocal individuals form two discrete groups, one with strontium values higher than this local range from 0.70850-0.70878, and one with strontium values lower than this range from 0.70762-0.70789.

The oxygen data are also presented in Table 4-1. The mean $\delta^{18}O$ value is -2.1‰, the median is -2.2‰, and the standard deviation is 0.6‰. The Shapiro-Wilk test of normality (0.977, df 74, p= 0.184) indicates the sample is essentially normally distributed, and the skewness (-0.197) and kurtosis (-0.604) are close to zero. There are no detectable outliers 1.5 times beyond the interquartile range, as demonstrated by the box plot in Figure 4-7.

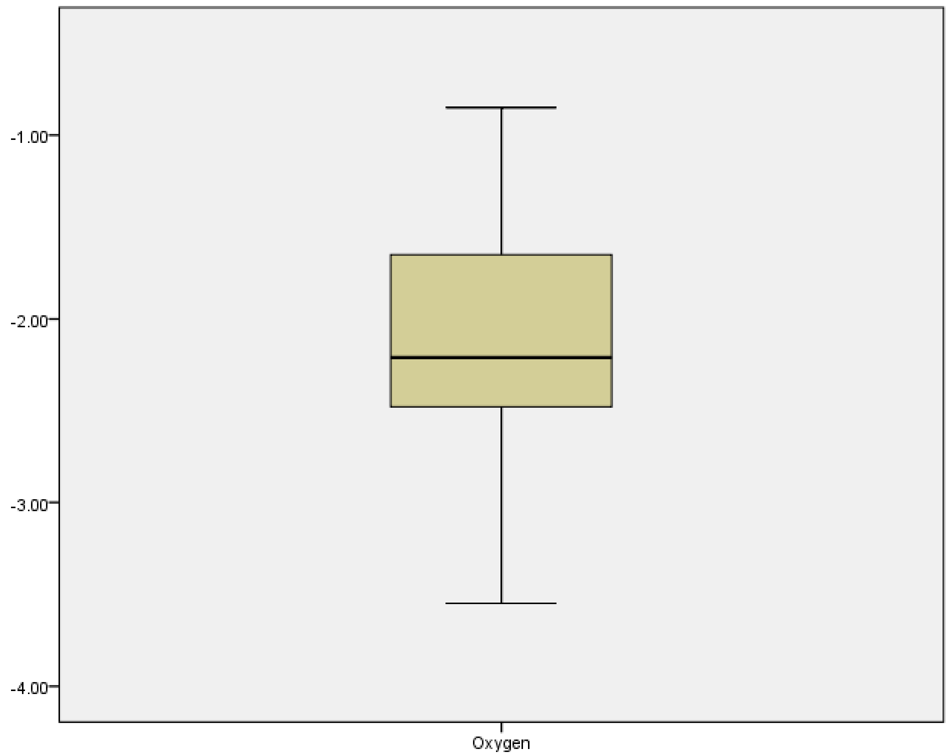

Figure 4-7. Boxplot of stable oxygen isotope ratios at Colha

The Q-Q plot of the oxygen data is presented in Figure 4-8, which also shows the locations of the strontium outliers marked in black. On the basis of this information, there are no nonlocals in this sample from regions with isotopically distinct water sources, and the local $\delta^{18}O$ range for Colha can be defined as -3.6 to -0.9‰, similar to much of the lowland Maya area. The $\delta^{18}O$ values are plotted against $^{87}Sr/^{86}Sr$ in Figure 4-9. The Colha skeletons who were identified as nonlocals based on strontium values therefore must have originated from regions with $\delta^{18}O$ values comparable to Colha, an observation that thereby excludes the Guatemalan highlands, the southeastern periphery near Copan, and highland Mexico (Wright et al. 2010; Price et al. 2000, 2010, 2014; White et al. 2007).

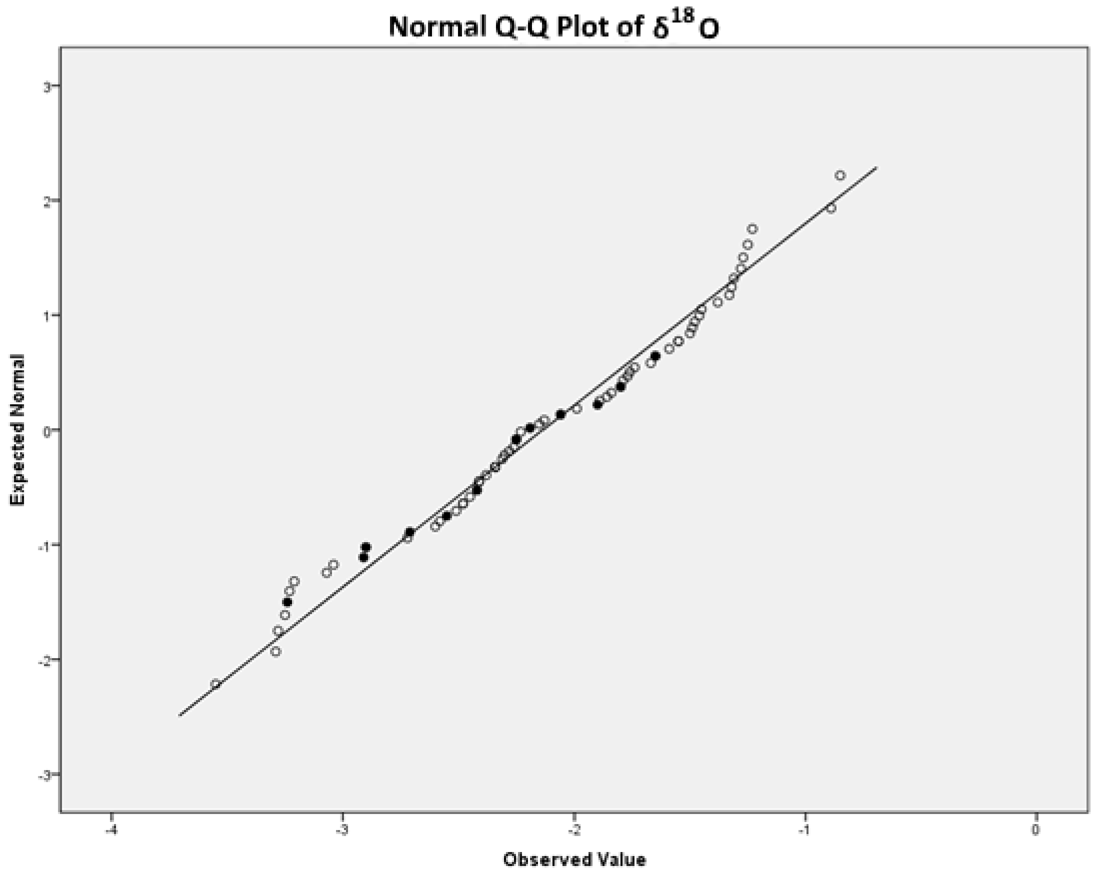

Figure 4-8. Q-Q plot of the oxygen isotope data from Colha. Strontium outliers are identified by black circles

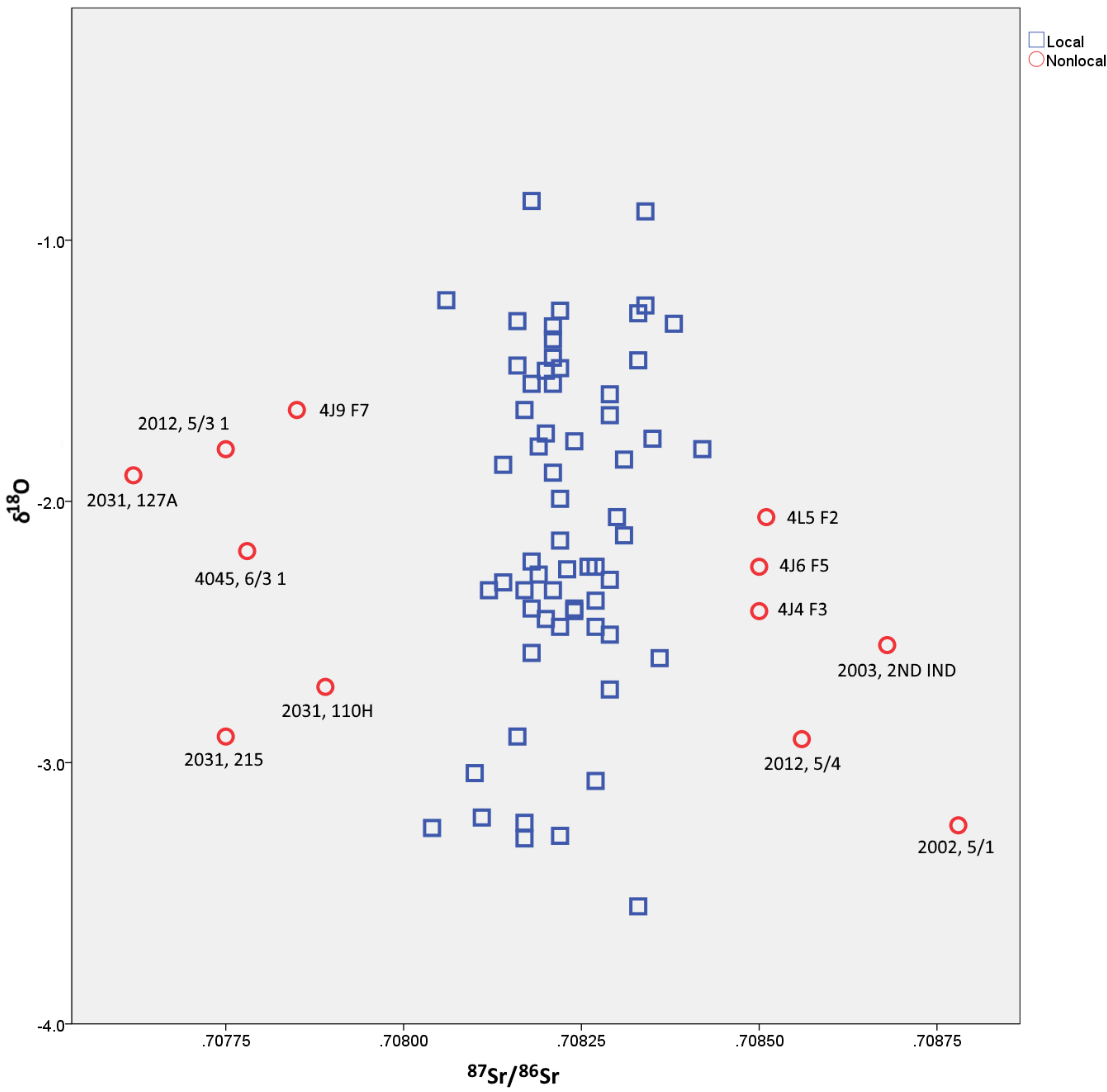

Figure 4-9. Oxygen and strontium isotope scatterplot. Nonlocal individuals are labeled by archaeological context

The carbon isotope descriptive statistics are further presented in Table 4-1. The mean $\delta^{13}C$ value is -7.8‰, the median is -8.1‰, and the standard deviation is 2.0. The data are highly skewed, with six individuals exhibiting much heavier $\delta^{13}C$ values, around -3.0‰, indicating significantly greater maize consumption in this subset of the Colha skeletal assemblage. In fact, four of the six carbon outliers are also strontium outliers, as previously suggested by the oxygen and strontium isotopes. The $\delta^{13}C$ boxplot is presented in Figure 4-10 with strontium outliers identified. It is likely that the high $\delta^{13}C$ values also point to the presence of nonlocals in this sample, even though these individuals may not have distinctive strontium isotope ratios.

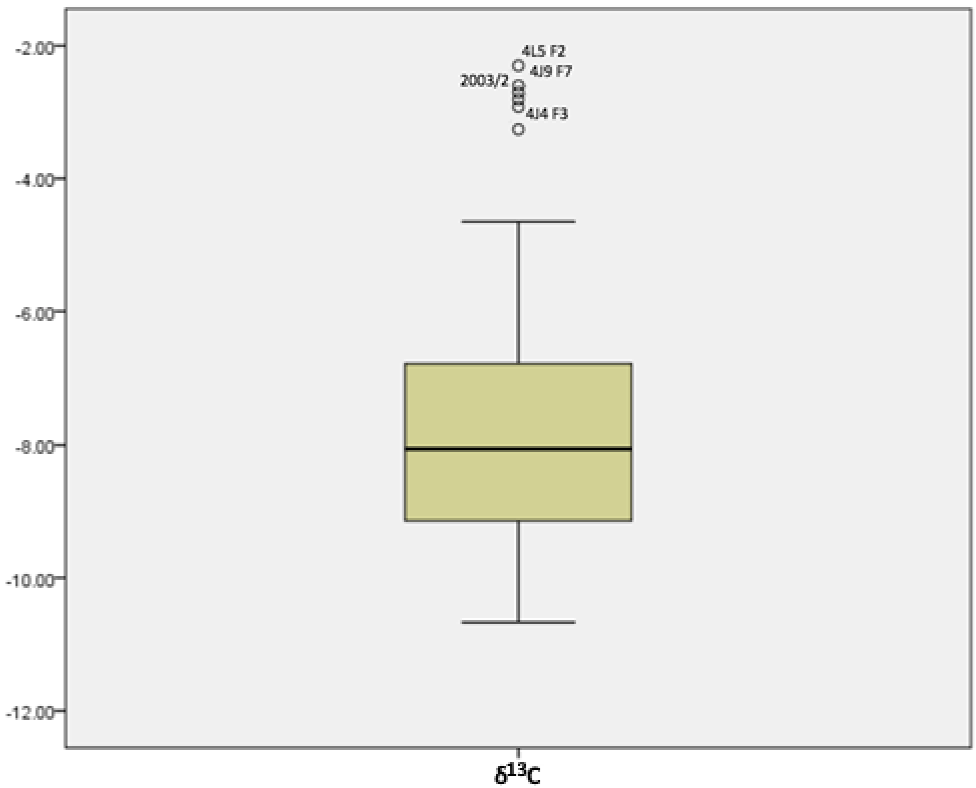

Figure 4-10. Boxplot of stable carbon isotope ratios in Colha teeth. The strontium outliers among the carbon isotope outliers are identified by burial number

4.4.1. Nonlocal Individuals

The nonlocal individuals, as determined by strontium and oxygen isotopes, are plotted against the local isotopic ranges for major sites in eastern Mesoamerica in Figure 4-11. No individuals buried at Colha originated from Copan, the highlands of Mexico, or sites along the eastern coast of the Yucatan peninsula. Three of the nonlocal individuals at Colha were buried in the Lot 118 complex of Op. 2031, the large cluster of Late Preclassic burials. All three of these individuals are subadults, and all are in the lower group of strontium nonlocals.

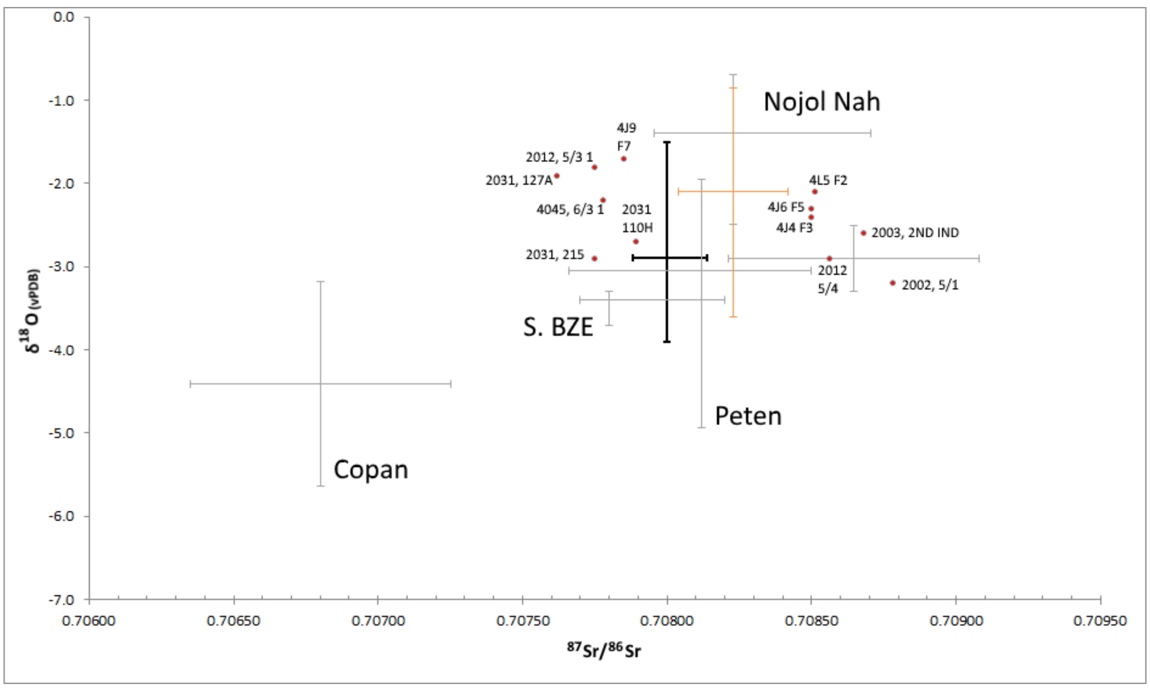

Figure 4-11. Regional strontium and oxygen isotope ratios comparing Colha data to other Maya sites. Crosses represent local ranges for other Maya sites. The Colha cross is in orange, and Cuello is represented in black. The red dots are Colha nonlocal individuals.

The first of these individuals, Skull H from Lot 110 in Op. 2031, is a Late Preclassic subadult who was ~10 years of age at death. This lot is part of the central feature of the large clustered burial Op. 2031, and Skull H was buried in a large dish in the lap of Individual A (the old adult female covered in red ochre at the heart of this feature, who is local in origin), along with four other crania. Skull H was placed to the north, in the base of the dish facing southeast. Thus, this individual was buried in a secondary, disarticulated state in a multiple burial. On the basis of the strontium (0.70789) and oxygen (-2.7‰) isotope values, it is likely this individual originated either at another site in northern Belize, such as at nearby Cuello, or the Petén region of Guatemala.

In addition, Individual 127A was buried in Lot 127 of the Late Preclassic clustered context at Colha. This skeleton was also a subadult at time of death and was buried in a secondary, multiple, disarticulated context. Lot 127 may have resulted from two interment episodes. This individual was buried above a middle-old aged adult male, and Wright (1989) notes that it’s possible the original burial was later disturbed by the deposition of the subadult. This individual exhibits a combination of strontium (0.70762) and oxygen (-1.9‰) values that do not overlap directly with any previously studied site in the Maya area; however, the values are close to those reported from Tikal (Wright 2005a), so it is possible they originated from the Petén.

Finally, the subadult mandible found in Lot 215 is a likely nonlocal individual found in the large, Late Preclassic clustered context (Op. 2031). This was from a primary interment of multiple disarticulated individuals. Lot 215 consists of a tightly bound group of disarticulated remains, the long bones of which were stacked in a north-south direction. Lot 215 further appears to have been cut through by the intrusive Lot 223 (Wright 1989). This individual likely came from the Petén, based on their strontium (0.70775) and oxygen (-2.9‰) values.

Beyond the Late Preclassic individuals in Op. 2031, two other Late Preclassic individuals were likely nonlocals. The two individuals from Op. 2012, Subop. 5, located in a small temple in the ceremonial site core of Colha, date to the Late Preclassic and were found in a large secondary, multiple burial in which no remains were articulated. Neither individual could be aged or sexed. The first of these individuals, Individual 2 from lot 4, likely originated from a site in the Belize River Valley based on strontium (0.70856) and oxygen (-2.9‰) isotope values. Unlike all other Preclassic nonlocals at Colha, this individual is in the high $^{87}Sr/^{86}Sr$ group. The other nonlocal from this context, Individual 1 from lot 3, exhibits strontium (0.70775) and oxygen (-1.8‰) isotope values that are in the lower $^{87}Sr/^{86}Sr$ group and do not overlap with any previously studied site in the region. However, these isotope values are relatively close to the values reported for the central Petén region (Wright 2005a).

In addition, there are multiple nonlocal individuals at Colha from later time periods. An individual from Op. 2003 (listed in the literature as the second individual from this operation) is also nonlocal and groups with the higher strontium values. This individual is a probable female adult buried in a single, articulated, secondary mortuary context that dates to the Postclassic period. Op. 2003 is a large mound on the south side of the ceremonial core of Colha that included a Postclassic midden and structural deposits covering a Preclassic pyramid (Eaton 1979). This skeleton also has strontium (0.70868) and oxygen (-2.6‰) isotopic values consistent with an origin in the Belize River Valley, and their stable carbon isotopic value is a much heavier outlier compared to the rest of the Colha population as well, more in line with dietary signals identified in the Petén region of Guatemala (Gerry 1993, 1997).

Furthermore, two nonlocal skeletons were recovered from some of the many lithic workshops at the site, both of which cluster with the higher strontium nonlocal group. The first of these was found in Op. 2002 5/1. This skeleton is a fragmentary adult buried in a Late Classic lithic workshop. The remains are too incomplete to confidently assign sex, and unfortunately little mortuary information is available for this individual that would detail the specific circumstances of the burial context. This individual has strontium (0.70878), oxygen (-3.2‰), and carbon (-5.6‰) isotope values consistent with skeletons from the Belize River Valley reported by Freiwald (2011). Similarly, the adult skeleton from Op. 4045 6/3 is a Late/Terminal Classic nonlocal individual buried in a house/workshop compound at Colha (Meskill 1988). The skeleton is highly fragmentary, so no definitive sex can be estimated. The age estimate is based on the size and fusion of long bone fragments. The skeleton was buried in a primary, single, likely articulated context (Meskill 1988). This individual likely originated in the Petén region of Guatemala based on strontium (0.70778) and oxygen (-2.2‰) data.

Individual 4L5 F2 was buried in Op. 4L, which is located in the eastern end of mound 41 at the periphery of the site core (Pring et al. 1975). This young adult female dates to the Postclassic period, and was buried in a primary, multiple grave in articulation. On the basis of her strontium (0.70851) and oxygen (-2.1‰) isotope values, she clusters with the higher strontium group of nonlocals and likely spent her childhood elsewhere in northern Belize or possibly southern Mexico. Her carbon isotope value (-2.3‰) is significantly heavier than all other skeletons from Colha.

The remaining three nonlocal individuals were excavated in Op. 4J, located in the Postclassic plazuela group 35 in the ceremonial center of the site core (Pring et al. 1975). The first two of these individuals have higher strontium values, while the third (4J9 F7) is the only later nonlocal individual with a lower strontium value. Individual 4J4 F3 was buried as a single primary articulated adult. Due to the poor preservation, this individual could not be reliably sexed. Individual 4J6 F5 is a probable adult male in a single, secondary burial. These two individuals likely spent their childhoods in the Petén region around Tikal, although individual 4J4 F3 exhibits an atypical carbon value (-3.3‰) as well that is much heavier, indicating greater maize consumption than was typical at Colha. Finally, individual 4J9 F7 is a middle adult male buried in a primary, single, articulated context. The strontium (0.70785) and oxygen (-2.6‰) isotope data suggest that this individual was born in the nearby Cuello area of northern Belize, although their carbon value (-2.6‰) is atypical for either site.

4.4.2. Demographic Comparisons

Very few subadults were sufficiently preserved to sample for isotopic analysis in the Colha skeletal sample (n= 5). Of these, three of the four subadults sampled from Op. 2031, the cluster of Preclassic burials, are nonlocal in origin. A Fisher's exact test comparing the proportion of nonlocal adults and subadults within Op. 2031 indicates that this distribution is significant (Fishers p= 0.0011). Furthermore, all three nonlocal subadults have strontium values in the lower cluster of nonlocals, possibly indicating they originated in geochemically similar locations. These three individuals do not have unusual oxygen or carbon isotope signatures for Colha. Finally, the only subadult sampled from outside this context was local in origin. Thus, of the five subadults sampled at Colha, three were nonlocal in origin, all of which were buried in Op. 2031.

Poor preservation prevents confident sex assessments for the majority of individuals in the Colha sample. However, of the well-preserved individuals, there are no statistically significant differences between males and females in terms of strontium (t= -1.293, df= 23, p= 0.209), oxygen (t= -0.292, df= 23, p= 0.773), or carbon (t= 1.042, df= 23, p= 0.308) isotopes. A Fisher's exact test comparing the proportion of nonlocal males and females is not statistically significant (Fisher's p= 1.000).

4.4.3. Chronological Comparisons

Due to the small sample sizes for some of the finer chronological divisions, I can only compare major chronological periods of Preclassic and Classic periods. There are no statistically significant differences for stable oxygen ($t= -1.731$, $df= 72$, $p= 0.088$) or carbon ($t= -1.957$, $df= 72$, $p= 0.054$) isotopes between Preclassic and Classic Colha skeletons. However, there is a significant difference between the Preclassic and Classic periods for strontium isotopes ($t= -2.581$, $df= 72$, $p= 0.012$), indicating migrants from the two different time periods were not coming to Colha from the same locations. In fact, five of the six Preclassic individuals that are nonlocal in origin have low strontium isotope values. The Preclassic individual with a higher strontium value originated in the Late Preclassic component of Op. 2012 and was not atypical for this mortuary deposit.

Similarly, five of the six Classic period nonlocals have high strontium isotope values. The Classic individual with a lower $^{87}Sr/^{86}Sr$ value, 4J9 F7, was a primary, articulated individual without grave goods found in a house mound just outside the ceremonial center. The mortuary context for this individual is consistent with the three other individuals from this same house mound that were nonlocal in origin as well, all with higher $^{87}Sr/^{86}Sr$ values. This could indicate some mortuary patterning based on origin, although one of the individuals from this structure does exhibit a lower $^{87}Sr/^{86}Sr$ value. However, when comparing the proportion of nonlocals to locals between the Preclassic and Classic periods, there are no statistically significant differences (Fisher's $p= 0.352$).

4.4.4. Mortuary Comparisons

In terms of differences in isotopic values between mortuary contexts, there are no statistically significant differences for the three isotopes for most burial characteristics considered individually. There are no statistically significant differences between single and multiple burials for strontium ($t= 0.688$, $df= 69$, $p= 0.494$), oxygen ($t= -0.361$, $df= 69$, $p= 0.719$), or carbon ($t= 0.136$, $df= 69$, $p= 0.892$) isotopes. Similarly, there are no statistically significant differences between articulated and disarticulated individuals for strontium ($t= 0.727$, $df= 68$, $p= 0.47$), oxygen ($t= -1.239$, $df= 68$, $p= 0.22$), or carbon isotopes ($t= 0.176$, $df= 68$, $p= 0.861$). Finally, there are no significant differences between individuals in primary versus secondary interments for strontium ($t= -0.866$, $df= 68$, $p= 0.389$), oxygen ($t= -1.338$, $df= 68$, $p= 0.185$), or carbon ($t= -0.248$, $df= 68$, $p= 0.805$) isotopes.

When comparing the individuals in the clustered burials to their Preclassic contemporaries, there are no statistically significant differences for strontium isotopes ($t= 0.927$, $df= 39$, $p= 0.359$) or oxygen isotopes ($t= 0.149$, $df= 39$, $p= 0.882$). However, there are significant differences between these groups for carbon isotopes ($t= -2.218$, $df= 39$, $p= 0.032$). However, the proportion of nonlocals in these Preclassic clustered contexts is not significantly different from those in other Preclassic residential mortuary deposits (Fisher's $p= 1.000$). These results suggest that the individuals who were buried in these mortuary contexts largely originated in the local population, but they had a distinct diet compared to their peers.

4.5. Discussion

On the basis of these strontium and oxygen isotope results, at least 12 nonlocal individuals are present in the Colha sample (16.2% of individuals sampled). It is likely that some nonlocals remain grouped in the "local" Colha population due to the overlapping isotopic ranges with other sites in the region. Although there is overlap especially within the area of northern Belize, the local range for Colha is still distinguishable from that of nearby Cuello, as determined in the previous chapter, and parts of the Nojol Nah sample (Das Neves 2011).

The proportion of nonlocals at Colha (16.2%) is comparable to that identified at other small sites in the Maya lowlands, although somewhat less than that identified at larger regional centers. At the nearby site of Cuello, 16% of individuals sampled were nonlocal in origin, as discussed in the previous chapter. However, at the small site of Nojol Nah in the nearby Blue Creek area of northern Belize, Das Neves (2011) found no nonlocals in a sample of 14 individuals. At sites to the north of Colha in the Yucatan peninsula, mobility patterns seem to vary. At Noh Bec, eight of 32 individuals (25%) were nonlocal in origin (Cucina et al. 2015), while Ortega-Muñoz et al. (2019) assessed mobility at El Meco, El Rey, and Tulum and found between 0-20% nonlocals at these sites. Elsewhere in Belize, approximately 14-26% of individuals sampled from 15 sites in the Belize River Valley were nonlocal in origin (Freiwald 2010). At Pusilha in southern Belize, four of 16 individuals (25%) sampled originated outside of the eastern Maya lowlands (Somerville et al. 2016), while Trask et al. 2012 identified only one nonlocal (~3.4%) in a sample from Uxbenka. Thus, the proportion of nonlocals in the Colha sample is not atypical for small sites in the Maya area.

At Copan, Price et al. (2014) note that more than one-third of burials sampled from a Classic period enclave are likely nonlocal in origin. As with other sites, the origins of these individuals vary. In the case of Copan, it is clear from the isotopic data from individuals buried in these Classic period structures as well as the Acropolis that some of the site's rulers spent their childhoods elsewhere (Price et al. 2010, 2014). At the large regional center of Tikal, Wright (2012) notes that approximately 11-16% of individuals sampled are nonlocal in origin, most of which originate in Early Classic and high-status mortuary contexts. As with Copan, the presence of nonlocals in the elaborate royal burials indicates mobility among the elite segment of society in particular, although migration was by no means exclusive to the higher social strata at either site. The prevalence of nonlocals at Copan is much higher than that documented at Colha, although this could be an artifact of sample selection, as the Copan samples were primarily recovered from higher status contexts. However, the proportion of nonlocals at Colha is comparable to the upper estimates at Tikal, demonstrating the variable mobility patterns in the region. It is further noteworthy that these larger sites have more evidence for longer distance migration and individuals originating in distinct geochemical zones; in contrast, the migrants at Colha were generally coming from fairly close locations.

In terms the origins of individuals in the Op. 2031 cluster of burials, the majority of skeletons from this feature who were sampled for isotopes are local in origin. Of the 26 individuals sampled from this feature, only three are nonlocals (13.04%). The strontium and oxygen isotope values are not significantly different for individuals in these clusters, and the proportion of nonlocal individuals in this feature is not significantly different, suggesting that these individuals largely originated in the local population. However, the stable carbon isotopes indicate a significant difference between individuals in these features compared to their contemporaries, suggesting they had a distinct diet. These findings are consistent with the interpretation that the clustered burials represent a local group that had differential access to food resources. Thus, I find support for the hypothesis that individuals interred in these complex clustered burials originated in the local population and had a distinct diet compared to individuals in residential mortuary contexts.

Of the individuals from Op. 2031 included in this study, five teeth were sampled from the lot 107 well-like crypt feature, all of which were local. This suggests that this feature, which was characterized by secondary skeletal deposits, served as an ossuary for the local population during the Late Preclassic period. Furthermore, the female in Lot 110 who was covered in red ocher, most of the disarticulated individuals in her lap and in various locations around her in the same burial, spent their childhoods at Colha. The remaining adults sampled from the cluster of burials were also local in origin; however, the three subadults sampled from Op. 2031 originated at sites further afield of Colha. Thus, the only three nonlocal individuals in this unusual mortuary context are subadults.

Although subadults are underrepresented in the Colha sample (as they are in most Maya mortuary samples), four of the five subadults at the site were included in this analysis. Of those four individuals, three are nonlocal in origin, and all of them were buried in the Late Preclassic mortuary cluster. These individuals also all have strontium values in the lower group of outliers, possibly indicating some similarity in their origins, although the overlap between the Belize River Valley and central Petén area strontium signals complicates exact identification of where they spent their early childhoods. These three nonlocal subadults were further found in different burials of Lot 118, and all of them are accompanied by at least one adult individual in varying stages of articulation. The subadult in Lot 215 is represented only by a mandible found in a primary disarticulated burial of at least six individuals. In addition, the subadult from Lot 127 was located in a burial that likely resulted from two interment episodes. The other individual, an adult likely buried at an earlier time, has local isotopic signatures. The final subadult, Skull H from lot 110, is one of the disarticulated individuals found in the lap of the old adult female covered in red ochre. Thus, there is no consistency, in the mortuary treatments of these three subadults. Furthermore, Skull H from Lot 110 was likely around 10 years of age at death, while the other two individuals were adolescents (Wright 1989). Given the young age of these individuals, it is unclear how they arrived at Colha. The presence of nonlocal children but only local adults in the Late Preclassic clustered mortuary feature is difficult to reconcile.

One possibility for the presence of nonlocal subadults in this feature is some kind of ritual human sacrifice. There is ample ethnohistoric and archaeological data to indicate that subadults were preferentially selected as sacrificial victims, often associated with rituals involving rain deities (de Anda 2007). However, there are no other mortuary or non-funerary characteristics that distinguish these individuals from others buried in similar contexts in the clustered burial feature. These individuals could alternatively have been relocated to Colha for the purposes of elite intermarriage, which is well documented at larger sites throughout the region, or even for participation in the manufacture and trade of lithics at Colha, which was influential throughout the area. These scenarios are currently speculative and warrant further investigation.

In addition, these isotope data indicate significant changes to mobility patterns over time at Colha in terms of where nonlocals originated. While the proportion of individuals did not change significantly over time from the Preclassic to Classic period, the significant differences in strontium isotope values between these periods suggest a change in the likely origins of nonlocals coming to the site. Indeed, the Preclassic nonlocals are almost exclusively characterized by low $^{87}Sr/^{86}Sr$ values, while all but one of the Classic period nonlocals exhibit high $^{87}Sr/^{86}Sr$ values. This difference could reflect the changing dynamics of long-distance trade, as Colha's position in the lithic exchange sphere shifted over time (Hester and Shafer 1994). Alternatively, it could indicate shifts in the geopolitical sphere and exactly which external sites Colha was engaging and interacting with over time.

4.6. Conclusions

The preponderance of locals in the Late Preclassic Op. 2031 clustered burial contexts further supports the conclusion that these individuals a burgeoning elite group that spent their childhoods at Colha. Unlike the Late Preclassic "mass burials" at nearby Cuello, which do likely reflect human sacrifice due to the highly skewed sex ratio, high proportion of nonlocals, and significantly different diet compared to the rest of the Cuello population (see chapter 3) the clustered burial context at Colha instead likely reflects an ancestralization process, as has been suggested for a comparable feature at nearby K'axob (McAnany 1995). McAnany (1995) suggested that the Preclassic K'axob mortuary features reflect the secondary deposition of primary burials to create lineal ties to space, and ultimately power, via the genesis of ancestors. Building on this concept of ancestralization, Fitzsimmons (2011) notes that the Maya considered ancestors to be active social participants who were frequently referenced in the negotiation of identity and power by the living. Insecure rulers have also been documented to have used public rituals invoking ancestors to establish and confirm the sociopolitical hierarchy (Scherer 2015). Applying these observations to Late Preclassic Colha, the clustered mortuary context likely represents an area of repeated, often secondary, interment of local individuals from a burgeoning elite group. As ties to space, resources, and power were established via the interment of venerated ancestors, the physical location of these remains was transformed into the main civic-ceremonial focus of the site itself, broadly contemporaneous with an expanding population and lithic production, solidifying the sociopolitical power of this group.

These isotopic data further indicate shifting origins for the nonlocals at Colha over time. This shift perhaps indicates changes in Colha's position in the Maya political or economic spheres from the Preclassic to Classic periods. By the Late Preclassic, Colha had become the primary lithics producer in the area, and it was likely a largely independent craft specialization center (Hester and Shafer 1984). However, this lithics production dominance diminished over time, as did the site's independence. By Late Classic times, there were many more lithics production locales in the chert-bearing zone of northern Belize. In addition, Colha itself may have come under the control of Altun Ha (Hester and Shafer 1994). The differences in mobility patterns over time therefore likely reflect these economic and geopolitical changes.

It is important to note that many, if not most, of the individuals included in this study (and most isotopic studies) were generally excavated from the site core or areas in the close periphery. This likely suggests that the less privileged individuals in Maya society are poorly represented in these studies, preventing holistic assessments of mobility at different social status levels. Further research with other isotopes, such as lead or sulfur, might provide additional information and help identify possible nonlocal individuals hidden due to overlapping strontium and oxygen ranges between sites.

5. THE ORIGINS AND IDENTITIES OF THE COLHA SKULL PIT SKELETAL REMAINS

5.1. Introduction

The Terminal Classic period was a time of remarkable upheaval and change for the ancient Maya. During this time, many large regional centers in the southern lowlands fell into decline and were abandoned during the Classic Maya collapse. The exact mechanisms for this collapse are a perennial focus of archaeological inquiry and continue to be debated today. At the site of Colha in northern Belize, an extraordinary deposit of 30 skulls was discovered in a structure on the south side of the site’s main plaza that sheds light on the social processes occurring during the Terminal Classic period. The Colha Skull Pit, as this deposit came to be known, represents a single interment event of 30 decapitated and flayed individuals, almost equally divided between adult males, adult females, and subadults. Shortly after the pit was formed, the structure above it was burned and destroyed, and the site was abandoned for over a century. Given the unusual nature of this deposit, there has been a wealth of research on the Colha Skull Pit. Previous studies have proposed competing interpretations of this unusual deposit, including religious human sacrifice, termination ritual, internal insurrection, and external warfare (Barrett and Scherer 2005; Buttles and Valdez 2016; Hester et al. 1980, 1983; Massey 1989; Mock 1994; Valdez and Adams 1982) and raise further questions regarding the origins of these individuals. Therefore, the purpose of this study is to use stable oxygen ($\delta^{18}O$), stable carbon ($\delta^{13}C$), and radiogenic strontium

($^{87}Sr/^{86}Sr$) isotopes to directly assess the mobility patterns of individuals buried in the Skull Pit and to determine the geographic origins of these individuals.

5.2. The Site of Colha, Belize

Colha is a Lowland Maya site located in modern day Belize, approximately 53 km northwest of Belize City (Figure 5-1). The site was discovered during the Corozal Project's regional survey in 1973-1974 and was subsequently investigated by the Colha Project from 1979-1995 (Barrett et al. 2011; Buttles 2002; Hester and Shafer 1994; Hester *et al.* 1994). Colha is characterized by a monumental center on the northern side of the site that includes a dominant small pyramid, at least four additional pyramidal structures, two large plazas, and several linear buildings (Eaton 1980, 1982). This monumental core served as the center for political and religious activity for inhabitants of Colha (Figure 5-2; Eaton 1982). There is also a ball court, as well as several additional large plaza groups, *plazuela* groups, lithic tool workshops and house structures surrounding the site core of Colha (Eaton 1980, 1982; Hester and Shafer 1994; King 2000).

Occupation at Colha began in the preceramic Archaic period, with possibly sedentary peoples living in the area due to fields found in the nearby Cobweb Swamp (Iceland and Hester 1996; Jones 1994). By the Middle Preclassic period (~1000-400 BC), groupings of permanent structures appeared in the archaeological record, with subsequent increases in size, number, and level of elaboration moving into the Late Preclassic (Buttles 2002;

Eaton 1982). The Late Preclassic period (400 BC-250 AD) at Colha was characterized by growing complexity in terms of the size and organization of both the site itself and the population living at Colha (Eaton 1982; King 2000; Shafer and Hester 1983). Evidence for long distance trade first appeared during this period of rapid expansion, and Colha became the primary lithic production center in northern Belize during the Late Preclassic (Barrett et al. 2011; Brown et al. 2004; Eaton 1982; Hester and Shafer 1994; Shafer and Hester 1983, 1991).

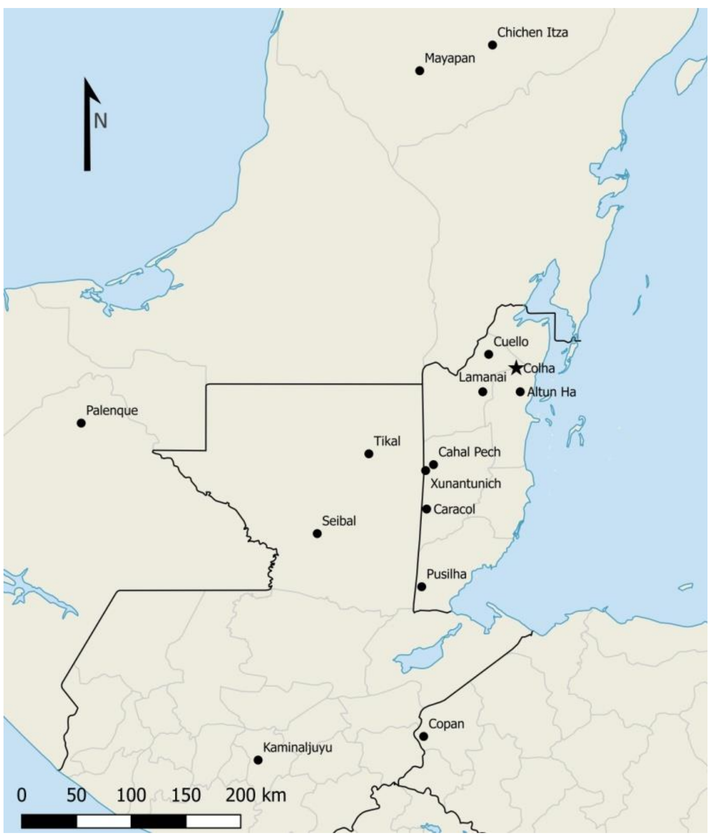

Figure 5-1. Regional map of Colha (starred) in the Maya area

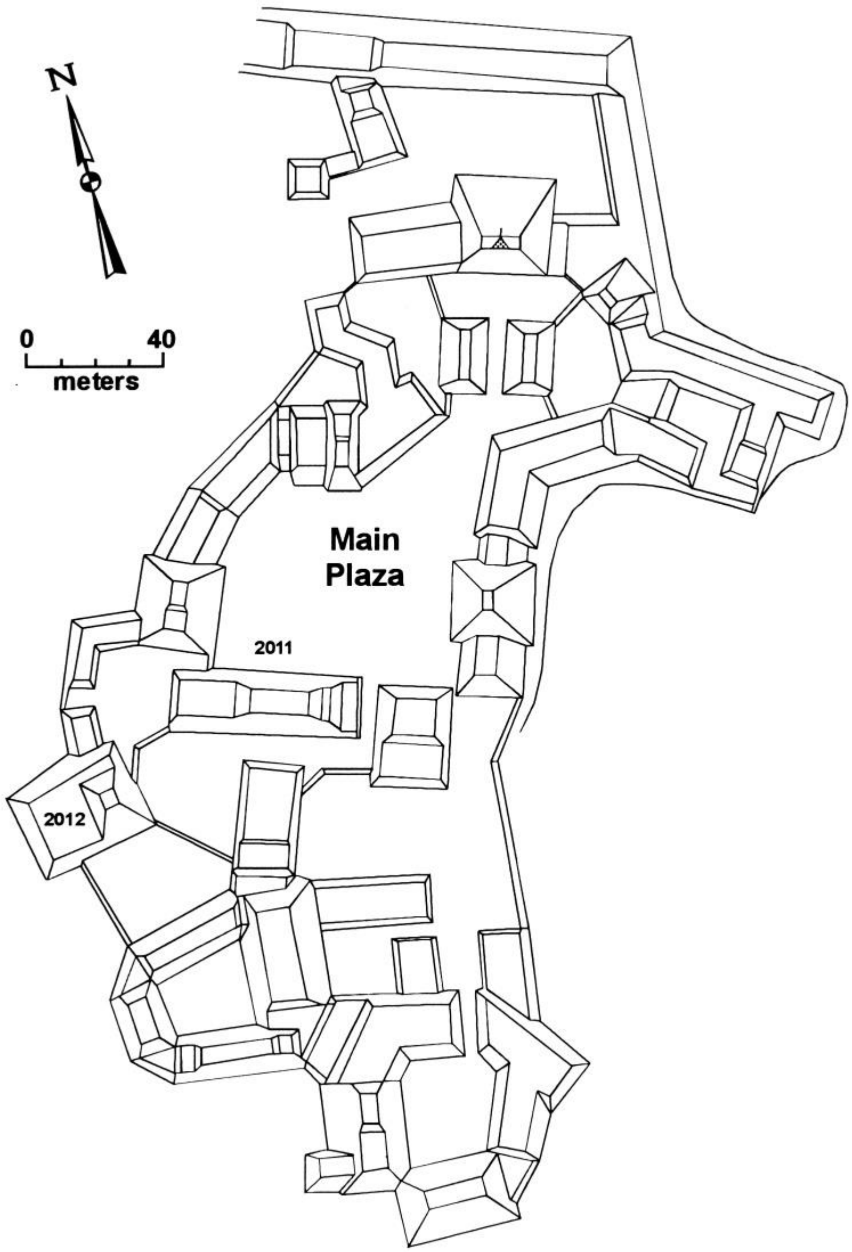

Figure 5-2. Map of Colha's site core. Operations identified by number

The trends that began at Colha during the Late Preclassic persist and continue to expand throughout the Classic period (AD 250-800), with the apex of settlement expansion occurring during the Late to Terminal Classic periods (King 2000). The Terminal Classic at Colha is characterized by growing evidence of unrest and collapse, ultimately culminating in the destruction and abandonment of the site at the end of this period (Barrett and Scherer 2005; Barrett et al. 2011; Hester 1985). Following this collapse, there was a hiatus in occupation of approximately 100 years (Eaton 1982; Hester et al. 1983a; Valdez 1987). The subsequent Early Postclassic archaeological remains at Colha were culturally distinct from any prior occupation, indicating a lack of cultural continuity between these two time periods (Barrett et al. 2011; Eaton 1980; Shafer and Hester 1983; Valdez 1987).

Colha is primarily known for the extensive lithic production and specialization that occurred throughout the site's occupation. The site is located atop Eocene and Miocene limestone deposits that contain chert, which was heavily exploited by inhabitants throughout the site's occupation, ultimately resulting in Colha becoming the primary lithic production center in northern Belize (Hester and Shafer 1984; Shafer and Hester 1983). Colha stone tools have been found throughout the Maya Lowlands, indicating that Colha was actively participating in regional trade via the network of estuaries and rivers throughout Belize (Buttles 2002; Shafer and Hester 1983). The archaeological evidence additionally suggests that Colha's elites controlled chert resources for the region (Buttles 2002; Hester and Shafer 1994; Shafer 1994; Shafer and Hester 1983).

5.3. The Human Skeletal Remains of the Colha Skull Pit

One of the most remarkable features found at Colha is the Skull Pit. The 30 skulls of this feature were discovered in a pit that had been dug into the second terrace of a large Late Classic elite residential structure on the southern side of the site's main plaza (Figure 5-2; Hester et al. 1983b; Massey 1989; Steele et al. 1980). A superstructure originally stood where the Skull Pit was located, but the structure was destroyed shortly after the deposition of skulls in the pit, as evidenced by the presence of heat-fracturing on the stones of the adjacent terrace wall and materials covering the pit (Eaton 1980).

Following the destruction of this superstructure, no reconstruction was attempted and the site itself was abandoned soon thereafter. The Skull Pit represents a single interment episode, and there were no subsequent attempts to reenter the pit prior to modern archaeological investigations (Figure 5-3; Massey 1989). Terminal Classic ceramics were found within the Skull Pit feature, and subsequent radiocarbon dating of bone provided dates of 1231 ± 60 BP (GX-18788; bone) and 1291 ± 50 BP (GX-18787; bone) (Thomas R. Hester, personal communication 2017).

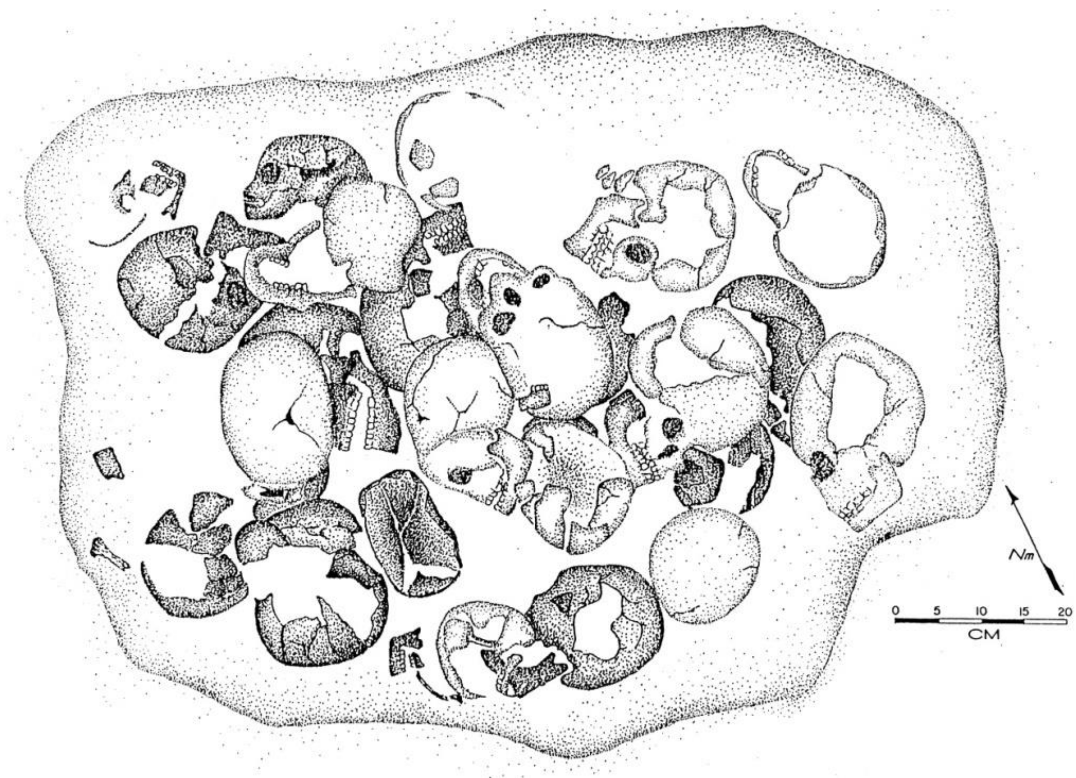

Figure 5-3. Line drawing of the Colha Skull Pit courtesy of the Colha Project. Drawing prepared for the project by Kathy Roemer (Massey 1989)

Thirty individuals were identified in the Skull Pit, represented only by cranial remains and associated cervical vertebrae of the neck (Massey 1989; Massey and Steele 1997). The presence and positioning of the cervical vertebrae and mandibles in articulation suggest that the skulls were deposited with at least some soft tissue intact, indicating that there was little time between the beheading event and the placement of the skulls in the pit. Massey (1989) reported thirty individuals, including 8 adult males, 10 adult females, 2 adults of indeterminate sex, and 10 subadults under the age of 8, which I confirmed during skeletal analysis in 2016 (Massey 1989; Massey and Steele 1997). The skulls were deposited within the pit in two rough layers, with younger individuals placed in the lower layer and older adults towards the top of the feature (Massey 1989; Massey and Steele 1997).

The abundance of cut marks on remains from the Skull Pit is unusual within ancient Maya mortuary patterns. Massey (1989) reports 20 individuals with evident cut marks. After Massey's (1989) study, some skulls were left in matrix with preservative adhering to the bone. Upon further cleaning, I have documented at least one perimortem cut mark on almost every Skull Pit individual with observable cortical bone. The cut marks are most commonly located around the orbits, nasal aperture, mandible, and external cranial vault. In addition, there are also cut marks on two cervical vertebrae. Broadly, these cut marks can be categorized into two groups: cut marks associated with the decapitation event and cut marks associated with facial flaying (Massey 1989; Massey and Steele 1997). In addition, three skulls show evidence of pre-depositional burning, with one (Skull BB) having been burned extensively prior to deposition. Steele et al. (1980) noted that the burning likely did not occur in the Skull Pit as there was no other evidence of burning within the feature itself. Instead, the burning likely occurred elsewhere and the skulls were subsequently placed in the pit (Steele et al. 1980).

Several of the skulls additionally exhibit evidence of antemortem pathological conditions, including those associated with developmental anomalies, nutritional deficiencies, infection, and joint degeneration. Aside from the evidence for perimortem decapitation and facial flaying, there is no evidence of antemortem trauma on any of the skulls. Furthermore, dental defects were present in the Skull Pit skeletal assemblage, including caries, antemortem tooth loss, periodontitis, calculus, and linear enamel hypoplasias. There is also substantial evidence of cultural modification of the Skull Pit remains. Eight skulls exhibit definite antemortem cranial modification, which occurred in two forms: tabular erect and tabular oblique. Several types of dental modification were also documented on the teeth of ten adults. Aside from dental modification, which is only found on adult remains, there are no sex- or age-based differenced in cultural modifications, pathology, or trauma patterns within the Skull Pit skeletal sample.

5.4. Previous Interpretations of the Skull Pit

Several theories have been proposed to account for the identities of the individuals in the Skull Pit, as well as the social and cultural significance of the deposit itself. Massey (1989) performed an osteological analysis of the Skull Pit remains and explored several possible identities for these individuals, including defeated warriors or defenders of Colha, victims of religious sacrifice, or a deposed ruling lineage. Massey (1989) interpreted the prevalence of cultural modifications to the cranium and dentition as indicating the elite status of the Skull Pit individuals (Massey 1989), although such conclusions are very problematic in light of more recent bioarchaeological data that suggest bodily modification was not exclusive to any particular social group among the Maya (e.g., Palommo et al. 2017; Barrett and Scherer 2005).

Massey (1989) further noted that the demographic composition of the pit, which she argued approximates that of a nuclear family, might be symbolic; however, there could also be unrelated individuals in this pit, such as slaves, servants, or others. Furthermore, Massey (1989) suggests the age stratification of the skulls in the pit is significant and could be related to ritual sacrifice, including that of the ruling family (Massey 1989; Massey and Steele 1997). The cut marks that indicate decapitation and skinning are further consistent with ritual sacrifice. Conversely, the other archaeological evidence from Colha, including the subsequent destruction and abandonment of the site center soon after the formation of the Skull Pit, suggests a violent end to the ruling elite. Massey (1989) concluded that ritual sacrifice or an internal revolt and overthrow of the elite are the most likely interpretations of the Skull Pit, but ultimately suggested that there is insufficient evidence to distinguish between any of the proposed scenarios (Massey 1989; Massey and Steele 1997).

In addition, many other researchers argue that the Skull Pit represents the overthrow of the ruling class by the local population of Colha (Buttles and Valdez 2016; Valdez 1987; Valdez and Adams 1982). Proponents of this theory argue for an ecological basis for civil unrest at Colha that is related to the broader collapse of many Lowland Maya sites around 800 AD (Buttles and Valdez 2016). The authors suggest that by the Terminal Classic period, the population of Colha experienced a series of droughts that forced people to exploit increasingly marginal areas for food production. In conjunction with an increasingly large population, this led to class conflict and an internal uprising to violently depose the local rulers of Colha, who were decapitated and deposited in the Skull Pit with their children (Buttles and Valdez 2016, 197-198).

Mock (1994, 1998) also reviewed the archaeological and osteological evidence and suggested that the Skull Pit represents a politically motivated termination ritual that involved human sacrifice of the local elite. Mock (1994, 1998) noted that the location of the Skull Pit within a large pyramidal structure does not suggest that it was a hasty action. Furthermore, the placement of the skulls was accompanied by violent behavior, including the destruction of the building above the pit, as well as burning the area and smashing ceramics. Mock (1994, 1998) also argued that the facial flaying documented in the Skull Pit is similar to the defacement of monumental art and masks across Mesoamerica during termination rituals. Thus, Mock (1994, 1998) concluded that the skulls were placed in a liminal space in an elite structure accompanied by violent behavior designed to ritually terminate habitation of the site.

Alternatively, Barrett and Scherer (2005) argued that the Skull Pit is the result of external warfare that ended with the execution of the site's elite and abandonment of the site itself. The authors noted several sources of archaeological evidence for warfare with an unknown external assailant at Colha. Settlement patterns at Colha shifted dramatically leading up to the Terminal Classic period, with inhabitants moving to the site's central area, which was more defensible than a dispersed population. In addition, although stone weaponry produced at Colha was not uncommon prior to this time period, during the Terminal Classic period, the proportion of weapons being produced increased significantly (Barrett and Scherer 2005). Finally, the authors described a nearby Terminal Classic commingled burial of disarticulated, adult, largely male individuals and related them to the violent events that led to the formation of the Skull Pit. Barrett and Scherer (2005) ultimately suggested that the male individuals in this mortuary context were possibly warriors who were intentionally destroyed during warfare along with the individuals in the Skull Pit.

5.5. Analytic Methods

5.5.1. Sampling Procedures

First and third permanent molars were sampled for isotopic analysis to assess the geographic locations of the Skull Pit individuals during two different time periods in human development. First molar crowns are formed from around birth to 2.5 years of age, while permanent third molars reflect later childhood and form from around 8-12 years of age (Reid and Dean 2006). Of the skulls reported by Massey (1989), Skulls H, V, and AA were not available for analysis; all remaining skulls could be assessed for isotopic sampling. Twenty individuals in the Skull Pit had at least one permanent first molar preserved, and ten individuals had at least one permanent third molar preserved. As a result, some younger individuals are only represented in this analysis by the first molar, thereby preventing the comparison of geographic locations between different developmental time periods in the lives of these individuals (see Table 5-1). Mandibular and maxillary teeth have similar ages of enamel development, so the isotopic composition of upper and lower molars in the same position should yield comparable isotope ratios (Dolphin et al. 2005). While many isotopic analyses of mobility use both dental enamel and bone to assess migratory patterns during the life of an individual, this project only sampled dental enamel because it is more resistant to diagenesis (Budd et al. 2000) and only cranial bone is available, which is not ideal for isotopic analysis. Prior to sampling the teeth, all dental remains were systematically photographed and assessed following established dental data collection protocols (Buikstra and Ubelaker 1994).

A Horico diamond dental drill bit was used to remove 10-15 mg samples of tooth enamel for both heavy and light isotopic analysis. Bulk samples were taken as longitudinal cross sections of the entire height of the crown. Thus, the resulting isotopic ratio from each cross section represents an average value for the developmental time period for that tooth. The isotopic composition of different crown surfaces does not vary significantly, so sections were taken from crown surfaces least affected by pathology and surface contaminants (Dolphin et al. 2005). Enamel samples were further mechanically cleaned by abrasion to remove the outer layers of enamel that are most susceptible to diagenesis and any other organic materials adhered to the enamel surface.

Table 5-1. Carbon, oxygen, and strontium isotope data with the bioarchaeological data for the Colha Skull Pit individuals sampled in this analysis

Skull	Age	Sex	Cranial Mod	Dental Mod	Cut Marks	Burn	Tooth	$^{87}Sr/^{86}Sr$	$\delta^{18}O$ (vPDB)	$\delta^{13}C$ (vPDB)
B	A	F	Y	Y	Y		LRM1	0.70830	-2.2	-6.9
C	SA	-			Y		LLM1	0.70822	-1.5	-5.6
D	SA	-			Y		LLM1	0.70811	-2.0	-7.6
E	A	M			Y		LLM1	0.70810	-0.7	-8.0
F	SA	-			Y		URM1	0.70815	-1.1	-6.4
G	A	M		Y	Y		LRM1	0.70812	-1.7	-6.1
I	SA	-			Y		LLM1	0.70826	-0.6	-7.6
K	A	M	Y	Y	Y		LRM1	0.70818	-0.8	-5.5
P	A	M	Y		Y		LRM1	0.70865	-1.5	-5.9
Q	A	F		Y	Y		URM1	0.70821	-2.3	-6.8
R	A	F					LLM1	0.70819	-2.4	-7.6
T	A	M	Y				LLM1	0.70814	-0.7	-7.1
W	SA	-	Y		Y		LLM1	0.70818	-4.1	-2.4
X	A	F			Y	Y	ULM1	0.70784	-2.5	-7.5
Y	SA	-			Y		LRM1	0.70828	-1.4	-6.8
Z	SA	-			Y		LLM1	0.70816	-2.3	-6.6
BB	A	F			?	Y	LLM1	0.70862	-2.8	-7.5
CC	SA	-			Y		LLM1	0.70836	-2.6	-8.2
II	A	M		Y	Y		LLM1	0.70813	-1.6	-6.6
B	A	F	Y	Y	Y		LRM3	0.70829	-1.3	-6.9
E	A	M			Y		LRM3	0.70809	-1.3	-9.3
K	A	M	Y	Y	Y		LRM3	0.70816	-1.4	-6.4
P	A	M	Y		Y		LRM3	0.70861	0.0	-7.8
Q	A	F			Y		URM3	0.70822	-2.6	-6.2
R	A	F					URM3	0.70817	-1.7	-10.1
T	A	M	Y				LLM3	0.70817	-1.5	-5.1
BB	A	F			?	Y	LLM3	0.70872	-3.4	-7.5
II	A	M			Y		LLM3	0.70813	-1.5	-8.6

5.5.2. Isotopic Analysis

Enamel samples for stable oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) isotope analysis of enamel carbonate were prepared for mass spectrometry following previously used methodology (Price *et al.* 2010). Enamel samples were first rinsed with 1 ml of 0.25M HCl for one minute, immediately followed by 3x rinses of deionized, filtered water. Once dry, enamel samples were ground with an agate mortar and pestle and rinsed with deionized, filtered water. Organics were subsequently removed by soaking the ground enamel samples in a 1.5% sodium hypochlorite solution for 48 hours. Samples were then centrifuged, rinsed 3x with deionized, filtered water, and dried. Finally, ground enamel samples underwent a series of diagenetic rinses in alternating 1 ml of 1M acetic acid solution and deionized, filtered water. Treated enamel samples were reacted with H_3PO_4 in a Kiel IV carbonate device coupled to a 10-kV Thermo Scientific MAT 253 isotope ratio mass spectrometer at the Texas A&M University Stable Isotope Geosciences Facility.

Enamel samples for strontium isotope analysis were first rinsed with distilled water and sonicated for 20 minutes in 1M acetic acid optima. Samples were then rinsed again with distilled water and sonicated following the same protocol. Following sonication, the enamel samples were rinsed three times with distilled water and dissolved in 500 µL of 7N HNO_3 overnight. Dissolved samples were subsequently transferred into Savillex beakers and evaporated. Once dried, samples were redissolved in 500 µL of 3N HNO_3. Strontium was then separated from the sample matrix to reduce isobaric interference using SrSpec resin. Samples were evaporated and re-dissolved in 1µL of 0.32M H_3PO_4, then loaded onto degassed rhenium (Re) filaments. Samples were run on a Thermo Scientific Triton thermal ionization mass spectrometer (TIMS) at the Texas A&M University R. Ken Williams Radiogenic Isotope Geosciences Laboratory. Long-term analyses on this machine over the past three years have yielded an SRM 987 average value of 0.7102393 ± 15.2 ppm.

The Colha Skull Pit isotope data were subsequently compared to the local Colha range established in the previous chapter in order to identify possible nonlocal individuals in the Skull Pit sample. The previously established $^{87}Sr/^{86}Sr$ range for Colha is 0.70804-0.70842, while the $\delta^{18}O$ range is -3.6‰ to -0.85‰.

5.6. Results

Isotopic data and descriptive statistics for $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C$ data of both first and third molars are presented in Table 5-1 and Table 5-2. First molar samples from the Colha Skull Pit (n= 19) exhibit an overall $^{87}Sr/^{86}Sr$ range of 0.70784-0.70865, with a mean value of 0.70822 and median value of 0.70818 (Table 5-2). Third molars from the Skull Pit (n= 9) have an overall strontium range of 0.70809-0.70872, with a mean value of 0.70828 and median value of 0.70817.

Table 5-2. Complete descriptive statistics for the Skull Pit strontium, oxygen, and carbon isotope data by tooth type

$^{87}Sr/^{86}Sr$		$\delta^{18}O$		$\delta^{13}C$	
First Molars		First Molars		First Molars	
Mean	0.70822	Mean	-1.8	Mean	-6.7
Median	0.70818	Median	-1.7	Median	-6.8
Variance	3.245E-08	Variance	0.8	Variance	1.7
Std. Deviation	0.00018	Std. Deviation	0.9	Std. Deviation	1.3
Minimum	0.70784	Minimum	-4.1	Minimum	-8.2
Maximum	0.70865	Maximum	-0.6	Maximum	-2.4
Range	0.00081	Range	3.5	Range	5.8
Interquartile Range	0.00015	Interquartile Range	1.3	Interquartile Range	1.5
Third Molars		Third Molars		Third Molars	
Mean	0.70828	Mean	-1.6	Mean	-7.5
Median	0.70817	Median	-1.5	Median	-7.5
Variance	5.040E-08	Variance	0.9	Variance	2.5
Std. Deviation	0.00022	Std. Deviation	0.9	Std. Deviation	1.6
Minimum	0.70809	Minimum	-3.4	Minimum	-10.1
Maximum	0.70872	Maximum	0.0	Maximum	-5.1
Range	0.00063	Range	3.4	Range	5.0
Interquartile Range	0.00031	Interquartile Range	0.9	Interquartile Range	2.6

When compared to the local Colha $^{87}Sr/^{86}Sr$ range of 0.70804-0.70842 obtained in chapter 4, several outliers are apparent (Figure 5-4). The first and third molars for both Skull P and Skull BB are outside the local range, while only the first molar of Skull X indicates a likely nonlocal origin. A paired t-test indicates there are no statistically significant differences in the mean $^{87}Sr/^{86}Sr$ between M1s and M3s for those 9 individuals whose first and third molars were sampled ($t = -0.806$, $df = 8$, $p = 0.444$). Thus, the small differences (≤ 0.0001) in $^{87}Sr/^{86}Sr$ between tooth types could indicate little movement during childhood or movement between geologically similar locations.

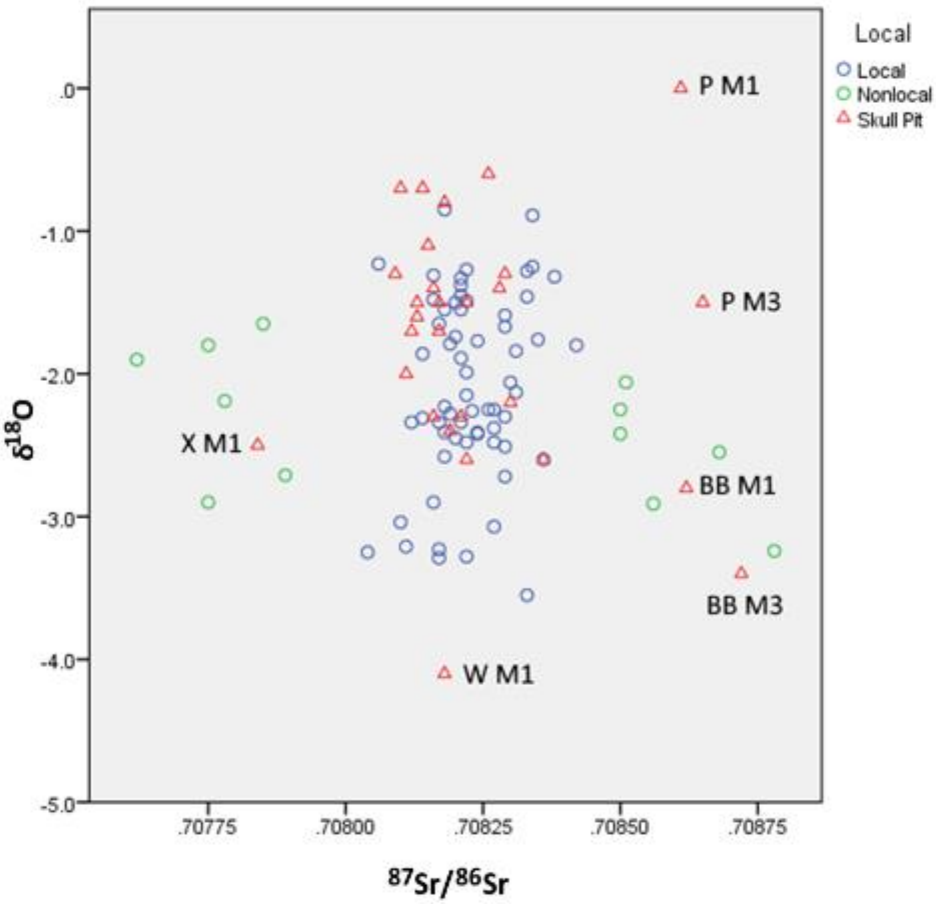

Figure 5-4. Colha Skull Pit strontium and oxygen isotope data compared to isotope samples from the rest of the site. The possible nonlocal individuals are identified by skull and tooth type

Oxygen isotope ratios for the Colha Skull Pit sample range from -4.1‰ to -0.6‰ with a mean value of -1.8‰ for first molars, and -3.4‰ to 0.0‰ with a mean value of -1.6‰ for third molars. When examining the $\delta^{18}O$ first molar data compared the broader Colha isotopic data, a single outlier of -4.13‰ (the first molar of Skull W) is apparent (Figure 5-5). In addition, two outliers are evident for third molars, representing the teeth of Skulls P and BB, which are both also strontium outliers as well, lending further support to the identification of these individuals as nonlocal in origin. Skull X, which has the lowest $^{87}Sr/^{86}Sr$ value in the Skull Pit sample and groups with other nonlocal strontium isotope signatures at Colha, has an oxygen isotope value within local range. However, the much lower strontium value suggests that this individual is nonlocal. A paired t-test comparing the $\delta^{18}O$ of first and third molars indicates there are no statistically significant differences between M1s and M3s (t = -0.141, df = 8, p = 0.891).

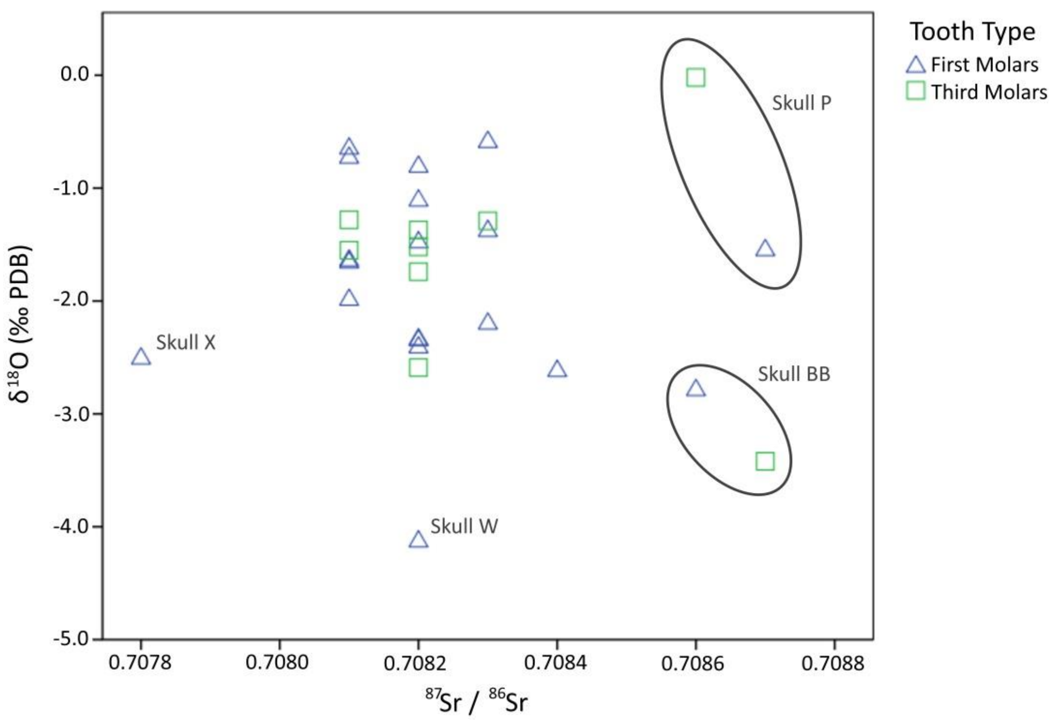

Figure 5-5. Strontium and oxygen isotope values for the Colha Skull Pit by tooth type. Outliers identified by skull

With the exception of Skull P, most individuals for whom two teeth were sampled exhibit differences of less than a permil between first and third molars, a difference that is consistent with the offset expected due to nursing (Wright and Schwarcz 1998), suggesting little movement during childhood. For Skull P, the differences between first and third molars likely indicate movement between two regions outside of Colha during childhood. This is because the third molar is higher in $\delta^{18}O$ than the first molar for Skull P, which is the opposite of what is expected due to nursing.

The carbon isotope ratios range from -8.2‰ to -2.4‰ with a mean value of -6.7‰ for first molars, and -10.1‰ to -5.1‰ with a mean value of -7.5‰ for third molars. Most of the Skull Pit individuals exhibit a diet consistent with the eastern Maya lowlands of modern Belize and the Preclassic Colha sample of lighter $\delta^{13}C$ values. However, one $\delta^{13}C$ outlier is apparent in Figure 5-6: -2.4‰ (the first molar of Skull W). Skull W is a $\delta^{18}O$ outlier and the difference in $\delta^{13}C$ for this individual is therefore likely a reflection of regional dietary differences in the Maya area, with the dietary signal of Skull W being more consistent with a dietary pattern found in the Petén region. For those individuals previously identified as migrants based on oxygen and strontium isotope values (Skulls P, BB, and X), their $\delta^{13}C$ values indicate a diet that is consistent with an eastern Maya lowlands of reduced reliance on maize compared to the central lowlands. Examining the remaining adults for whom first and third molars were sampled, there is up to 2‰ difference between first and third molars, although a paired t-test does not indicate any significant differences between the tooth types ($t = 1.402$, $df = 8$, $p = 0.199$). There is no patterning in these shifts from lighter to heavier values or the reverse, indicating some individuality in dietary shifts during the lives of these individuals.

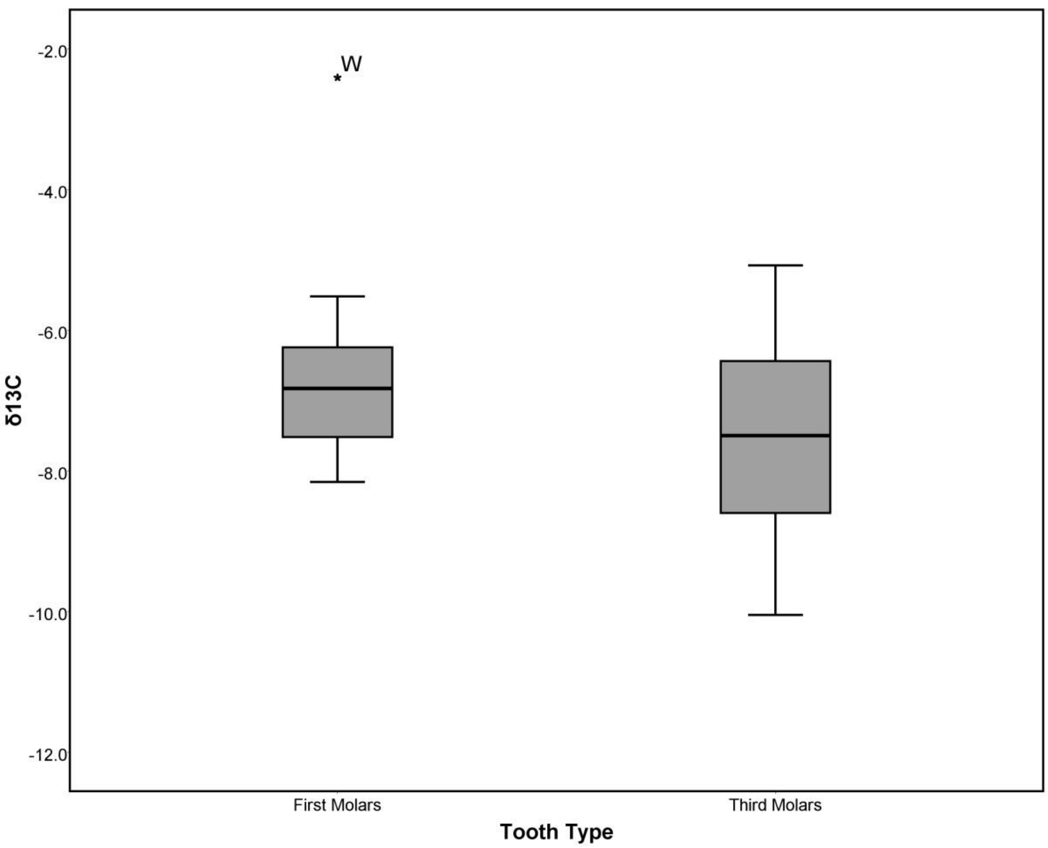

Figure 5-6. Boxplots of carbon isotope data from the Colha Skull Pit separated by tooth type. Statistical outliers are identified by skull

There are no significant differences in strontium isotopes (t= -0.633, df= 68, p= 0.529), oxygen isotopes (t= 1.251, df= 68, p= 0.215), or the proportion of nonlocal individuals in the Skull Pit compared to residential burials at Colha (Fisher's exact p= 0.739). However, the stable carbon isotopes indicate a significantly different diet in the Skull Pit compared to residential skeletons, with Skull Pit individuals exhibiting higher carbon isotope values on average ($t= 2.737$, $df= 52.329$, $p= 0.008$).

5.6.1. Mobility Patterns in the Skull Pit

For the Colha Skull Pit sample, strontium isotopes indicate the presence of three likely nonlocal individuals (Skull P, BB, and X), representing 15.8% of the individuals analyzed from this feature. Skull P and Skull BB additionally have outlier $\delta^{18}O$ values at Colha. Figure 5-7 shows $\delta^{18}O$ plotted against $^{87}Sr/^{86}Sr$ for the Colha Skull Pit, with likely nonlocal individuals identified by skull. The $\delta^{18}O$ data further indicate the presence of a fourth nonlocal individual (Skull W) in the Colha Skull Pit, which additionally exhibits carbon isotopic values more consistent with a dietary signature seen in the central Petén. Therefore, 21% of individuals sampled for isotopic analysis in the Skull Pit originated somewhere outside Colha.

When considering these four nonlocal individuals, there is significant variability in terms of demographic, cultural, or health-related variables. Skull P is an adult male, Skulls BB and X are adult females, and Skull W is a subadult of 3-5 years of age. Two of the skulls (BB and X) exhibit evidence of burning, but the remaining two do not. Three of the individuals exhibit cut marks, but it is impossible to definitively assess for the presence of cut marks on Skull BB due to the severity of the burning. There is no evidence of any dental modification on any of these individuals, but two of these individuals (Skulls P and W) exhibit cranial modification. With regard to health-related characteristics, there is evidence of dental pathology on all four individuals in the form of caries, calculus, and linear enamel hypoplasias, which are typical for archaeological Maya populations and found throughout the Skull Pit sample. The only unusual pathology present on any of these individuals is the fused deciduous mandibular incisors on Skull W, a genetically based non-metric trait that is not present on any other cranium in the Skull Pit.

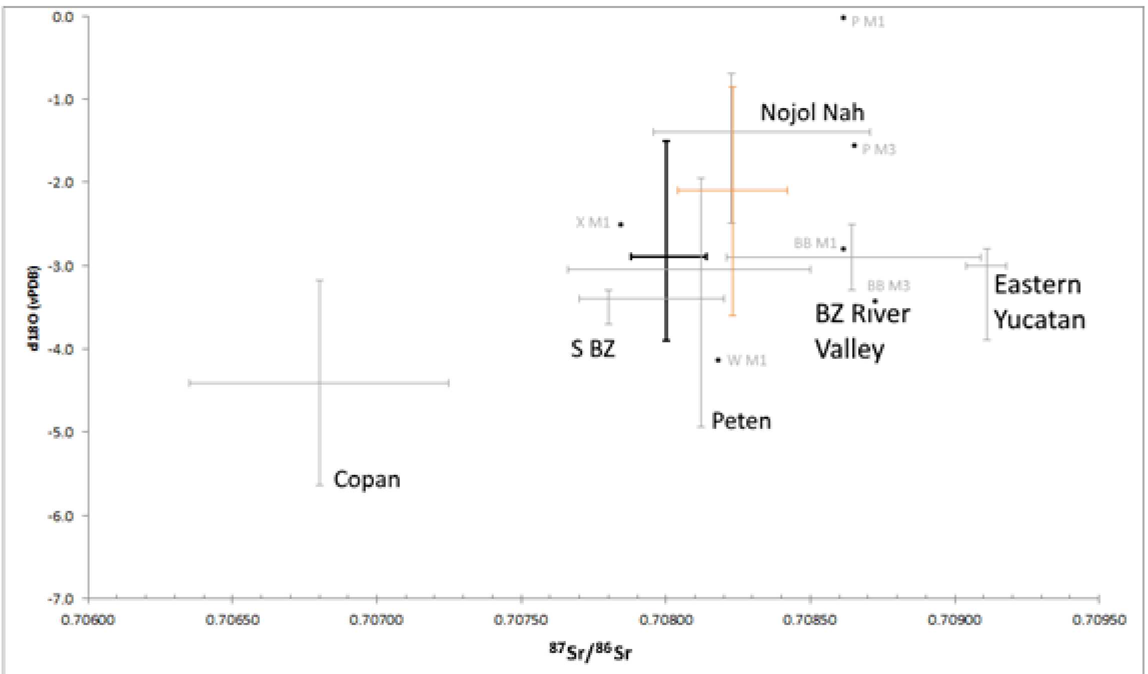

Figure 5-7. Plot of Colha Skull Pit strontium and oxygen isotope data compared to other sites in the Maya area. Colha local range identified in orange, while Cuello is in bold. Nonlocal individuals in the Skull Pit are identified by skull and tooth type

Furthermore, these individuals seem to have originated from different locations in the Maya region. In order to reconstruct possible homelands for these nonlocal individuals, the isotopic data in the Skull Pit was compared to published data on $\delta^{18}O$ and $^{87}Sr/^{86}Sr$

from elsewhere in Mesoamerica (Das Neves 2007; Freiwald 2011; Ortega-Nuñoz et al. 2019; Price et al. 2010; Somerville et al. 2016; Trask et al. 2012; White et al. 2007; Wright 2005a, 2005b, 2012; Wright et al.). These data are compiled in Figure 5-7, which shows $\delta^{18}O$ plotted against $^{87}Sr/^{86}Sr$ for sites throughout the region.

It must be noted that for both $\delta^{18}O$ and $^{87}Sr/^{86}Sr$, there is significant overlap between Colha and other sites across the Lowlands, including large regional centers such as Tikal in the Petén region of Guatemala. This overlap hinders definitive identification of mobility patterns at Colha, although many locations can be excluded for the origins of these nonlocal individuals, including distant sites like Copan, central Mexico, the eastern coast of the Yucatan, and Kaminaljuyu. Despite these limitations, the data from the Colha Skull Pit indicate that the four likely nonlocal individuals originated from at least three distinct areas. Skulls X and W exhibit oxygen and strontium isotope values consistent with those of the Petén region of Guatemala. The $\delta^{13}C$ value for the subadult Skull W additionally falls in line with dietary values from the Petén as well. Skull X could alternatively originate from the nearby northern Belizean site of Cuello based on its oxygen and strontium isotope values. Skull BB likely originates from the nearby Belize River Valley. The first molar of Skull P exhibits oxygen and strontium isotope values that do not directly overlap with any site yet analyzed, although the strontium and oxygen isotope values are geologically consistent with an origin in the eastern Maya lowlands where water was obtained from standing bodies, such as lakes or *aguadas*. The third molar of Skull P is consistent with an origin around Nojol Nah (Das Neves 2007).

Given the variability in demographic characteristics and origins of these four individuals, it is challenging to infer how they came to live and die at Colha. Male and female exogamy patterns could account for the three adults in the Skull Pit. There is epigraphic and ethnohistoric evidence for elite intermarriage as a means to construct and maintain political alliances between sites (Schele and Mathews 1991). Previous isotopic work has similarly suggested such practices in the Maya region (Wright 2012; Somerville et al. 2016). Thus, Skulls P, BB, and X could have arrived at Colha due to exogamous practices among the Maya elite to establish relationships between localities in the Maya area. However, Skull W, a subadult likely from the Petén region, does not easily fit into this narrative. While both Skull X and Skull W likely originated in the Petén region, a genetic relationship between the two individuals cannot be determined on the basis of skeletal evidence alone. Overall, the majority of individuals in the Skull Pit originated at Colha or the immediately surrounding areas.

5.6.2. The Skull Pit Reconsidered?

These isotopic data shed some light on the origins of the Skull Pit individuals, as well life at Colha during the Terminal Classic period. The isotopic data indicate that most individuals in the Skull Pit spent their childhoods at Colha. The presence of the four nonlocal individuals in the Skull Pit sample further suggest that the population at Colha was not isolated from others in the Maya area during the Terminal Classic period. The local community at Colha was actively participating in regional interactions with sites elsewhere in modern day Belize and the Petén. The isotopic data shows considerable evidence for mobility during this time period of both individuals and perhaps even families given the nonlocal subadult (Skull W) in the Skull Pit.

With regard to previous interpretations of the Skull Pit, a number of scenarios for the formation of this deposit and the subsequent abandonment of the site have been proposed, including prisoners of war, victims of religious sacrifice, or a deposed ruling lineage via internal insurrection or external warfare. Many of these scenarios are not mutually exclusive and are therefore difficult to tease apart (for example, war captives and the local elite could have been ritually sacrificed).

In the years since the Skull Pit was initially analyzed, there has been a wealth of research on complicated mortuary deposits in the Maya area that combines traditional archaeological data sources with detailed analysis of the biocultural aspects of death and burial (e.g., Cucina and Tiesler 2008; Tiesler 2008; Tiesler et al. 2017; Geller 2005; Novotny 2015). Drawing on this rich literature, it is possible to revisit the previous interpretations of the Skull Pit while drawing on the new information about the geographic origins of these individuals.

Although not a favored hypothesis, Massey (1989) reviewed the notion that these individuals reflect foreign prisoners of war. However, it is clear based on the isotopic data that the majority of individuals in the Skull Pit were local in origin. It is therefore unlikely that the Skull Pit represents the execution of external prisoners of warfare, unless those prisoners originated from areas immediately surrounding or geologically very similar to Colha.

With regard to Massey's (1989) argument for religious sacrifice, archaeological and ethnohistoric evidence suggests a wide variety of sacrificial practices (Berryman 2007; Geller 2011; Price et al. 2007; Tiesler 2007; Tiesler and Cucina 2006; Tozzer 1941). Sacrificed victims originated from all social and demographic groups in society, so the varied demographic distribution of the Skull Pit would fit within a sacrifice scenario (Tiesler and Cucina 2006). The location of the Skull Pit within an elite structure at the site's core is further consistent with a conclusion of state-sanctioned elite ritual sacrifice. Ethnohistoric records also indicate that most victims of ritual human sacrifice pulled from the local population were peripheral members of society, such as orphans, slaves, and criminals (Tiesler and Cucina 2006; Tozzer 1941). This brings up important questions regarding the social status of the individuals in the Skull Pit during life.

Previous researchers inferred that the Colha Skull Pit individuals represent an elite group based on several archaeological and bioarchaeological factors. Massey (1989) suggests that the bodily modification found in the Skull Pit indicates an elite status, although this conclusion is problematic in light of more recent findings that cranial and dental modification was not exclusive to any specific demographic or social grouping (see Tiesler et al. 2017). However, both dental and cranial modification are much more prevalent in the Skull Pit compared to the rest of the Colha skeletal assemblage, which includes only 14 other teeth exhibiting dental modification. This represents 2.9% of teeth in the rest of the assemblage and a minimum of eight individuals, which is less than that found in the Skull Pit itself (17 teeth representing 8% of the total teeth and at least eight individuals). This finding lends credence to the suggestion that the individuals in the Skull Pit were distinct from the rest of the population in some way. Generally, elite individuals are also expected to have relatively better health than their contemporaries due to differential access to resources. Similarly, while the high degree of fragmentation of the Colha skeletal remains precludes systematic comparisons of pathological skeletal conditions, the picture exhibited by the pathologies present in the Skull Pit (Table 1) is not anomalous for the population as a whole. The location of the Skull Pit in a large pyramidal structure in the civic-ceremonial core of Colha, rather than in a surrounding residential structure for example, suggests some kind of preferential mortuary treatment, as does the prevalence of smashed Terminal Classic ceramics (Massey 1989; Buttles and Valdez 2016).

The sum total of this archaeological and biological data is not consistent with a conclusion that the individuals in the Skull Pit were social outsiders, as might be expected from sacrificial victims. The location, unusual prevalence of bodily modification, health, and associated ceramics do not suggest that these people existed on the periphery. Rather, their physical location at the central core of the site likely reflects their social positioning during life as the site's elites. As a result, a conclusion of human sacrifice is less likely than an alternative proposed by Massey (1989) and further explored by Buttles and Valdez (2016) and Barrett and Scherer (2005) that the Skull Pit is the result of conflict or warfare during the Terminal Classic period. Terminal Classic unrest and collapse is widely documented throughout the Lowlands, and previous interpretations of an internal insurrection (Buttles and Valdez 2016; Valdez 1987; Valdez and Adams 1982) and external warfare (Barrett and Scherer 2005) as the causes for the Skull Pit formation are therefore consistent with broader violence patterns in the region. The destruction of the local elite group would also fit either scenario.

5.7. Summary and Conclusions

On the basis of the stable oxygen ($\delta^{18}O$), stable carbon ($\delta^{13}C$), and radiogenic strontium ($^{87}Sr/^{86}Sr$) isotopes, the individuals in the Terminal Classic Skull Pit are predominantly local, with four likely having spent their early childhoods in areas outside the site. During the Terminal Classic period, it is clear that even a peripheral site like Colha was not isolated and was instead engaged in regional interactions, in this case seemingly leading to the destruction of the local elite group and subsequent abandonment of the site.

6. ORAL HEALTH AT CUELLO AND COLHA

6.1. Introduction

The increasing social stratification arising during the Late Preclassic period (1000 BC - 250 AD) ultimately had dramatic effects on the distribution of wealth, power, and resources among Classic period occupations at Cuello and Colha. In order to assess the impact of these sociopolitical shifts on the populations of Cuello and Colha in northern Belize, this study uses linear enamel hypoplasias (LEH) and dental caries. I compare the prevalence of each defect per tooth between time periods at both sites. I also these differences between sexes and mortuary contexts to investigate possible emerging sociopolitical groups.

6.2. Background

Linear enamel hypoplasias are an important nonspecific indicator of childhood health status. Although the exact etiology of these dental defects is unclear, it is generally understood that they reflect physiological stress events that cause a disruption in amelogenesis that results in linear horizontal depressions on the enamel surface. These defects have been utilized as general indicators of overall health and stress experienced by a population throughout the world (Cook and Buikstra 1979; El-Najjar et al. 1978; Goodman and Armelagos 1985; Goodman et al. 1980; Skinner and Goodman 1992; Wright 1997b). Because teeth are formed during childhood and do not remodel during life, LEH specifically provides potential insight into childhood health, nutritional status, and living conditions. As a result, it is therefore possible to assess childhood experiences using adult skeletal remains with preserved dental remains.

LEH has been extensively studied in Maya skeletal populations, usually using macroscopic methods comparable to those employed in the present study. Differences in the prevalence and timing of LEH have been related to various sociocultural aspects of life and death among the Maya. In assessing ecological models for the Classic Maya collapse, Wright (1997b) found no statistically significant differences in LEH prevalence among the anterior teeth in several archaeological populations in the Pasión area of Guatemala. However, LEH differences for several posterior tooth types suggest differences in stress over time, perhaps indicating subtle changes in childcare between time periods. Wright (1990) also assessed enamel hypoplasias and the associated Wilson bands at Lamanai, Belize, and found a statistically significant increase in defects in the Historic occupation, likely due to the changing post-Conquest epidemiological patterns.

At Copan, Storey (1997) assessed subadult frailty and mortality in a specific compound at the site and found that most individuals experienced multiple stress episodes despite their likely higher status. In assessing frailty and morbidity specifically, Storey (1997) noted that the high prevalence of defects suggest the Maya of Copan had difficulty caring for children, and infant mortality was also likely high. Whittington (1992) further assessed enamel defects in lower status individuals from Copan and found that most individuals around the time of the Classic Maya collapse experienced chronic stress, as indicated by a relatively high LEH prevalence in every subpopulation included in the study.

Several studies have also assessed LEH prevalence at Xcambo, Yucatan. Méndez Collí et al. (2009) examined LEH during the Classic period and found evidence for high stress loads experienced despite the fact that the individuals included in the study were likely higher status. In addition, Cucina (2011) evaluated the relationship between LEH and age-at-death and found few significant relationships aside from individuals with unusually high (8+) numbers of LEH.

At Cuello, one of the sites included in the present study, Saul and Saul (1991, 1997) previously assessed LEH presence and absence by individual, where the presence of one LEH in the dentition counted as that individual having a stress event. The authors found that the average age of LEH occurrence likely coincided with weaning, comparable to that observed elsewhere in the region (Saul 1972; Saul and Saul 1997). The authors found that LEH was present in 59% of the individuals in the Preclassic sample (Saul and Saul 1997), with LEH presence fluctuating over time. They further note that mass burial 1 exhibits 64% LEH presence, and mass burial 2 exhibits 100% presence. There also appears to be a sex difference in LEH frequency, with more females exhibiting LEH. The methods used by Saul and Saul (1997) differ from the present study, and these results will be further tested here.

Overall, these studies demonstrate that rather than a homogeneous experience of stress among the Maya across different sites, social contexts, and time periods, there was great diversity in childhood stress throughout the region. The present study will allow for greater understanding of stress experiences during the Preclassic period at Cuello and Colha.

In addition, dental caries are areas of progressive tooth decay on the surface of teeth due to microbial activity (Pindborg 1970). The dental enamel is demineralized, eventually forming a cavity that perforates into the dentine below the enamel crown. Previous research has indicated that there is a relationship between significant changes in subsistence and dental health around the world (Cohen and Armelagos 1984; Larsen et al. 1991; Lukacs 1992, 2008). In particular, agriculture is associated with a higher prevalence of caries than what has been documented among hunter-gatherers (Cook and Buikstra 1979; Goodman and Rose 1990; Lukacs 1992, 2008, 2011). This association has been attributed to malnutrition during dental development and the greater carbohydrate content in agriculturalist diets (Cook and Buikstra 1979; Larsen et al. 1991; Lukacs 2008; Scherer et al. 2007; Temple and Larsen 2007).

In the Maya area, caries rates have been related to nuanced dietary and behavioral shifts over time at sites throughout the region. Whittington (1999) assessed caries and antemortem tooth loss among commoners at Copan during the Classic Maya collapse. Approximately 68.2% of individuals had at least one permanent tooth affected by caries in this sample, and females exhibited more caries than males. At Xcambo, Cucina et al. (2011) found an increase in caries from the Early to Late Classic in both males and females at the site, which the authors related to changes in overall food behavior and lifestyle changes experienced by higher class segments of society. In addition, Cucina and Tiesler (2003) examined dental caries and antemortem tooth loss in the northern Petén region of Mexico. Caries were overall less frequent in elite males than any other demographic or cultural subgroup. Furthermore, while there were sex-based differences in caries in elite contexts, lower status individuals had broadly similar caries rates, indicating sex discrimination in dietary behavior among elites.

At Piedras Negras, Scherer et al. (2007) evaluated dental caries in conjunction with porotic hyperostosis and stable carbon and nitrogen isotopes to assess social and chronological differences in diet over time. Caries were present in 76.8% of individuals included in this sample, which the authors suggest is consistent with a carbohydrate-rich diet. There are minimal differences in caries presence between mortuary contexts or chronological period at this site. Seidemann and McKillop (2007) assessed dental markers of diet in adult teeth from a small Postclassic coastal population at Fighting Conch Mound on modern-day Wild Cane Caye, Belize. At this site, 36.2% of teeth were affected by caries, although poor preservation at the site precluded any comparisons based on demographic or mortuary variables. This rate is lower than that found at many inland sites, further suggesting dietary differences across locations in the Maya area.

At Cuello, Saul and Saul (1997) only briefly discuss caries prevalence due to the largely incomplete dentitions preserved at the site. They note that caries affected at least 25% of the teeth in at least 13 individuals, and the caries rate increased over time. The mass burials had caries rates largely consistent with the overall rate at the site (12%). These observations will further be evaluated in the present study.

6.3. Methods

Linear enamel hypoplasias were scored on all teeth following established observational techniques (Buikstra and Ubelaker 1994). The presence of hypoplasias on the labial surface was macroscopically assessed under natural light, using touch, and with a Dino-lite digital microscope to confirm their presence. The type of defect and severity was recorded following the criteria identified by Buikstra and Ubelaker (1994). To ensure that each individual was only represented once in the analysis, only one antimere was selected to include in the sample. Furthermore, rather than correlating stress events for individuals, which is problematic in contexts with multiple fragmentary individuals, the present study focuses on each individual tooth type as the unit of analysis (Wright 1997b). High-resolution images were also taken using a Dino-lite digital microscope to record hypoplasia locations.

Caries were also scored on all available teeth following Buikstra and Ubelaker (1994). Small pits in the enamel that do not perforate the dentine were not considered in this study. Differential preservation of dental remains makes comparisons on an individual basis extremely difficult. As a result, comparisons were done by individual tooth type and the caries frequency was calculated via the tooth count method (Hillson 1996). While some studies calculate caries rates for all teeth in a sample, a single well-preserved individual with many defects could easily overwhelm small samples. As a result, only one antimere will be considered for this method. Correction factors for caries rates have been proposed in the literature (Lukacs 1995), but are not included in this study due to the high prevalence of fragmentary remains that prevents the positive identification of individual dentitions in many mortuary contexts.

I compared the prevalence of LEH and caries between each site, as well as between time periods using Fisher's exact tests due to small sample sizes for most teeth. I also examined differences between the clustered/mass burial contexts other mortuary contexts to investigate emerging sociopolitical groups.

6.4. Sample Description

Overall, 3878 teeth are present in the skeletal collections of Cuello (n= 2317) and Colha (n= 1561), and individuals are represented from all mortuary contexts and time periods at each site. Of these, 3480 are permanent teeth. In order to ensure that each individual is only represented once in this sample (to prevent against the overrepresentation of potentially atypical individuals in the sample), the right antimere was selected because there are more right permanent teeth (n= 1742) than left (n= 1738), although the difference between the two is small.

6.5. Results

LEH prevalence does not significantly differ between Cuello and Colha for any maxillary tooth type or most mandibular teeth (Table 6-1). LEH presence is significantly different for the mandibular central incisor (Fisher's p= 0.018) and the mandibular first molar (Fisher's p= 0.009), but no other tooth type exhibits a significant difference. This likely reflects some differences in early childhood stress events between the two sites, with Colha subadults experiencing more stress events compared to people who grew up at Cuello.

With regard to the caries comparisons between the two sites, there are minimal differences in caries prevalence between Cuello and Colha (Table 6-1). Only the mandibular first molar exhibits a significant difference (Fisher's p=.038), with Colha molars exhibiting more caries. This difference is likely due to random chance rather than any biological or diet-related process due to the lack of any other tooth types exhibiting a significant difference in caries prevalence.

Table 6-1. LEH and caries comparison by site

		Colha		Cuello		Fisher's
		LEH Present	LEH Absent	LEH Present	LEH Absent	Exact *p*
MAX	I1	20	18	12	24	0.107
	I2	20	15	21	15	1
	C	32	14	27	13	1
	P3	8	29	5	33	0.375
	P4	6	31	5	36	0.748
	M1	7	26	4	27	0.512
	M2	8	16	11	26	0.784
	M3	3	13	4	19	1
MAND	I1	10	15	2	22	**0.018**
	I2	15	24	6	24	0.119
	C	39	14	35	18	0.526
	P3	15	26	11	32	0.347
	P4	8	33	9	41	1
	M1	14	32	4	43	**0.009**
	M2	6	23	7	37	0.756
	M3	4	20	3	22	0.702

		Colha		Cuello		Fisher's
		Caries Present	Caries Absent	Caries Present	Caries Absent	Exact *p*
MAX	I1	1	37	3	33	0.351
	I2	1	34	2	34	1
	C	2	44	2	38	1
	P3	2	35	2	36	1
	P4	6	31	3	38	0.295
	M1	8	25	4	27	0.341
	M2	7	17	7	30	0.37
	M3	7	9	5	18	0.174
MAND	I1	0	25	0	24	-
	I2	0	39	0	30	-
	C	3	50	1	52	0.618
	P3	3	38	4	40	1
	P4	2	39	4	46	0.687
	M1	13	33	5	42	**0.038**
	M2	10	19	7	37	0.091
	M3	8	16	10	15	0.769

The Fisher's exact test results for the sex comparisons at Colha are presented in Table 6-2. At this site, only two tooth types exhibit significant differences in LEH prevalence: the maxillary lateral incisor ($p = 0.05$) and the maxillary second premolar ($p = 0.025$). The lateral incisor indicates males had more LEH compared to females, while the premolar indicates the opposite. These contradictory results could be due to the relatively small sample sizes for each tooth type, an unintended sampling bias, or something perhaps more nuanced in the timing of LEH insult based on sex, with males experiencing more stress earlier (during the formation of the lateral incisor) and females experiencing more stress later (during the later formation time of premolars). There are no significant differences in caries prevalence between the sexes at Colha.

In addition, the results for the sex comparisons at Cuello are presented in Table 6-3. In contrast to the Colha results, neither LEH nor caries significantly differ between males and females at Cuello.

Table 6-2. LEH and caries comparison by sex at Colha

		Males		Females		Fisher's Exact *p*
		LEH Present	LEH Absent	LEH Present	LEH Absent	
MAX	I1	7	6	2	2	1
	I2	8	1	3	5	**0.05**
	C	10	4	6	1	0.624
	P3	2	13	3	3	0.115
	P4	1	13	4	3	**0.025**
	M1	1	7	0	3	1
	M2	4	8	0	1	1
	M3	1	7	0	2	1
MAND	I1	4	16	1	4	1
	I2	3	9	3	4	0.617
	C	14	4	6	3	0.653
	P3	4	9	3	3	0.617
	P4	3	12	1	7	1
	M1	6	9	0	5	0.26
	M2	1	11	2	3	0.191
	M3	2	9	0	5	1

		Males		Females		Fisher's Exact *p*
		Caries Present	Caries Absent	Caries Present	Caries Absent	
MAX	I1	1	12	0	4	1
	I2	1	8	0	8	1
	C	0	14	0	7	-
	P3	0	15	1	5	0.286
	P4	1	13	3	4	0.088
	M1	3	5	1	2	1
	M2	5	7	0	1	1
	M3	3	5	1	1	1
MAND	I1	0	20	0	5	-
	I2	0	12	0	7	-
	C	1	17	2	7	0.25
	P3	0	13	1	5	0.316
	P4	0	15	0	8	-
	M1	4	11	2	3	0.613
	M2	5	7	3	2	0.62
	M3	4	7	2	3	1

Table 6-3. LEH and caries comparison by sex at Cuello

		Males		Females		Fisher's
		LEH Present	LEH Absent	LEH Present	LEH Absent	Exact *p*
MAX	I1	9	13	1	4	0.621
	I2	10	10	2	3	1
	C	13	7	5	2	1
	P3	3	18	1	7	1
	P4	2	26	1	3	0.34
	M1	2	14	0	6	1
	M2	1	18	2	2	0.067
	M3	2	13	2	3	0.249
MAND	I1	2	10	0	1	1
	I2	2	13	1	2	0.442
	C	18	11	5	3	1
	P3	5	21	1	4	1
	P4	5	26	2	4	0.315
	M1	2	26	0	4	1
	M2	4	23	0	5	1
	M3	3	15	0	6	0.546

		Males		Females		Fisher's
		Caries Present	Caries Absent	Caries Present	Caries Absent	Exact *p*
MAX	I1	2	20	0	5	1
	I2	2	18	0	5	1
	C	2	18	0	7	1
	P3	2	19	0	8	1
	P4	3	25	0	4	1
	M1	3	13	0	6	0.532
	M2	6	13	0	4	0.539
	M3	2	13	2	3	0.249
MAND	I1	0	12	0	1	-
	I2	0	15	0	3	-
	C	0	29	1	7	0.216
	P3	2	24	0	5	1
	P4	4	27	0	6	1
	M1	2	26	1	3	0.34
	M2	5	22	1	4	1
	M3	9	9	1	5	0.341

When comparing LEH prevalence between the Middle and Late Preclassic periods at both sites (Table 6-4 and Table 6-5), there are no significant differences for any tooth type at Cuello or Colha, except the maxillary central incisors at Colha ($p = 0.044$). This result is likely due to random chance and does not reflect any substantial differences in stress over time at the site.

Furthermore, there are no significant differences for any tooth type at either site when comparing caries prevalence between the Middle and Late Preclassic periods at Cuello and Colha (Table 6-4 and Table 6-5).

Similarly, there are no significant differences between the Preclassic and Classic periods at Colha (Table 6-6) in terms of caries or hypoplasia prevalence. Due to the small number of Classic period individuals in the Cuello collection, no statistical tests were performed for this comparison.

Table 6-4. LEH and caries comparison between Middle and Late Preclassic Colha

		Middle Preclassic		Late Preclassic		Fisher's Exact *p*
		LEH Present	LEH Absent	LEH Present	LEH Absent	
MAX	I1	0	5	7	5	**0.044**
	I2	3	3	6	5	1
	C	4	3	10	4	0.638
	P3	1	4	3	14	1
	P4	0	6	1	11	1
	M1	1	3	2	14	0.509
	M2	0	8	3	5	0.2
	M3	0	5	3	2	0.167
MAND	I1	1	15	6	12	0.09
	I2	1	5	7	10	0.369
	C	8	2	17	5	1
	P3	2	4	5	12	1
	P4	0	8	5	14	0.28
	M1	1	6	6	10	0.366
	M2	0	7	4	10	0.255
	M3	0	5	3	8	0.509

		Middle Preclassic		Late Preclassic		Fisher's Exact *p*
		Caries Present	Caries Absent	Caries Present	Caries Absent	
MAX	I1	1	4	0	12	0.294
	I2	0	6	0	11	-
	C	1	6	0	14	0.333
	P3	1	4	0	17	0.227
	P4	1	5	2	10	1
	M1	1	3	4	12	1
	M2	3	5	1	7	0.569
	M3	3	2	3	2	1
MAND	I1	0	16	0	18	-
	I2	0	6	0	17	-
	C	2	8	0	22	0.091
	P3	0	6	2	15	1
	P4	0	8	1	18	1
	M1	2	5	4	12	1
	M2	3	4	3	11	0.354
	M3	2	3	2	9	0.547

Table 6-5. LEH and caries comparison between Middle and Late Preclassic Cuello

		Middle Preclassic		Late Preclassic		Fisher's
		LEH Present	LEH Absent	LEH Present	LEH Absent	Exact *p*
MAX	I1	3	10	9	13	0.463
	I2	5	8	16	7	0.09
	C	9	6	17	7	0.508
	P3	1	16	4	15	0.342
	P4	3	13	1	21	0.291
	M1	0	10	4	15	0.268
	M2	2	13	8	12	0.134
	M3	1	6	3	12	1
MAND	I1	1	10	1	12	1
	I2	2	11	4	11	0.655
	C	11	8	22	9	0.373
	P3	2	12	8	18	0.446
	P4	1	16	7	24	0.23
	M1	1	16	3	25	1
	M2	1	16	4	19	0.373
	M3	0	9	3	12	0.266

		Middle Preclassic		Late Preclassic		Fisher's
		Caries Present	Caries Absent	Caries Present	Caries Absent	Exact *p*
MAX	I1	1	12	2	20	1
	I2	1	12	1	22	1
	C	2	13	0	24	0.142
	P3	0	17	2	17	0.487
	P4	1	15	2	20	1
	M1	2	8	2	17	0.592
	M2	4	11	3	17	0.43
	M3	3	4	2	13	0.274
MAND	I1	0	11	0	13	-
	I2	0	13	0	15	-
	C	1	18	0	31	0.38
	P3	0	14	4	23	0.28
	P4	0	17	4	27	0.282
	M1	0	17	5	23	0.14
	M2	1	16	6	17	0.205
	M3	2	7	7	8	0.389

Table 6-6. LEH and caries comparison between the Preclassic and Classic at Colha

		Preclassic		Classic		Fisher's
		LEH Present	LEH Absent	LEH Present	LEH Absent	Exact *p*
MAX	I1	7	10	13	8	0.328
	I2	9	8	11	7	0.738
	C	14	7	18	7	0.755
	P3	4	18	4	11	0.69
	P4	1	17	5	14	0.18
	M1	3	17	4	9	0.393
	M2	3	13	5	3	0.065
	M3	3	7	0	6	0.25
MAND	I1	7	27	5	10	0.473
	I2	8	15	7	9	0.74
	C	25	7	14	7	0.525
	P3	7	16	8	10	0.515
	P4	5	22	3	11	1
	M1	7	16	7	16	1
	M2	4	17	2	6	1
	M3	3	13	1	7	1

		Preclassic		Classic		Fisher's
		Caries Present	Caries Absent	Caries Present	Caries Absent	Exact *p*
MAX	I1	1	16	0	21	0.447
	I2	0	17	1	17	1
	C	1	20	1	24	1
	P3	1	21	1	14	1
	P4	3	15	3	16	1
	M1	5	15	3	10	1
	M2	4	12	3	5	0.647
	M3	6	4	1	5	0.145
MAND	I1	0	34	0	15	-
	I2	0	23	0	16	-
	C	2	30	1	20	1
	P3	2	21	1	17	1
	P4	1	26	1	13	1
	M1	6	17	7	16	1
	M2	6	15	4	4	0.39
	M3	4	12	4	4	0.363

Finally, when comparing teeth from individuals in clustered/mass burial contexts to those in residential contexts, there are minimal differences in the prevalence of linear enamel hypoplasias. In fact, only the maxillary third molars at Colha exhibit a significant difference ($p= 0.007$) for LEH (Table 6-7 and Table 6-8). Given the lack of corroborating results, this likely isn't indicative of any significant difference in stress between the clustered burials and those in residential contexts. Furthermore, there are no significant differences for LEH at Cuello.

The Fisher's exact test results for the caries comparisons between the clustered/mass burial contexts and residential burials are also characterized by a lack of significant results (Table 6-7 and Table 6-8). There are no differences in the prevalence of caries between these mortuary contexts at either Cuello or Colha.

Table 6-7. LEH and caries comparison by mortuary context at Colha

		Clustered burial		Residential		Fisher's
		LEH Present	LEH Absent	LEH Present	LEH Absent	Exact *p*
MAX	I1	6	1	14	17	0.093
	I2	2	2	18	13	1
	C	7	1	25	13	0.403
	P3	3	8	5	21	0.672
	P4	1	6	5	25	1
	M1	1	10	6	15	0.374
	M2	2	3	6	13	1
	M3	3	1	0	12	**0.007**
MAND	I1	3	4	9	33	0.34
	I2	6	5	9	19	0.277
	C	13	1	26	13	0.08
	P3	2	9	13	17	0.168
	P4	5	9	3	24	0.097
	M1	6	5	8	27	0.065
	M2	4	7	2	16	0.164
	M3	1	6	3	14	1

		Clustered burial		Residential		Fisher's
		Caries Present	Caries Absent	Caries Present	Caries Absent	Exact *p*
MAX	I1	0	7	1	30	1
	I2	0	4	1	30	1
	C	0	8	2	36	1
	P3	0	11	2	24	1
	P4	1	6	5	25	1
	M1	4	7	4	17	0.397
	M2	1	4	6	13	1
	M3	2	2	5	7	1
MAND	I1	0	7	0	42	-
	I2	0	11	0	28	-
	C	0	14	3	36	0.557
	P3	1	10	2	28	1
	P4	0	14	2	25	0.539
	M1	4	7	9	26	0.702
	M2	2	9	8	10	0.234
	M3	1	6	7	10	0.352

Table 6-8. LEH and caries comparison by mortuary context at Cuello

		Clustered burial		Residential		Fisher's
		LEH Present	LEH Absent	LEH Present	LEH Absent	Exact *p*
MAX	I1	4	6	8	18	0.7
	I2	8	1	13	14	0.051
	C	10	3	17	10	0.484
	P3	2	6	3	27	0.279
	P4	0	9	5	27	0.568
	M1	1	9	3	18	1
	M2	5	4	6	22	0.091
	M3	1	5	3	14	1
MAND	I1	0	4	2	18	1
	I2	1	4	5	19	1
	C	9	4	26	14	1
	P3	4	8	7	24	0.467
	P4	2	9	7	32	1
	M1	1	10	3	33	1
	M2	2	8	5	29	0.649
	M3	0	5	3	17	1

		Clustered burial		Residential		Fisher's
		Caries Present	Caries Absent	Caries Present	Caries Absent	Exact *p*
MAX	I1	1	9	2	24	1
	I2	0	9	2	25	1
	C	0	13	2	25	1
	P3	0	8	2	28	1
	P4	1	8	2	30	0.535
	M1	0	10	4	17	0.277
	M2	1	8	6	22	0.656
	M3	1	5	4	13	1
MAND	I1	0	4	0	20	-
	I2	0	5	0	24	-
	C	0	13	1	39	1
	P3	2	10	2	30	0.297
	P4	1	10	3	36	1
	M1	2	9	3	33	0.578
	M2	2	8	5	29	0.649
	M3	3	2	7	13	0.358

6.6. Discussion and Conclusions

For the most part, the distribution of both LEH and caries prevalence matches that found elsewhere in the Maya area and the world in general. The anterior teeth are most affected by LEH, likely due to the less complex morphology of the cusp and developmental chronologies that overlap with the significant transitions and stress associated with weaning. Furthermore, caries predominantly affects the posterior dentition, which has more complex occlusal surfaces and is more involved in chewing and macerating food items, which are notoriously maize-based and carbohydrate-rich in the Maya area.

Overall, there are minimal differences between the two sites, time periods, sexes, or mortuary contexts in terms of differences in LEH prevalence. Of the few differences noted, both anterior and posterior teeth were affected, demonstrating the utility of including all tooth types in this kind of analysis despite the differential susceptibility of the teeth. Furthermore, the minimal differences between variables compared in this analysis likely indicate some stability in the stress loads experienced by subadults at both sites who survived childhood and achieved adulthood. There are even fewer differences in the variables assessed for caries prevalence. In fact, the only significant difference detected in this analysis is for caries prevalence on first molars when comparing Cuello and Colha. This could indicate a lack of dietary diversity across the sites and time periods, although dietary differences were identified in previous chapters based on stable carbon isotopes.

Furthermore, the differences in LEH and caries observed by Saul and Saul (1991, 1997) at Cuello were not replicated in this study, likely due to the differences in methods and units of comparison (tooth types in this study vs. discrete individuals in previous studies).

Unfortunately, the high degree of fragmentation and poor preservation of many of these burials prevents the designation of demographic characteristics such as more narrow age categories that might yield a more nuanced look at LEH prevalence and selective mortality or caries prevalence and diet. The fragmentation also precludes significant assessment using individuals as the unit of analysis, which would allow for comparisons with other sites in the Maya area.

Future analysis of these LEH data will focus on the timing of LEH incidence using measurements of the crown heights at each site in conjunction with the exact position of each defect to assess possible nuanced differences in the timing of stress at Cuello and Colha (Goodman et al. 1980; Skinner and Goodman 1992; Wright 1997b).

7. CONCLUSIONS

In this study, I used archaeological, isotopic, and skeletal data to examine individuals in different mortuary contexts in northern Belize to assess geographic origins, childhood diet, childhood health, and adult dental health. I tested three hypotheses that allowed for a nuanced examination of how mortuary behavior relates to social stratification and change among the Maya during the significant transitions in the Late Preclassic and Terminal Classic periods.

Hypothesis 1. The individuals in Preclassic clustered burials at Cuello and Colha and the Terminal Classic Skull Pit were derived from the local population.

In order to test this hypothesis, I first established local strontium and oxygen isotope ranges for each site. Significantly, despite the geographic proximity and geologic similarity of Cuello and Colha, it is possible to distinguish their local isotopic signatures, with only some overlap (Figure 7-1). The oxygen isotope values are very similar, likely due to the homogenous hydrological regimes at each site. However, the strontium isotope ranges can be distinguished, with Colha exhibiting higher values on average than Cuello. These differences are possibly the result of greater access to and consumption of salt and other coastal foods at Colha, which was heavily involved in lithics production and trade throughout the area. Some of these differences could also be due to the presence of more migrants largely hidden in the tails of the local distributions.

Furthermore, there are differences in the underlying geological context between both sites that could affect the local strontium isotope ranges. Regardless, it is possible to generally distinguish between individuals originating at Colha from those at Cuello.

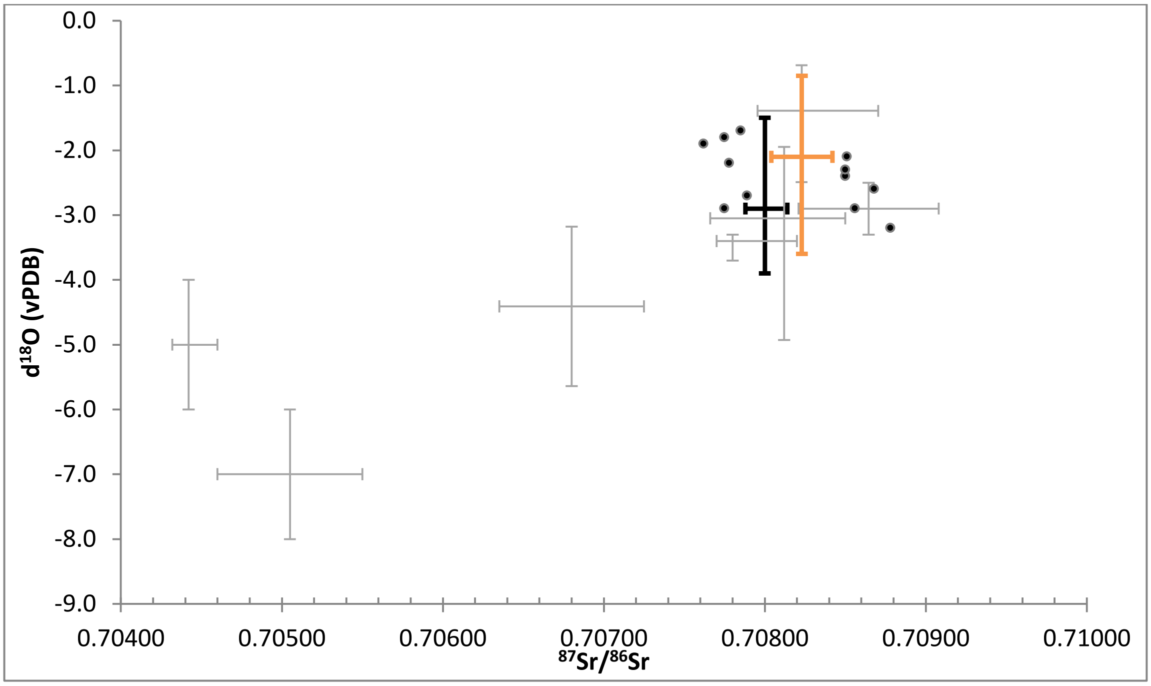

Figure 7-1. Comparison of local oxygen and strontium isotope ranges for Cuello (black) and Colha (orange)

The strontium and oxygen isotope results at Cuello and Colha indicate that mobility patterns differed in complex mortuary deposits, with migrants playing different roles at each site and in each mortuary feature. At Cuello, 15 of the 94 individuals sampled for isotopes are nonlocal in origin. This proportion is comparable to that documented at other sites in the region. Furthermore, there is a significantly higher proportion of migrants in the clustered burials than in residential mortuary contexts, and the oxygen isotope values are significantly different for individuals in the clustered context.

Thus, this first hypothesis is rejected in the case of Cuello. The preponderance of migrants at Cuello, in conjunction with other archaeological data such as the highly skewed sex ratio, are consistent with the argument that these features result from ritual human sacrifice, likely used during the negotiation of social power, roles, and identity in the Late Preclassic period. This interpretation follows the osteotaphonomic approach outlined by Tiesler (2007) to investigate and understand complex mortuary deposits and identify possible sacrificial victims in the archaeological record on the basis of multiple lines of evidence. Furthermore, an indigenous rising elite group like that expected from the result of ancestor veneration would be expected to have a greater prevalence of local individuals, although outside sociopolitical influences are also possible.

At Colha, at least 12 of the 74 individuals sampled for the Preclassic comparisons likely spent their childhoods some distance from the site, which is roughly the same proportion as that identified at Cuello. However, in the clustered mortuary context at Colha, only three individuals, all subadults, are nonlocal in origin. Furthermore, there are no significant differences in oxygen or strontium isotopes between individuals in these features compared to individuals in contemporaneous residential burials. This further differs from the case of Cuello, where there are significant differences in oxygen isotopes. Hypothesis 1 is therefore not rejected for the Preclassic mortuary feature at

Colha. Based on these data, it seems that the complex mortuary features reflect the generation and veneration of ancestors.

With regard to the Terminal Classic Skull Pit from Colha, the majority of skeletons sampled are local in origin. Only four of the 19 individuals sampled in this feature spent their childhoods elsewhere in Belize or the central Petén area. As a result, it seems that most individuals in this deposit are local to Colha and probably represent the local elite group based on associated contextual data. This hypothesis is therefore supported in the Skull Pit sample.

Hypothesis 2. The individuals in Preclassic clustered burials at Cuello and Colha and the Terminal Classic Skull Pit had a distinct diet compared to individuals in residential mortuary contexts.

The carbon isotope data further revealed dietary differences between individuals in these complex deposits and their peers buried in less elaborate burials at Cuello and Colha, probably resulting from the partitioning and distribution of resources based on social rankings. There are significant differences in stable carbon isotope ratios between the clustered mortuary contexts and residential burials at both Cuello and Colha, as well as between the Skull Pit individuals and residential Colha burials. Thus, this hypothesis is not rejected in any analysis in this study.

In terms of the significance of these dietary differences, it is likely they result from different causes at either site. At Cuello, the dietary differences in the clustered burials likely reflect the high prevalence of nonlocals buried in these features who consumed a distinct diet prior to arriving at the site. The dietary data therefore aid in the interpretation of these individuals as nonlocals. In the Preclassic Colha clustered burial, a dietary difference is present despite the local origin for most individuals. Thus, in this case, the carbon isotope differences likely reflect the preferential access to food items experienced by these people, providing supporting evidence for the interpretation of these individuals as a burgeoning elite group in the process of gaining power during the Late Preclassic period. Finally, the dietary differences in the Terminal Skull Pit likely also reflect a similar distribution of food items based on social hierarchy that had been solidified over time.

Hypothesis 3. The individuals in Preclassic clustered burials at Cuello and Colha had relatively better dental health than individuals in residential contexts.

The oral health data obtained from dental remains did not indicate any significant differences between individuals buried in diverse mortuary contexts in terms of linear enamel hypoplasia or caries prevalence. Although such differences have been extensively documented at other Maya sites during later time periods, they were not identified in this study despite some significant differences in mobility patterns, as well as the dietary differences indicated by the stable carbon isotope data at both Cuello and

Colha. This hypothesis was therefore not supported. Thus, there appears to be some stability in stress in these groups during the large-scale transitions in the Preclassic period that was experienced at all social strata. It is also important to note that the lack of differences in these analyses could also be an artifact of small sample size.

7.1. Preclassic Cuello and Colha in a Broader Preclassic Maya Context

When comparing the Cuello and Colha Preclassic isotope data to other sites in the Maya area, it is clear that there is a relative lack of contemporaneous samples. Most isotope studies, especially those that focus on mobility, instead emphasize later Classic period skeletons (e.g., Cucina et al. 2011; Gerry 1993, 1997; Freiwald 2011; Wright 2005a, 2005b). This is likely a reflection of both historical archaeological project directives that preferentially focused on the large Classic period centers and structures, as well as the frequently poor preservation of Preclassic skeletons. However, there are a few analyses that included Preclassic samples as part of broader isotope projects.

Henderson (2003) used stable carbon and nitrogen isotopes to assess Preclassic dietary variability at K'axob based on household organization. This study found subtle differences in how different households at the site managed crop production that reflected overall patterns in social inequality at the site. The largest households increased control over local resources as well (Henderson 2003). These differences are mimicked at Cuello and Colha, wherein possible emerging elite groups have a distinct diet compared to their contemporaries.

At the large regional center of Tikal, Wright (2012) sampled nine Preclassic individuals for isotopic analysis. Of these individuals, only one was considered to be possibly nonlocal in origin due to its high oxygen isotope values that potentially suggest an origin in the central Petén lakes region. The remaining Preclassic individuals are likely local to Tikal, and they include several high-status skeletons from significant areas of the site such as the North Acropolis. Related to this low prevalence of Preclassic migrants, Wright's (2012) analysis demonstrates that mobility was not uniform across the habitation of Tikal. Rather, the highest prevalence of migrants date to the Early Classic period, which is also the time of greatest overall growth at the site.

Furthermore, Wright et al. (2010) sampled several Preclassic individuals for isotopes at Kaminaljuyu, a site located in modern-day Guatemala City. Carbon isotope values at Kaminaljuyu decreased over time from the Preclassic to the Classic period, indicating greater maize consumption earlier in time, a pattern that differs from Colha in particular. In terms of Preclassic mobility patterns at Kaminaljuyu, only two individuals were sampled for both strontium and oxygen isotopes and both are local in origin.

Despite the paucity of Preclassic isotope studies, there is some evidence for Preclassic mobility patterns at other sites in the Maya area. For example, the differing levels of mobility between emerging elite groups and other segments of society documented at Cuello in particular mirror the pattern identified at Ceibal using archaeological data, which demonstrates that some early inhabitants of the site were mobile and lived in ephemeral structures contemporaneous with other groups living in permanent structures at the site (Inomata et al. 2015). In addition, isotope data from faunal remains at Ceibal indicate that multiple taxa were being transported to the site from distant locations during the Preclassic period, demonstrating the movement of people across the landscape as well (Sharpe et al. 2018).

It is also possible to situate Cuello and Colha within a broader picture of Preclassic Maya elaboration and development. Around 1000 BC, the adoption of ceramics and increasing reliance on maize precipitated a dramatic shift toward increasing sedentism throughout the Maya lowlands, with some variability in the exact timing of this change between regions (Inomata et al. 2013, 2015; Lohse 2010). For the earliest constructions throughout the Maya area, there are no clear differences in wealth or power that would lead to the identification of aggrandizers or early elites. Instead, construction projects and even early monuments were likely built via communal negotiations involving the community at large (Inomata et al. 2015). However, over time, it is clear that individuals with institutionalized ties to power gradually emerge at sites throughout the area, such as K'axob (McAnany 1995), Ceibal (Inomata et al. 2013, 2015), Cahal Pech (Peniche May 2016), and many others. At Ceibal, Inomata et al. (2015) further note that the transformation of the public sphere was integral in the sociopolitical transformations occurring during the Middle-Late Preclassic periods, which is consistent with the archaeological data for Cuello and Colha.

7.2. Final Conclusions

The data generated by these analyses yielded substantial insight in how rising elites gained and controlled power; rather than universal patterns in diet, mobility, and health during the rise of social inequality in the Preclassic period, this study revealed subtle differences between groups thought to be comprised of rising elite individuals. However, the dental data do not indicate any significant health differences between individuals at either site during the Preclassic period. While this could be a function of the sample size and/or the test sensitivity, it could also demonstrate that while subtle differences between social groups were emerging, the populations were still subject to the same general environmental stressors. Furthermore, this study provides additional isotopic evidence to better understand mortuary behavior during the dramatic changes of the Terminal Classic period.

With regard to the issues related to the rise and consolidation of sociopolitical power, Preclassic Maya governance has long been poorly understood. The results and Cuello and Colha suggest locally specific mortuary patterns during this time period. At Cuello, the clustered burial contexts seem to reflect the incorporation of ritual human sacrifice, although this does not necessarily preclude any kind of veneration behavior in these contexts. At Colha, the demographic diversity and preponderance of locals in the clustered burials more directly suggest ancestor veneration and the use of human remains as a means to tie particular social groups to an increasingly important plaza that ultimately became the main ritual focus at Colha. This emphasis on a specific place mirrors the assertion of a central political identity that materialized in the mortuary developments of the Late Preclassic period. The emphasis on local ancestors at Colha when compared with the results of Cuello could reflect the greater size and regional and economic significance of Colha, which was the primary lithics production center during the Late Preclassic (Hester and Shafer 1984, 1994; Shafer and Hester 1983). With more abundant natural resources involved in the sociopolitical maneuvering of rising elites, it is possible that invoking ancestors in power negotiations played an even more extensive role at the site.

As noted by McAnany (1995; 2004a), there appears to have been many manifestations of mortuary behavior during the Preclassic rather than a “golden rule” applicable to all sites and contexts in the region. This likely reflects the complexity inherent in establishing and negotiating increasingly complicated social roles over time. At K’axob, McAnany (2004b) and Storey (2004) note that the mortuary behavior associated with ancestor veneration experienced profound changes over time as well. In the Late Preclassic, the previously diverse mortuary features at K’axob increasingly emphasize young adult males buried in secondary deposits, which McAnany (2004b) associates with warriors involved in defense or some kind of site-wide or regional conflicts. While I have interpreted the Cuello mass burials as likely reflecting human sacrifice rather than ancestor veneration, it is possible these burials date to a later point during the Late Preclassic and thus reflect an increasing emphasis on the male population, like that seen at K’axob; however, the preponderance of nonlocals in these features at such a small site would still be difficult to explain in this scheme.

These Preclassic remains and the Terminal Classic Skull Pit feature at Colha further illustrate the challenges of interpreting complex mortuary deposits involving disarticulated human remains (Fitzimmons 2011; Osterholtz et al. 2014; Tiesler et al. 2017; Tiesler 2007). Numerous well-documented Maya activities were likely to produce mortuary features with broadly similar appearances, such as those seen at Cuello and Colha. Only using multiple sources of mortuary, biological, and archaeological data can such deposits be interpreted, and even in the clearest cases, there can still be ambiguity. It is further vitally important for archaeologists to take particular care when describing burial contexts and skeletal placement as well. Identifying primary and secondary deposits is a source of perpetual confusion, especially in archaeological samples excavated in previous decades like those in this study. Yet this clarification is absolutely critical for understanding the possible posthumous body processing and ritual behaviors producing such mortuary features, which can range from human sacrifice, termination rituals, the production and veneration of ancestors, and so forth (Duncan 2005, 2011; Tiesler 2007).

This study also demonstrates the importance of analyzing sites and osteological collections that had been excavated in previous decades. Despite challenges in obtaining access and reconstructing archaeological records, it is possible to obtain a wealth of information on older materials. Furthermore, this study shows the remarkable variability in diet, health, and mobility patterns even among geographically and chronologically very similar ancient Maya archaeological sites. Cuello, Colha, and other such sites provide a critical look into the diverse lives and livelihoods of Maya populations outside the large regional centers. Finally, this study also confirms the importance of a contextually sensitive osteotaphonomic approach to complex bioarchaeological research questions.

In the future, these analyses could be augmented by further isotopic research, including new approaches using lead or sulfur isotopes or adding collagen isotopic analysis. Lead isotope data would allow for an additional line of evidence when reconstructing mobility patterns among the Maya. Similarly, sulfur isotopes could yield information about diet and mobility, while collagen analysis would allow for a more thorough look at paleodiet via the assessment of dietary protein sources. There are also many avenues for research using the dental data, including reconstructing the timing of hypoplasias on Cuello and Colha dental remains to look for subtle differences in stress during childhood. Such approaches would allow for more thorough investigation into mortuary behavior during the significant transitions of the Preclassic and Terminal Classic Maya.

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APPENDIX A

CUELLO ISOTOPE DATA

A - 1. Cuello isotope data

Burial	Ind #	Date	Age	Sex	Tooth	Mass Burial	Grave Type	Artic/ Disart	Prim/ Sec	Single/ Multiple	Sr	O	C
CUELLO 2		MP	Y Adult	F	ULM1		Simple	D	S	S	0.70802	-2.9	-10.6
CUELLO 4		MP	Y Adult	M	ULM1		Simple	A	P	S	0.70790	-2.9	-7.8
CUELLO 5		MP	Mid Adult	M	LLM1		Cist	A	P	S	0.70800	-2.5	-7.5
CUELLO 7		MP	Y Adult	F	URM1		Simple	A	P	M	0.70792	-2.3	-7.8
CUELLO 9		MP	Mid Adult	M	LLM1		Simple	A	P	S	0.70792	-2.7	-9.0
CUELLO 10/11		LP	Adult	I	LLM1		Simple	D	S	M	0.70796	-2.7	-8.0
CUELLO 12		LP	Y-Mid Adult	F?	LRM1		Simple	D	S	M	0.70797	-2.8	-6.4
CUELLO 13		C	Subadult	-	LLM1		Simple	D	S	M	0.70811	-3.2	-9.4
CUELLO 17		LP	Y Adult	M?	LRM1		Crypt	A	P	S	0.70804	-2.0	-6.0
CUELLO 18		MP	Y-Mid Adult	F	ULM1		Simple	A	P	S	0.70798	-2.9	-9.5
CUELLO 19		LP	Y Adult	M	LRM1		Simple	A	P	S	0.70773	-2.4	-7.0
CUELLO 20		MP	Subadult	-	LLM1		Simple	A	P	S	0.70791	-2.3	-7.1
CUELLO 22		MP	Mid-Old Adult	M	ULM1		Simple	A	P	S	0.70791	-2.8	-6.8
CUELLO 23		LP	Subadult	-	LRM1		Simple	A	P	S	0.70776	-0.4	-5.8
CUELLO 24		LP	Mid Adult	F?	ULM1		Simple	A	P	S	0.70803	-0.3	-5.8
CUELLO 25		LP	Y Adult	F	LRM1		Cist	A	P	M	0.70801	-2.9	-6.5
CUELLO 29		LP	Y-Mid Adult	M	LLM1	YES	Simple	A	P	S	0.70813	-3.5	-6.1
CUELLO 30/31		LP	Adult	I	LRM1	YES	Simple	A	?	M	0.70802	-2.9	-5.4
CUELLO 32		LP	Mid Adult	M?	LRM1	YES	Simple	D	S	S	0.70799	-3.4	-8.4
CUELLO 36		LP	Y-Mid Adult	I	URM1	YES	Simple	A	P	S	0.70812	-3.0	-7.0

A – 1 Continued

Burial	Ind #	Date	Age	Sex	Tooth	Mass Burial	Grave Type	Artic/ Disart	Prim/ Sec	Single/ Multiple	Sr	O	C
CUELLO 39 - 40	1	LP	Y Adult	M?	LRM1	YES	Simple	A	P	M	0.70781	-3.0	-6.9
CUELLO 39 - 40	2	LP	Y Adult	M?	LRM1	YES	Simple	A	P	M	0.70793	-3.5	-6.8
CUELLO 45		LP	Y Adult	M?	URM1	YES	Simple	A	P	M	0.70769	-2.6	-8.6
CUELLO 46		LP	Mid Adult	M?	LLM1	YES	Simple	A	P	M	0.70769	-2.0	-8.0
CUELLO 47-49		LP	Adult	I	LRM1	YES	Simple	D	S	M	0.70797	-3.3	-5.8
CUELLO 50		LP	Y-Mid Adult	M	LRM1	YES	Simple	A	P	S	0.70780	-3.5	-8.3
CUELLO 51	1	LP	Y Adult	M	LLM1	YES	Simple	A	P	S	0.70798	-3.4	-7.1
CUELLO 51	2	LP	Adult	I	ULM1	YES	Simple	?	?	?	0.70767	-3.8	-6.1
CUELLO 52-60	1	LP	Adult	I	URM1	YES	Simple	D	S	M	0.70807	-3.7	-4.7
CUELLO 52-60	2	LP	Adult	I	URM1	YES	Simple	D	S	M	0.70809	-3.1	-6.1
CUELLO 52-60	3	LP	Adult	I	URM1	YES	Simple	D	S	M	0.70808	-3.4	-7.7
CUELLO 52-60	4	LP	Adult	I	URM1	YES	Simple	D	S	M	0.70804	-3.9	-6.2
CUELLO 62		MP	Y Adult	F	ULM1		Simple	A	P	S	0.70783	-2.5	-7.6
CUELLO 63		LP	Subadult	-	LRM1		Simple	A	P	S	0.70810	-3.4	-6.2
CUELLO 64		LP	Subadult	-	LLM1		Cist	A	P	S	0.70796	-2.3	-6.8
CUELLO 66		LP	Mid Adult	M	LLM1		Simple	A	P	S	0.70794	-3.6	-6.4
CUELLO 67		C	Y Adult	M	LLM1		Simple	A	P	S	0.70814	-3.1	-8.4
CUELLO 68	1	LP	Adult	M?	LLM1	YES	Simple	D	S	M	0.70806	-2.8	-9.5
CUELLO 69	2	LP	Adult	M?	LLM1	YES	Simple	D	S	M	0.70770	-3.7	-8.8
CUELLO 70		LP	Y Adult	M	URM1	YES	Simple	A	P	S	0.70807	-3.2	-5.5
CUELLO 71-74	1	LP	Adult	I	LLM1	YES	Simple	D	S	M	0.70800	-2.8	-8.0
CUELLO 71-74	2	LP	Adult	I	LLM1	YES	Simple	D	S	M	0.70805	-2.1	-7.9
CUELLO 75-78		LP	Adult	I	URM1	YES	Simple	D	S	M	0.70801	-3.3	-8.1
CUELLO 79	1	LP	Y Adult	M	LRM1	YES	Simple	A	P	S	0.70800	-3.2	-7.6
CUELLO 79	2	LP	Adult	I	LRM1	YES	Simple	D	S	M	0.70755	-2.7	-6.1
CUELLO 80		LP	Y-Mid Adult	F	ULM1		Simple	A	P	S	0.70810	-3.7	-9.1

A – 1 Continued

Burial	Ind #	Date	Age	Sex	Tooth	Mass Burial	Grave Type	Artic/ Disart	Prim/ Sec	Single/ Multiple	Sr	O	C
CUELLO 82		LP	Y-Mid Adult	F	ULM1		Simple	A	P	M	0.70788	-2.2	-7.0
CUELLO 84		LP	Subadult	-	LLM1		Simple	A	P	S	0.70805	-3.6	-8.7
CUELLO 85		LP	Mid Adult	M	LLM1		Simple	A	P	S	0.70806	-3.8	-8.9
CUELLO 86		LP	Subadult	-	LLM1		Simple	A	P	S	0.70810	-3.3	-8.5
CUELLO 89		LP	Mid Adult	F	LRM1		Cist	A	P	S	0.70791	-2.9	-8.3
CUELLO 90		LP	Y Adult	I	LLM1		Simple	A	P	S	0.70804	-3.5	-8.0
CUELLO 95		LP	Mid Adult	M	LRM1		Simple	A	P	S	0.70802	-3.3	-7.6
CUELLO 91		LP	Y Adult	M	LRM1		Simple	A	P	S	0.70798	-3.3	-7.9
CUELLO 97		LP	Subadult	-	LRM1		Simple	A	P	S	0.70802	-3.3	-7.9
CUELLO 98		LP	Y-Mid Adult	F	LRM1		Simple	A	P	S	0.70813	-1.5	-7.5
CUELLO 99		LP	Y Adult	M	LLM1		Simple	A	P	M	0.70810	-2.0	-6.9
CUELLO 103		LP	Y-Mid Adult	M	LRM1		Simple	A	P	S	0.70807	-3.0	-9.8
CUELLO 104		LP	Y-Mid Adult	M	ULM1		Simple	A	P	S	0.70806	-3.2	-7.5
CUELLO 105		LP	Y Adult	M	LLM1		Simple	A	P	S	0.70802	-3.9	-8.4
CUELLO 107		LP	Y Adult	M	LLM1		Simple	A	P	S	0.70810	-2.4	-8.5
CUELLO 109	1	LP	Adult	M?	LLM1		Simple	D	S	S	0.70796	-3.2	-6.7
CUELLO 110		LP	Y Adult	M	LLM1		Simple	A	P	S	0.70794	-2.4	-6.7
CUELLO 112		LP	Y Adult	F	LRM1		Simple	A	P	M	0.70789	-2.8	-8.7
CUELLO 113		LP	Mid Adult	M	LRM1		Simple	A	P	S	0.70806	-3.4	-9.4
CUELLO 115		MP	Subadult	-	LRM1		Simple	A	P	S	0.70790	-2.9	-8.6
CUELLO 116		MP	Subadult	-	LRM1		Cist	A	P	S	0.70790	-1.9	-9.2
CUELLO 118		MP	Mid Adult	M	URM1		Simple	A	P	S	0.70802	-2.4	-7.7
CUELLO 119		LP	Y Adult	M	LLM1		Crypt	A	P	S	0.70805	-3.1	-6.2
CUELLO 121		LP	Y Adult	M	LLM1		Simple	D	S	M	0.70813	-2.9	-7.7
CUELLO 123		MP	Y-Mid Adult	M	LLM1		Simple	A	P	S	0.70806	-1.8	-7.1
CUELLO 139		C	Y Adult	M	LLM1		Crypt	A	P	S	0.70795	-2.5	-9.5

A – 1 Continued

Burial	Ind #	Date	Age	Sex	Tooth	Mass Burial	Grave Type	Artic/ Disart	Prim/ Sec	Single/ Multiple	Sr	O	C
CUELLO 146		MP	Y Adult	M	LRM1		Simple	A	P	S	0.70774	-2.7	-9.4
CUELLO 147		MP	Y Adult	M?	ULM1		Simple	A	P	S	0.70797	-3.2	-9.3
CUELLO 149		MP	Subadult	-	LRM1		Simple	A	P	S	0.70796	-2.5	-8.4
CUELLO 150		MP	Y Adult	M	LLM1		Simple	A	P	S	0.70795	-3.1	-8.1
CUELLO 154		MP	Y Adult	M	LLM1		Simple	A	P	S	0.70777	-3.2	-5.1
CUELLO 156		MP	Y-Mid Adult	?	LLM1		Simple	A	P	S	0.70800	-2.8	-7.3
CUELLO 158		MP	Subadult	-	ULM1		Simple	A	P	S	0.70798	-3.0	-9.9
CUELLO 160		MP	Mid Adult	M	LLM1		Simple	A	P	S	0.70801	-2.8	-8.0
CUELLO 161		MP	Y Adult	M?	ULM1		Simple	A	P	S	0.70770	-2.9	-5.9
CUELLO 162		MP	Y-Mid Adult	F	LLM1		Simple	D	P	S	0.70795	-2.7	-7.6
CUELLO 165		MP	Subadult	-	LLM1		Simple	A	P	S	0.70799	-3.4	-7.1
CUELLO 166		MP	Subadult	-	LRM1		Simple	A	P	S	0.70798	-2.6	-9.6
CUELLO 167		MP	Subadult	-	ULM1		Simple	A	P	M	0.70791	-2.3	-7.7
CUELLO 169		MP	Y Adult	F?	LRM1		Simple	A	P	S	0.70791	-2.9	-9.7
CUELLO 170		MP	Y Adult	M	URM1		Simple	A	P	S	0.70796	-2.3	-9.5
CUELLO 171		MP	Y Adult	M	LLM1		Simple	A	P	S	0.70799	-3.8	-6.5
CUELLO 172		MP	Y Adult	M	LLM1		Simple	A	P	S	0.70799	-3.6	-6.4
CUELLO 173		MP	Y Adult	M	ULM1		Simple	A	P	S	0.70797	-3.1	-8.2
CUELLO 174		MP	Y Adult	F	URM1		Simple	A	P	S	0.70797	-2.9	-8.0
CUELLO 177		MP	Subadult	-	LLM1		Simple	A	P	S	0.70796	-2.2	-9.2
CUELLO 178		MP	Mid Adult	M?	URM1		Simple	A	P	S	0.70790	-2.0	-8.8
CUELLO 179		MP	Subadult	-	LLM1		Simple	A	P	M	0.70778	-2.9	-6.8

APPENDIX B

COLHA ISOTOPE DATA

A - 2. Colha isotope data

Op	Subop	Burial/ Ind	Date	Age	Sex	Tooth	Cluster?	Art/ Disart	Prim/ Sec	Single/ Multiple	Sr	O	C
2031	223	A	Late Pre	Mid Adult	M?	LLM1	YES	A	P	M	0.70824	-2.4	-8.0
2031	223	Bone 32	Late Pre	Adult	F?	LLM1	YES	D	S	M	0.70814	-1.9	-7.3
2031	223	Bone 32	Late Pre	Adult	-	LLM1	YES	D	S	M	0.70823	-2.3	-7.7
2031	223	Ind L	Late Pre	Y Adult	-	ULC	YES	D	S	M	0.70827	-2.3	-9.1
2031	223	BONE 10	Late Pre	Adult	I	URM1	YES	D	S	M	0.70821	-1.9	-8.7
2031	110	A	Late Pre	Old Adult	F	LLC	YES	A	P	M	0.70818	-2.2	-9.6
2031	110	Bone 10	Late Pre	Adult	I	LLC	YES	D	S	M	0.70822	-3.3	-6.7
2031	110	Bone 84	Late Pre	Adult	I	LLM1	YES	D	S	M	0.70814	-2.3	-9.8
2031	110	Skull H	Late Pre	Subadult	-	LLM1	YES	D	S	M	0.70789	-2.7	-6.1
2031	110	Misc	Late Pre	Adult	I	LLM1	YES	D	S	M	0.70811	-3.2	-6.2
2031	110	Bone 50	Late Pre	Adult	I	LLC	YES	D	S	M	0.70822	-1.5	-8.4
2031	238		Mid Pre	Y Adult	M	LRM1		A	P	S	0.70816	-2.9	-7.9
2031	219		Mid Pre	Mid Adult	F?	LRC		A	P	S	0.7081	-3.0	-9.6
2031	142		Late Pre	Subadult	-	LLM1		A	P	S	0.70812	-2.3	-8.1
2031	214		Late Pre	Old Adult	F?	ULM1	YES	A	P	S	0.70822	-2.5	-10.5
2031	203		Late Pre	Mid Adult	F	URM1	YES	A	P	M	0.70818	-2.6	-8.8
2031	165		Late Pre	Mid Adult	M	LLM1	YES	A	P	S	0.70819	-2.3	-9.1
2031	184	A	Late Pre	Mid Adult	F	LLM1	YES	A	P	M	0.70817	-3.3	-9.9
2031	184	B	Late Pre	Adult	M?	URM1	YES	A	P	M	0.70817	-3.2	-9.9

A – 2. Continued

Op	Subop	Burial/ Ind	Date	Age	Sex	Tooth	Cluster?	Art/ Disart	Prim/ Sec	Single/ Multiple	Sr	O	C
2031	107		Late Pre	Adult	I	URM1	YES	D	S	M	0.70833	-1.5	-8.0
2031	107		Late Pre	Adult	I	URM1	YES	D	S	M	0.70829	-2.3	-4.7
2031	107		Late Pre	Adult	I	URM1	YES	D	S	M	0.70829	-2.7	-5.6
2031	107		Late Pre	Adult	I	URM1	YES	D	S	M	0.70806	-1.2	-2.9
2031	107		Late Pre	Adult	I	URM1	YES	D	S	M	0.70831	-1.8	-5.5
2031	218		Mid Pre	Y Adult	M?	URM1		A	P	S	0.70826	-2.3	-6.5
2031	87	89-1	Late Pre	Adult	F	URM1		A	P	S	0.70817	-1.7	-10.1
2031	117		Late Pre	Old Adult	M	LRM1	YES	A	P	S	0.70818	-2.4	-10.7
2031	127	A	Late Pre	Subadult	-	LLM1	YES	D	S	M	0.70762	-1.9	-7.8
2031	215	Mandible	Late Pre	Subadult	-	LRM1	YES	D	P	M	0.70775	-2.9	-7.3
2031	215	Adult	Late Pre	Adult	M?	ULM1	YES	D	P	M	0.70822	-2.0	-7.6
2002	3/1	1	Late Clas	Adult	I	LLM1		?	?	?	0.70817	-2.3	-9.3
2002	5/1	1	Late Clas	Adult	I	ULM1		?	?	?	0.70878	-3.2	-5.6
2003		2	Post	Adult	F?	LLM1		A	S?	S	0.70868	-2.6	-2.7
1002	2/2	2	Late Clas	Adult	I	ULM1		A	P	S	0.70842	-1.8	-9.7
4045	6/3		Late/Term C	Adult	M?	LLI1		A	P	S	0.70821	-1.6	-9.2
4045	6/3	Ind I	Late/Term C	Adult	I	ULM1		-	P	S	0.70778	-2.2	-8.5
3017		1	Late Clas	Old Adult	M?	LRM1		?	?	S	0.70827	-2.5	-8.8
3017		3	Late Clas	Y Adult	F	ULM1		A	P	S	0.70833	-3.6	-9.0
3017		5	Late Clas	Mid Adult	M	ULM1		A	P	S	0.70819	-1.8	-7.9
3017		6	Late Clas	Adult	F?	ULM1		D	S?	S	0.7082	-2.5	-8.8
3017		10	Late Clas	Mid Adult	M	LLM1		A	P	S	0.70818	-1.6	-6.8

A – 2. Continued

Op	Subop	Burial/ Ind	Date	Age	Sex	Tooth	Cluster?	Art/ Disart	Prim/ Sec	Single/ Multiple	Sr	O	C
3017		11	Late Clas	Adult	I	LRM1		A	P	S	0.70816	-1.3	-7.4
3017		13	Late Clas	Adult	I	URM1		A	P	S	0.70821	-2.3	-8.6
2012	5 - B4	4	Late Pre	Adult	I	LLM1		D	S?	M	0.70834	-0.9	-7.0
2012	5 - B4	4	Late Pre	Adult	I	URM1		D	S?	M	0.70821	-1.6	-10.2
2012	5 - B4	4	Late Pre	Adult	I	URM1		D	S?	M	0.7083	-2.1	-8.6
2012	5 - B4	4	Late Pre	Adult	I	URC		D	S?	M	0.7082	-1.7	-10.5
2012	5 - B4	4	Late Pre	Adult	I	URC		D	S?	M	0.70856	-2.9	-8.7
2012	5 - B3	3	Late Pre	Adult	M?	URM1		D	S?	M	0.70775	-1.8	-7.6
2012	5-7		Late Pre	Adult	I	LRC		D	S?	M	0.7082	-1.5	-10.4
2012	5-7		Late Pre	Adult	I	LRC		D	S?	M	0.70822	-2.2	-6.5
2012	F8	Feat 8	Early C	Subadult	-	LRM1		A	P	S	0.70833	-1.3	-2.8
2012	FT7	Feat 7	Early C	Adult	I	LRC		A	P	S	0.70835	-1.8	-6.9
2012	5 LVL 2		Late Pre	Adult	I	LRC		D	S?	M	0.70827	-3.1	-8.1
2012	5 LVL 2		Late Pre	Adult	I	LRC		D	S?	M	0.70824	-2.4	-9.1
2012	3-6	3-9	Term C	Adult	I	LRC		D	S	M	0.70829	-1.6	-7.7
2012	3	1	Term C	Adult	I	LLM1		D	S	M	0.70822	-1.3	-7.0
2012	3	1	Term C	Adult	F?	LRM1		D	S	M	0.70821	-1.3	-9.3
2012	3	Dent E	Term C	Adult	I	ULM1		D	S	M	0.70818	-0.9	-8.3
2012	3	Dent F	Term C	Subadult	-	LRM1		D	S	M	0.70829	-1.7	-6.9
2012	3		Term C	Adult	I	LRM1		D	S	M	0.70838	-1.3	-10.4
2012	3		Term C	Adult	I	LRM1		D	S	M	0.70824	-1.8	-9.0
2012	3		Term C	Adult	I	LRM1		D	S	M	0.70821	-1.4	-7.0
2012	3/3	3	Term C	Adult	I	LRM1		D	S	M	0.70836	-2.6	-6.4

A – 2. Continued

Op	Subop	Burial/ Ind	Date	Age	Sex	Tooth	Cluster?	Art/ Disart	Prim/ Sec	Single/ Multiple	Sr	O	C
2012	3/3	3	Term C	Adult	I	LRM1		D	S	M	0.70829	-2.5	-9.3
2012	3/3	3	Term C	Adult	I	LRM1		D	S	M	0.70804	-3.3	-6.5
2012	3/3	3	Term C	Adult	I	LRM1		D	S	M	0.70834	-1.3	-7.2
2003	1:F2	FT 2	Post	Adult	I	LRM1		D	?	?	0.70827	-2.4	-9.1
4J7 F6			Post	Adult	F	ULM1		D	S	S	0.70831	-2.1	-8.6
4L5 F2			Post	Y Adult	F	LLM1		A	P	M	0.70851	-2.1	-2.3
4J4 F3			Post	Adult	I	LLM1		A	P	S	0.7085	-2.4	-3.3
4J6 F5			Post	Adult	M?	LLM1		D	S	S	0.7085	-2.3	-6.6
4M3 F1			Late Pre	Adult	I	LLM1		A	P	S	0.70816	-1.5	-9.6
4J9 F7			Post	Mid Adult	M	LLM1		A	P	S	0.70785	-1.7	-2.6
2011		B	Term C	Adult	F	LRM1		D	P	M	0.70830	-2.2	-6.9
2011		C	Term C	Subadult	-	LLM1		D	P	M	0.70822	-1.5	-5.6
2011		D	Term C	Subadult	-	LLM1		D	P	M	0.70811	-2.0	-7.6
2011		E	Term C	Adult	M	LLM1		D	P	M	0.70810	-0.7	-8.0
2011		F	Term C	Subadult	-	URM1		D	P	M	0.70815	-1.1	-6.4
2011		G	Term C	Adult	M	LRM1		D	P	M	0.70812	-1.7	-6.1
2011		I	Term C	Subadult	-	LLM1		D	P	M	0.70826	-0.6	-7.6
2011		K	Term C	Adult	M	LRM1		D	P	M	0.70818	-0.8	-5.5
2011		P	Term C	Adult	M	LRM1		D	P	M	0.70865	-1.5	-5.9
2011		Q	Term C	Adult	F	URM1		D	P	M	0.70821	-2.3	-6.8
2011		R	Term C	Adult	F	LLM1		D	P	M	0.70819	-2.4	-7.6

A – 2. Continued

Op	Subop	Burial/ Ind	Date	Age	Sex	Tooth	Cluster?	Art/ Disart	Prim/ Sec	Single/ Multiple	Sr	O	C
2011		T	Term C	Adult	M	LLM1		D	P	M	0.70814	-0.7	-7.1
2011		W	Term C	Subadult	-	LLM1		D	P	M	0.70818	-4.1	-2.4
2011		X	Term C	Adult	F	ULM1		D	P	M	0.70784	-2.5	-7.5
2011		Y	Term C	Subadult	-	LRM1		D	P	M	0.70828	-1.4	-6.8
2011		Z	Term C	Subadult	-	LLM1		D	P	M	0.70816	-2.3	-6.6
2011		BB	Term C	Adult	F	LLM1		D	P	M	0.70862	-2.8	-7.5
2011		CC	Term C	Subadult	-	LLM1		D	P	M	0.70836	-2.6	-8.2
2011		II	Term C	Adult	M	LLM1		D	P	M	0.70813	-1.6	-6.6
2011		B	Term C	Adult	F	LRM3		D	P	M	0.70829	-1.3	-6.9
2011		E	Term C	Adult	M	LRM3		D	P	M	0.70809	-1.3	-9.3
2011		K	Term C	Adult	M	LRM3		D	P	M	0.70816	-1.4	-6.4
2011		P	Term C	Adult	M	LRM3		D	P	M	0.70861	0.0	-7.8
2011		Q	Term C	Adult	F	URM3		D	P	M	0.70822	-2.6	-6.2
2011		R	Term C	Adult	F	URM3		D	P	M	0.70817	-1.7	-10.1
2011		T	Term C	Adult	M	LLM3		D	P	M	0.70817	-1.5	-5.1
2011		BB	Term C	Adult	F	LLM3		D	P	M	0.70872	-3.4	-7.5
2011		II	Term C	Adult	M	LLM3		D	P	M	0.70813	-1.5	-8.6