

USING ISOTOPE ANALYSIS TO UNDERSTAND THE INTERACTION
BETWEEN MIGRATION AND BURIAL AT THE EASTERN
STRUCTURE OF GROUP 1 AT ACTUNCAN, A MAYA
ARCHAEOLOGICAL SITE IN BELIZE

by

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Abstract

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Strontium, oxygen, and carbon isotope ratios for seven individuals buried at the eastern shrine of Group 1 at Actuncan were analyzed in an attempt to elucidate the relationship between natal origin, burial location, and mortuary patterns. These data were correlated with archaeological evidence of burial practices to better understand who was interred at this ritually significant space. Results indicate that none of the individuals sampled could be identified as originating outside the Belize River Valley. Burials 7-1 and 9-1 had strontium and oxygen isotope ratios closest to expected values for the area surrounding Actuncan and the Upper Belize River Valley. While Burial 13 appeared nonlocal based on burial presentation, isotope ratios could not exclude an origin within the Belize River Valley.

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Chapter 1

Introduction

The act of relocating from place to place across the landscape was a common practice among the ancient Maya. Throughout the Classic period, individuals at sites within the Belize River Valley (Freiwald 2011), as well as Tikal (Wright 2005, 2012), Copán (Price et al. 2010), and Kaminaljuyu (White et al. 2000; Wright et al. 2010), have been identified as nonlocal. Past studies have relied upon a variety of methods to identify migrant individuals within a population; however, advances in archaeochemistry have provided quantitative techniques for use in this field (Ericson 1985; Price et al. 1994; Sealy 1989).

The extraction of strontium, carbon, and oxygen isotopes from bone tissue and tooth enamel has proven to be a useful tool for identifying migrants. This process can be accomplished by comparing chemical signatures from skeletal material to the surrounding environment and known values of other areas within the Maya region, as well as through the use of statistical techniques to differentiate local from nonlocal. Individuals with isotope levels that are inconsistent with regional values are identified as having relocated during their lifetime (Freiwald 2011; Price et al. 2008; Price et al. 2000; White et al. 2000; Wright 2005). These isotope values can be studied in concert with burial practices in attempt to elucidate differences between local and migrant interments.

Decades of research on the burial practices of the Maya have resulted in a rich knowledge base of ancient Maya mortuary activity, including details on burial locations, body positioning, and grave good inclusions. The placement of graves within residential structures was a common practice across the Maya landscape. These interments were often associated with the eastern structure of a *plazuela* group (Becker 1971, 1992, 2003; Chase and Chase 2011; Helmke 2000; McAnany 1995). Residential burial patterns are frequently linked to ancestor worship and the act of reinforcing land ownership through tangible connectedness to a space (Gillespie 2000; McAnany 1995). The act of interring ancestors within residences solidifies the sacredness of the household structure and indicates ritual significance and meaning in the place where people are buried. The custom of laying claim to a space through the interment of important individuals raises questions about whether this burial space was reserved for natal members of the community or whether individuals with nonlocal origins were also interred in this manner.

The purpose of this project is to perform isotope analysis on the dental enamel of seven individuals associated with the eastern structure patio of Group 1 at Actuncan, Belize in order to answer questions about the relationship between burial practices and migration. Actuncan is located in the upper Belize River Valley, approximately five kilometers from the Guatemalan border and two kilometers from its closest neighbor, Xunantunich (Figure 1.1). Group 1 is

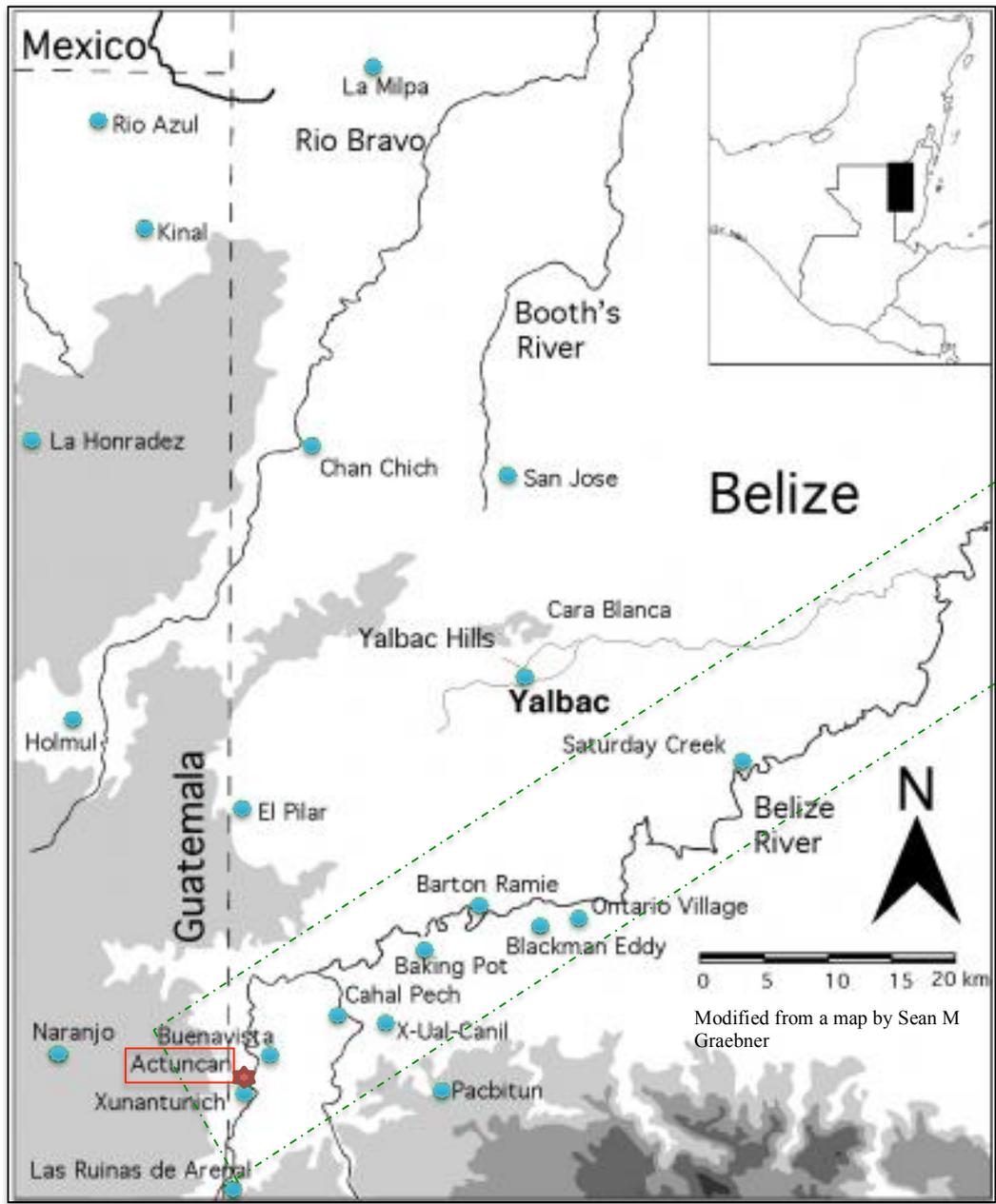


Figure 1.1 Archaeological sites of Belize and eastern Guatemala. The approximate location of the Belize River Valley is indicated by dashed lines. Actuncan is identified bottom left.

located in the northern aspect of the site and has a large and complex series of burials including Burials 6-10 and 13, the extent of which has yet to be discovered. Based on data collected so far, the patio appears to have maintained ritual significance as a burial location through time, with the development of an eastern shrine sometime late in the Classic period (AD 250 to 900) (Freiwald 2012; LeCount and Blitz 2001; Scopa Kelso 2005). Evidence suggests that Actuncan was a place of in-migration between the Late and Terminal Classic (AD 600 to 800) to Postclassic (AD 800 to 900) periods. The potential presence of nonlocal individuals at Actuncan contemporaneous with active use of the eastern shrine patio (Group 1, Structure 60) as a burial ground raises questions about whether the ritually significant space was reserved for interment of only those who were locally born or was used for migrants as well.

This thesis uses strontium and oxygen isotope ratios to identify whether individuals interred at the eastern structure were locals or immigrants. Supporting evidence of possible migrant status is given by evaluating dietary inputs through carbon isotope analysis. Data on geographic origin will be correlated with archaeological evidence of burial practices at the eastern structure to provide a more nuanced understanding of whom the Maya interred in this space. Analysis of strontium, carbon and oxygen isotope values of the individuals interred in the Structure 60 patio will allow several questions to be addressed. At a time when in-migration to centers ranged between 10-25% of the population (Wright 2005;

Price et al. 2008), did the Maya at Actuncan bury nonlocals at the eastern structure? Do the unique features of Burial 13 represent distinct practices for interment of a nonlocal? If any of the individuals excavated to date from the Group 1 patio are nonlocal, can their childhood origins be identified from their isotopic signatures? These questions will be addressed within the framework of previously published material on the migration and burial practices of the Maya (e.g. Freiwald 2011). I am working from the null hypothesis that the individuals excavated from the eastern structure will have isotope signatures indicating that they are natal members of Actuncan. This is a parsimonious assumption made in order to simplify hypothesis testing.

Chapter 2

Literature Review

Many of the mortuary patterns observed at Actuncan's Group 1 are similar to those found at other Maya sites across Mesoamerica. Interment location, treatment of the dead, and burial association with the eastern structure exhibit patterns that can be used to identify changing social or political constructs as individuals moved across the Maya landscape (Freiwald 2011; Freiwald 2012; Freiwald and Micklin 2013). This movement has been evaluated by comparing strontium and oxygen isotope ratios found in human remains to those of standards obtained across the Maya region. The addition of carbon isotope analysis provides information on dietary input to facilitate a more robust understanding of locality.

Actuncan, Belize River Valley

The site of Actuncan is in the Belize River Valley and has a deep occupation history and evidence of shifting power dynamics with the rise of state level society (LeCount 2012). Arguably, it is the most architecturally impressive Preclassic (BC 1000 to AD 250) site in the region. Actuncan is composed of two architectural groups linked by a wide causeway: Actuncan South is the triadic temple complex, and Actuncan North is a set of civic monuments, elite residences, and commoner patio-focused residences (Figure 2.1).

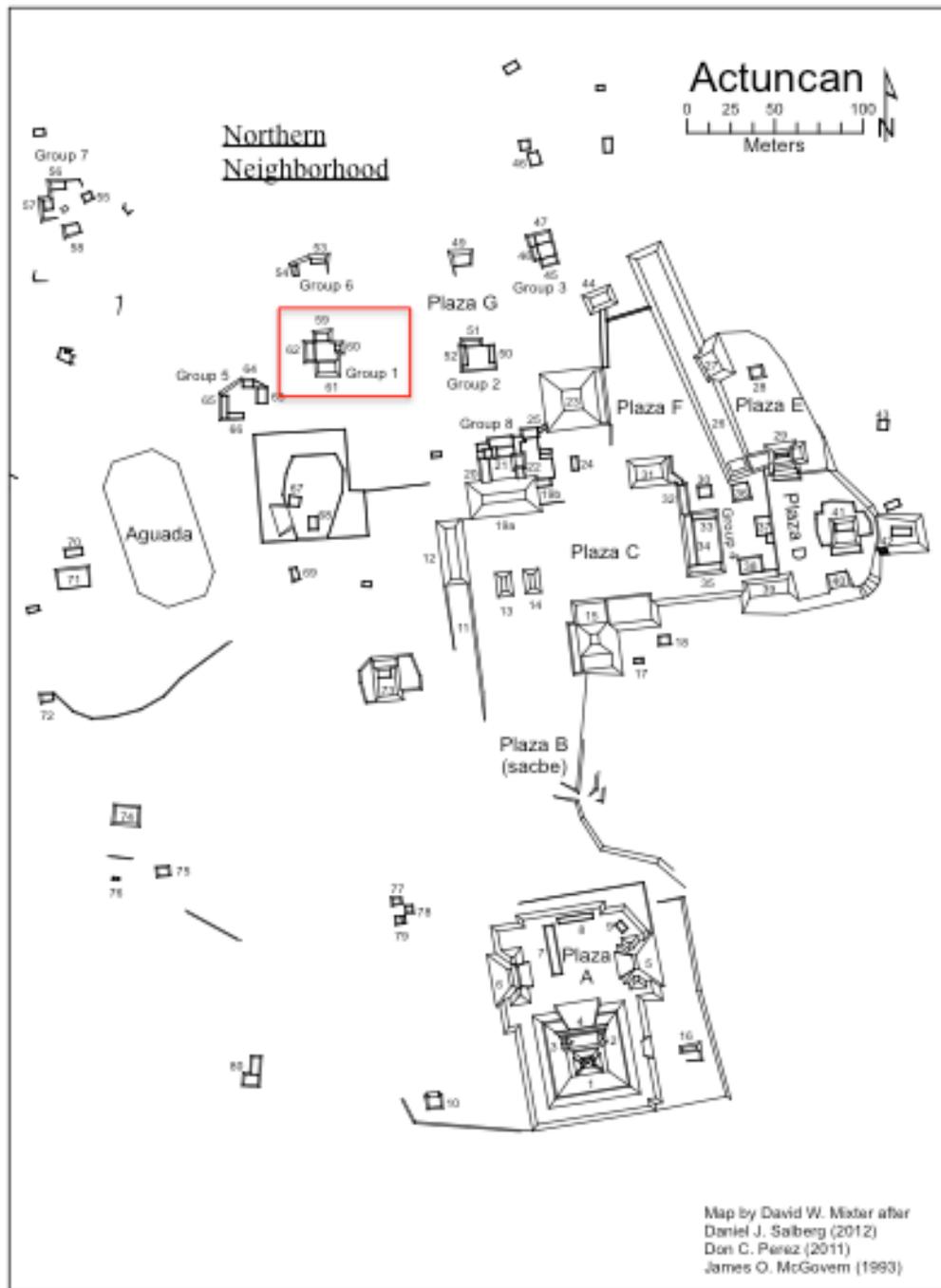


Figure 2.1 Maler image of Actuncan depicting the southern temple complex and northern structures with Group 1 indicated. Map adapted from Mixter (2013).

Most commoner residences are located in the Northern Neighborhood, a cluster of seven patio-focused groups located immediately north of the noble palace complex (Group 8), of which Group 1 is the largest and most centrally located.

Civic monuments include hallmarks of early Maya civilization such as the 32-m high triadic temple group, the E-Group (a cosmological-ritual complex), and a ballcourt (Estrada-Belli 2011) (Figure 2.2). These monuments, in addition to a Preclassic carved stela (Fahsen and Grube 2005:79), are considered archaeological indicators of *ajaw*, a Mayan term for a ruler identified in Preclassic and Classic hieroglyphs and iconography (Estrada-Belli 2011; Freidel and Schele 1988).

The Actuncan Archaeological Project, directed by Dr. Lisa LeCount (University of Alabama), has focused on investigating Actuncan North since 2000 (Figure 2.2). The large formal civic zone there includes the ball court (Structures 13 and 14), range structures (Structures 12 and 19), pyramids (Structures 15, 23, and 31), the E-Group (Structures 26, 27 and 23), and a possible Terminal Classic integrative structure (Group 4). Elite residential structures (Structures 29, 41 and 73) flank the civic zone and smaller commoner patio-focused groups are located to the north and west of the civic center.

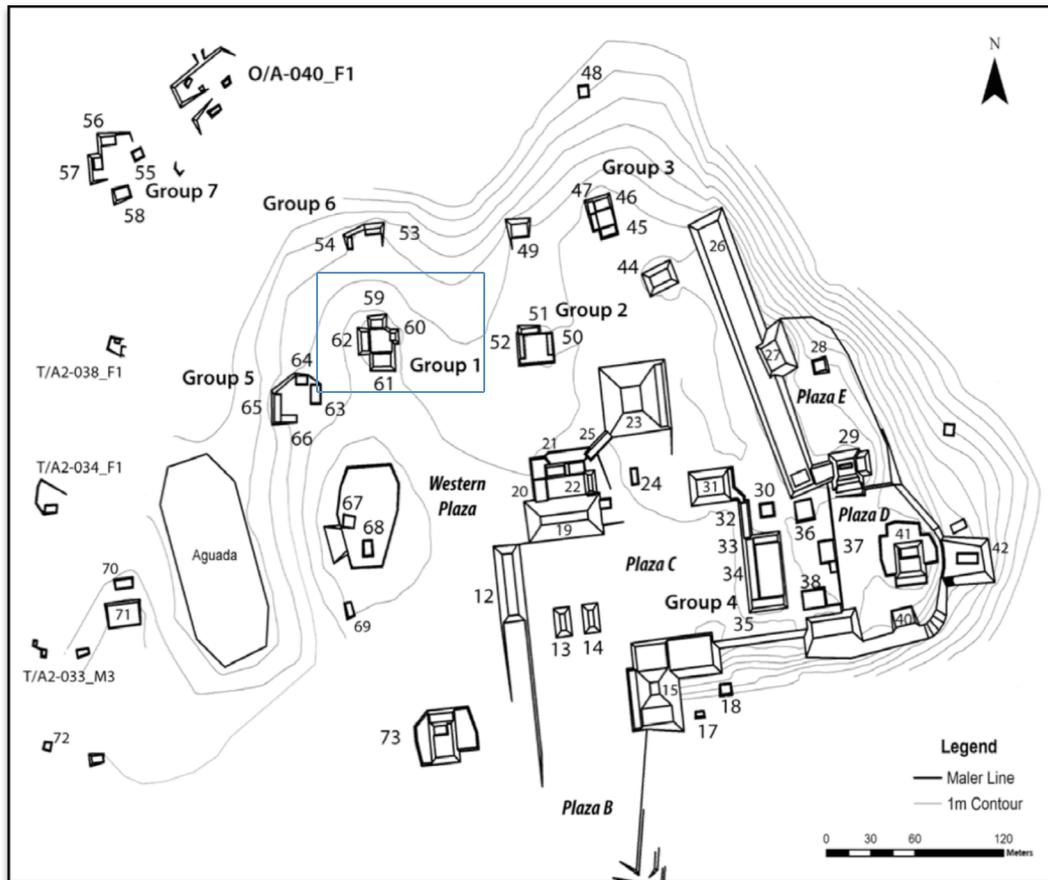


Figure 2.2 Maler image and topographic map of Actuncan North. Adapted from Don Perez. © Copyright 2010.

Several changes occurred at Actuncan between the Late and Terminal Classic (AD 600 to 800) to Postclassic (AD 800 to 900) periods that imply Maya might have migrated to this site during a changing political landscape after the fall of divine kingship in the Late Classic period. There is evidence of renovation of many domestic structures including Structure 41 (Mixer 2011), Group 1 (Antonelli and Rothenberg 2011), and Group 5 (Hahn 2012), in addition to the

appearance of a C-shaped arrangement of buildings at Group 4, similar to a council house or *popal nah*, during the Terminal Classic (AD 800 to 900) and, possibly, the Early Postclassic (AD 800 to 1200) (LeCount et al. 2011; Mendelsohn and Keller 2011). The building of a *popal nah* and the renovation of domestic structures during the Terminal Classic period lend evidence to suggest that the site gained population during this time period.

Group 1 is situated in the Northern Neighborhood and consists of four buildings on a raised platform (Rothenberg 2012) (Figure 2.2). The eastern structure of this *plazuela* group has an extensive burial deposit that was used for an extended period of time (Freiwald and Micklin 2013). The burials at Group 1 are located on both the western side of the patio (by Structure 62) and the eastern side of the patio near Structure 60, the eastern shrine (Figure 2.3). Burials 1 and 4 were single interment crypt burials that were excavated in 2001 and 2004 from the western side of the patio, associated with Structure 62 (LeCount and Blitz 2001; Scopa Kelso 2005). Both individuals were buried in an extended prone position (Scopa Kelso 2005). Burial 3 was that of a single child placed in a supine position with its head to the south (Scopa Kelso 2005). Burials 6-10, with a minimum number of individuals (MNI) of 9, were excavated in 2011 from the western side of Structure 60; some of these burials were comingled and/or disturbed by repeated reuse of the burial space to inter subsequent individuals (Freiwald 2012) (Figure 2.4). These individuals were positioned in a north-south

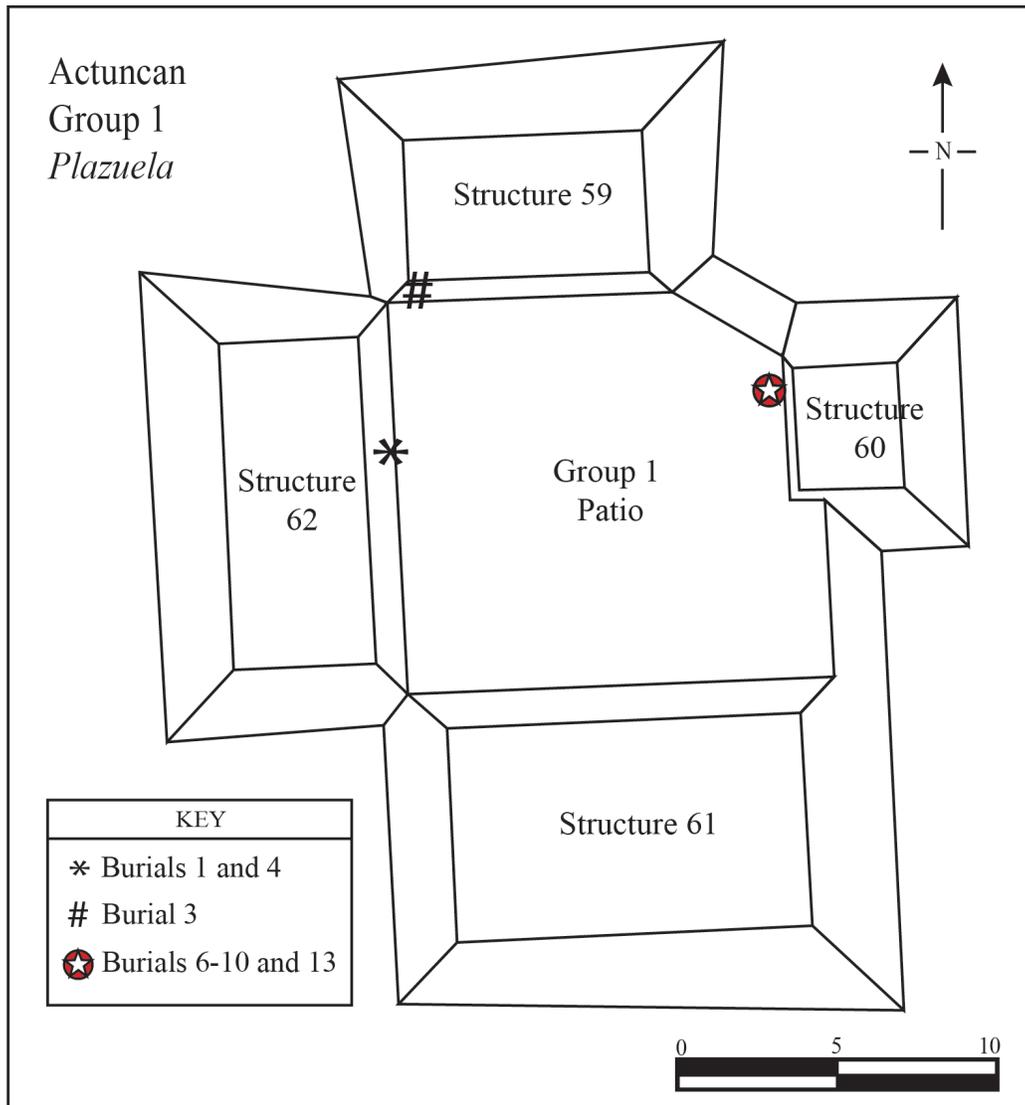


Figure 2.3 Maler image of Group 1 *plazuela* depicting location of burials in relation to structures and patio.

orientation and were constrained to the patio adjacent to the building platform of Structure 60. Details on Burials 6-10 are provided in the following section.

Burial 13 was excavated in 2012 on the west side of the eastern structure

(Freiwald and Micklin 2013). The individual was interred with head to the south and arms extended, as was common in the upper Belize River Valley; however, unlike other burials associated with the eastern structure, which were often in a prone position, Burial 13 was supine. Several funerary goods, including a ceramic vessel containing a human distal manual phalanx, a chert point, and a total of nine obsidian blades, were excavated in proximity to Burial 13. The unique body positioning and associated grave items may indicate that this individual was of a different status or significance than the others interred at this eastern shrine (Freiwald and Micklin 2013). Burials 6-10 and 13 are the focus of this study.

The long-term use of this eastern structure for burials is consistent with McAnany's (1995) identification of an ancestor shrine, and lends evidence to suggest that Group 1 may have been the home of an important founding family (LeCount 2012). In addition to prolonged use, this burial space is different from others excavated at Actuncan to date in that it is extensively disturbed (Freiwald 2012). The disarray and sometimes comingling of remains may be indicative of changing social norms or beliefs about the dead (Freiwald 2012). Questions arise about whether this disarray signals the in-migration of individuals who do not worship the ancestors previously interred in this significant space, or if this is the archaeological expression of new cultural practices, making isotope analysis particularly relevant at Actuncan.

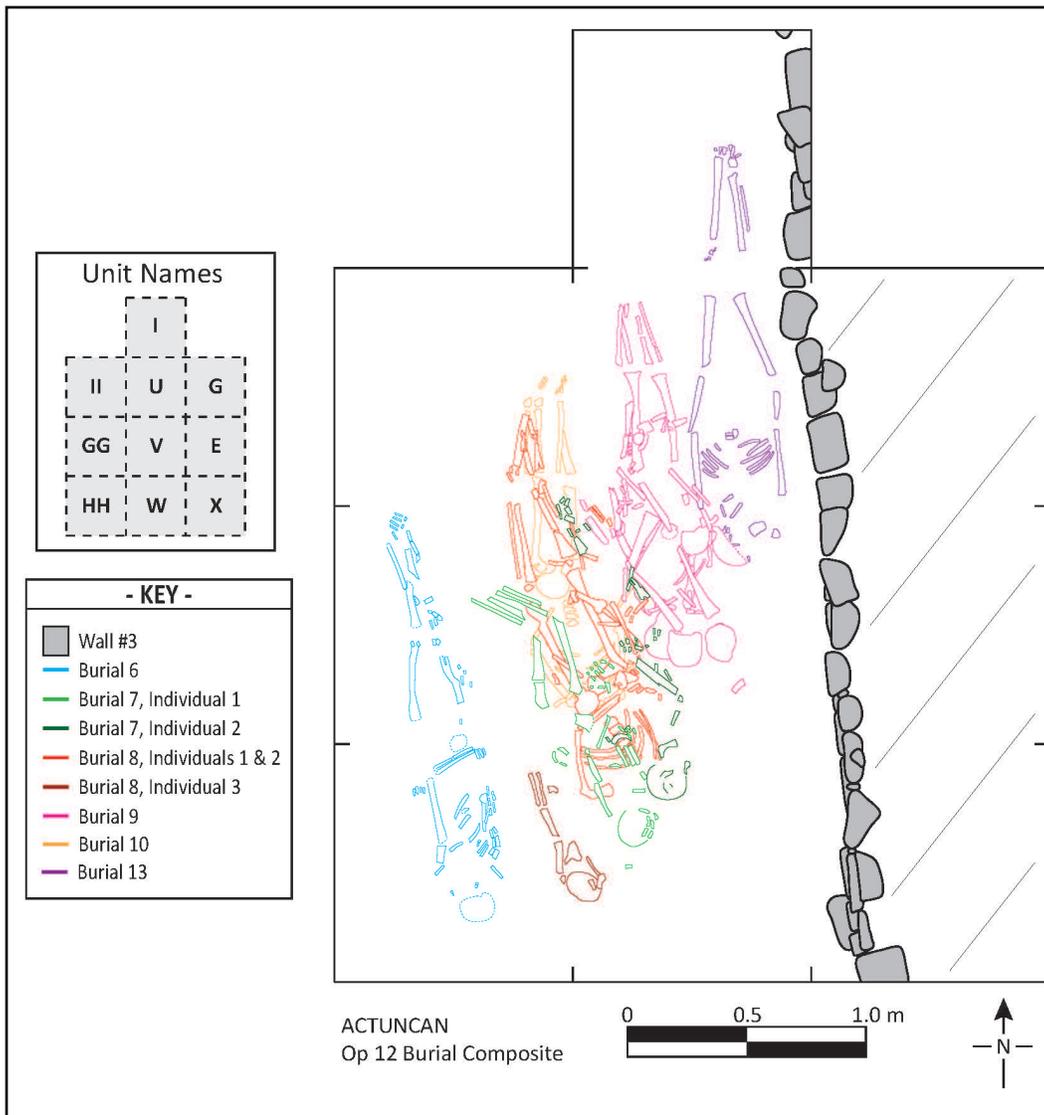


Figure 2.4 Complex series of burials from Group 1. Burial 9 consists of crania from two individuals. Image by Kara Fulton and Carolyn Freiwald, 2013.

A total of six burials with a combined minimum number of ten individuals (MNI) have been excavated from the patio in front of Structure 60 (Freiwald and Micklin 2013). While this is a small sample size, the isotopic results will still

provide meaningful data on the eastern structure burials and the presence or absence of migrant interments here.

Burial Position and Grave Inclusions

In 2011, excavations were begun at Group 1 initially to investigate the construction history of Structure 60, as well as to identify what its role was in relationship to the other structures of the *plazuela* group (Rothenberg 2012). This focus shifted when several human burials were discovered. The following details on burial position and grave inclusions of Burials 6-10 are summarized in the Actuncan Archaeological Project site report from 2011 (Freiwald 2012: 49-54) (Figure 2.4).

Burial 6 was a single individual interred in a simple pit. The individual was interred in the prone position with head to the south. The body extended to the north with the right arm flexed behind the back. Although preservation was poor and many bones were highly fragmented, the skeleton was mostly in anatomical position. Cobbles and boulders placed on top of and surrounding the body caused some movement of the bones and crushing of the skull. There were no grave goods discovered in this burial, although a worked marine shell was found within the surrounding area.

Burial 7 included the skeletal remains of two individuals: one adolescent (Individual 1) and one adult (Individual 2). Individual 1 was interred in a simple pit that had no grave goods within the burial itself. A drilled shell bead and a bird

bone were excavated near the grave that could have originally been placed within the proximity of the skeleton intentionally. Several sherds of Late Classic ceramics were contained in the matrix in direct contact with the skeletal remains. Individual 1 was interred in the prone position with the head to the south and the body extended to the north. Similar to Burial 6, the right arm was flexed behind the back and the left arm was straight. The skeleton was mostly articulated; however, the skull was highly fragmented from the weight of a boulder above it. Individual 2 was a collection of bones located to the east of Individual 1. This accumulation of long bones and a skull may have been from a single person that became highly disturbed by bioturbation and re-access of the burial space to inter subsequent individuals, or a collection of bones that is a catchment from multiple disrupted graves. Under either scenario, it represents a separate person from Individual 1 since both had skulls present. Original burial position, grave preparation, and grave inclusions are not ascertainable due to the highly disturbed condition. Isotope samples were collected from each.

Burial 8 consists of the remains from three different people. Individual 1 was a largely intact skeleton that lacked a skull and left arm. The remains were placed in a simple pit that had minimal preparation similar to those of Burials 6 and 7, but with fewer cobbles and artifacts in the surrounding matrix. Individual 1 was observed to be in a prone position with upper extremities to the south, lower extremities extended to the north, and right arm flexed behind the back. To

date, Individual 2 consists only of lower limbs since the remainder of the skeleton extends into an unexcavated section of the patio. Based on directionality of the limb bones, the individual appears to be oriented with the feet to the south and head to the north, provided these elements are present and the recovered bones represent an intact skeleton. The partial excavation of this individual leaves questions about grave preparation, grave inclusions, and full body positioning unanswered. Individual 3 consists of only a skull, shoulder girdle, and right arm. Based on the bones present, the body was oriented with the skull to the south and the right arm extending to the north.

Burial 9 consists of a minimum of two individuals (but likely several more) and is the most complex of the burials excavated to date from the patio. Unlike Burials 6-8, Burial 9 was located within a crypt lined with small to medium sized cobbles and upright limestone blocks as well as three capstones placed horizontally over the southern portion of Individual 1's grave. The crypt was topped with flat limestone slabs and shows similar construction features to burials located elsewhere at Actuncan. Individual 1 was the primary inhabitant of the crypt and appeared to be mostly complete and articulated. This person was placed in a prone position, but orientation of the skeleton has not yet been ascertained. Artifacts including a speleothem, obsidian, and a miniature bottle were discovered at the same level as Individual 1, but their association with the burial is not well understood. A carved antler was excavated from the region of

the upper thorax and may have been an original grave inclusion. Individual 2, represented by a cranium in very close proximity to Individual 1, was also interred in the prone position. Freiwald suggests that this individual was probably an intact burial that predated the construction of the stone lined crypt and was dislocated during the building of it. The only grave inclusions associated with Individual 2 were shell ear ornaments found near the cranium. The remainder of Individual 2 may be mixed into a number of articulated limbs and other comingled bones that were excavated from the crypt. Due to the highly disturbed nature of the crypt, the relationship between all of the skeletal elements present is not yet clear.

Burial 10 contains the remains of two individuals. Individual 1 is lacking a skull, but is otherwise largely intact. This person was interred in a prone position with torso to the south and the remainder of the body extended to the north. Individual 2 consists of lower limbs that extend farther into the north end of the grave. Information on burial position and grave inclusions is unavailable since the second individual was not excavated.

Burial Practices and Veneration of the Dead

Many of the mortuary patterns observed at Actuncan's Group 1 are similar to those found at Caracol and other Maya sites. Throughout the Late Classic period, burials at Caracol were most commonly located within residential plazas and were associated with the eastern structure (Chase and Chase 2011). The

ancient Maya's tendency to inter the dead in relation to eastern structures is also well documented at the site of Tikal in Guatemala. Marshall Becker's (1971, 1992, 2003) analysis of plaza types led to the discovery that a large number of burials at Tikal were associated with eastern structures, which appear to have had a mortuary capacity in some residential groups. This indicates that the act of burying individuals at the eastern structure involved some ritual function and held significance to the ancient Maya (Becker 1971). Burial at the eastern shrine has also been identified at Pook's Hill (Helmke 2000) and Zubin (Iannone 1996), both in the Belize River Valley.

The contents of caches accompanying these burials varied greatly, from rich to nonexistent. Caches at Caracol occasionally included finger bowls containing human phalanges and obsidian eccentrics (Chase and Chase 1998), as well as ceramic vessels (Chase 1994). Some of the burials from the eastern structures contained several individuals and showed evidence of multiple episode interments where graves were disturbed a number of times for the subsequent placement of human remains (Chase and Chase 2011). In these instances, skeletal material and cache assemblages show evidence of being disturbed and appear to have had items added or removed (Chase and Chase 2011).

The Maya came into contact with existing graves in two distinct ways: reuse and re-access. Reuse of a burial space to inter more than one individual was a common practice that resulted in the disturbance of existing graves during

creation of new ones. A series of burials at La Caldera in northern Belize was excavated from beneath a plaster floor that had been cut through to create an interment space (Kunen et al. 2002). The upper portion of an earlier burial was disturbed during later placement of a second corpse. Viewing the plaster floor from below reveals that the floor was apparently patched after being opened more than once to inter subsequent individuals. A burial in the E-group at the Chan archaeological site in the Belize River Valley consisted of a female interment that was later shifted to the side of the burial crypt for placement of a male skeleton (Novotny and Kosakowsky 2009).

Similarly, movement of existing skeletal material during the interment of a new individual occurred in the complex series of burials in the patio of Group 1 at Actuncan, which consists of graves that were disturbed during the placement of subsequent burials (Freiwald 2012). Similar practices of reusing grave space are present across the Maya landscape and differ from the practice of reopening graves to add or remove materials.

Burial spaces were frequently re-accessed for the addition or removal of grave goods or human remains. At Zubin, one grave was reopened in order to add a ceramic vessel and remove jadeite beads, which were then deposited into a later burial (Iannone 1996). It is also possible that the individual's cranium was removed during this episode of re-access for ritual purposes. A grave at the Chan site also showed evidence of being reopened (Novotny and Kosakowsky 2009).

The burial was observed to have a cairn above it that was hypothesized to serve as a marker for identification by later descendants. At Pook's Hill, Helmke (2002) suspects that a grave associated with the eastern shrine was likely reopened and the contents removed, leaving only a number of bone fragments. The series of burials excavated from Actuncan Group 1 included several individuals who had skeletal elements either missing or additional ones deposited with them, a pattern that could be consistent with later re-access of the grave for the purpose of interaction with the dead (Freiwald 2012).

Within the context of rituality and locality are the social dynamics of interring the dead in residential *plazuela* groups. The dead were not separated from the living, but instead had a continued relationship with them through reopening of graves and prolonged residence in buildings used for mortuary practices (Chase and Chase 2011). This continued interaction with the deceased is associated with ancestor veneration and the tangible connection between honoring important family members and maintaining ownership rights of the land where they are interred (McAnany 1995). Burial of individuals under the floor of household structures is described as early as the Early Middle Preclassic period at Cuello in Belize (Hammond 1999). Placement of interments beneath households occurred during the construction phase, while the residences were actively occupied, and after they were abandoned (Hammond 1999). Veneration of the

deceased, with which the Maya maintained prolonged contact, is intensified with preferential burial location at the eastern structure.

The interaction between burial practices and migration was evaluated across 15 archaeological sites in the Belize River Valley in a study that combined osteological analysis with archaeochemistry (Freiwald 2011). Xunantunich, Actuncan's closest neighbor, was among the sites studied, as were Pook's Hill and Zubin. Southern burial orientation was determined to be highly correlated with strontium isotope signatures consistent with the Belize River Valley, as was prone positioning (Freiwald 2011:317). Freiwald's study found that locals more often occupied single interment burial spaces, while nonlocals were much more likely to be buried in interment places consisting of multiple individuals (2011:319). Additionally, burials with only the skull present were most commonly found to be nonlocals. The evaluation of these trends in burial practices with isotopic data allows for a more robust understanding of changes in social and cultural norms combined with the movement of nonlocals into a site (Freiwald 2011).

Isotope Analyses and Migration

Strontium and oxygen isotopes values are used to infer migration, while carbon isotope values provide information on dietary inputs that can provide supporting evidence for geographic location. While both bone and tooth enamel can be processed for isotope sampling, each material has its own benefits and

limitations. Bone remodels throughout an individual's lifetime, and therefore provides data on isotope exposure since the last osteological turnover occurred. The availability of bone collagen is affected by preservation of skeletal material, and chemical signatures can be skewed by post-depositional diagenesis. In contrast, the biogenic isotope signal of tooth enamel has been demonstrated to persist much longer than that of bone collagen (Kohn et al. 1999; Lee-Thorp and Sponheimer 2003). Since tooth enamel is deposited beginning in utero and continues until around 12 years of life, sampling this material provides data on childhood nutrient intake (Hilson 1996). Tooth enamel preserves well and is not as susceptible to uptake or leaching of elements from the surrounding soil due to its mostly inorganic composition and decreased surface area of the large hydroxyapatite crystals (Hilson 1996). Analysis of tooth enamel allows archaeologists to gain an understanding of whether individuals were interred in the same place in which they resided as an infant or child.

Sampling procedures greatly affect the successfulness of isotope testing. Dentine, the substance underlying enamel, is more susceptible to diagenic changes and must be carefully removed to prevent skewed or contaminated results (Budd et al. 2000). The enamel cap of individual permanent teeth is formed at different times during dental development, meaning that each type of tooth can provide information about a particular interval of childhood growth.

Understanding the ages at which this occurs helps to determine which teeth to

sample for which age profile. Enamel is laid down on first molars from birth to 3 months, canines from 4 months to 6 years, premolars mostly between the ages of 2-6 years, and third molars around 9-12 years (Hilson 2005). Because of this variation in timing, sampling is best performed on teeth of the same tooth class across a population, or on teeth that have similar enamel formation times, in order to obtain results that focus on a more targeted age group.

Strontium

Strontium is found in bedrock and is transferred to the human body through foods that are ingested, linking diet to geographic region. While strontium-86 (^{86}Sr) is a naturally occurring isotope, strontium-87 (^{87}Sr) is produced as a result of the decay of rubidium-87 (^{87}Rb). In places where geological deposits are older, and original rubidium/strontium ratios were high, the ratio of $^{87}\text{Sr}/^{86}\text{Sr}$ is expected to be higher, resulting from a longer time span for radioactive decay of ^{87}Rb to have occurred (Bentley 2006; Faure and Powell 1972). Plants take up strontium as it is made available through the weathering of rock; these plants are then ingested by animals and humans, leading to a largely similar strontium isotope expression by the flora and fauna of a specific region (Price et al. 2002). Strontium can sometimes substitute for calcium in tooth enamel due to their very similar atomic sizes (Schroeder et al. 1972). When strontium replaces calcium during dental development, it becomes part of the

permanent tooth enamel that is formed during childhood (Price et al 2008; Wright 2005, 2012).

Strontium isotope values are expressed as a ratio of ^{87}Sr to ^{86}Sr and reflect the amount of isotopes present in soil composition, not the types of food choices people made (Wright 2012). Several environmental and dietary elements have been examined for their impact on human strontium isotope levels. Sediments carried from one isotope zone to another through fluvial transport and the creation of floodplains could theoretically affect the levels of strontium found in a region (Bentley 2006). However, because the suspended sediment particles remain in motion, they appear to have no impact on local isotope levels (Bentley 2006).

It is possible for ocean water to have different effects on strontium isotope levels. For example, sea spray can cause elevated strontium levels in coastal areas, which can be a concern for obtaining baseline values in these regions (Sealy et al. 1991). The consumption of marine resources like fish and shellfish may skew strontium isotope levels away from those expected of residents in a particular area. While evidence of marine resource consumption has been found in Maya inland sites, the use of these food items in the diet would have been uncommon and not affected isotope levels (Wright 2005). Finally, the intake of salt that was imported from coastal regions may influence strontium levels and has been attributed to increased strontium levels at Tikal (Wright 2005). This

case of elevated isotope levels due to salt consumption has not yet been identified in other Maya sites (Freiwald 2011).

Strontium isotope analysis is becoming a more commonly used method to address questions about population movement in Mesoamerica. One of the initial instances for which this technique was employed was at Teotihuacan.

Comparison of strontium values resulted in the identification of several migrants, some of whom aggregated to form communities of outsiders (Price et al. 2000).

Additionally, immigration to Tikal has been identified using strontium isotope analysis to determine that migrants were present at the site, and also to

demonstrate that both commoners and elites had a mobile residence pattern

(Wright 2005, 2012). Furthermore, Price and colleagues (2010) performed

studies of strontium isotope analysis at Copán to show migration in Honduras,

and Freiwald (2011) demonstrated migration throughout the Belize River Valley.

The literature base on the use of strontium isotopes to identify geographic origin is getting larger as more and more researchers are using this tool.

The Belize River Valley is unique in that strontium isotope levels are constrained within small geographic areas and changes in values can be detected over short distances (Freiwald 2011; Hodell et al. 2004). Multiple studies have been performed using strontium isotope analysis on human remains, fauna, and geologic samples throughout this region. Hodell and colleagues (2004) pioneered the publication of a dataset of strontium isotope values across the

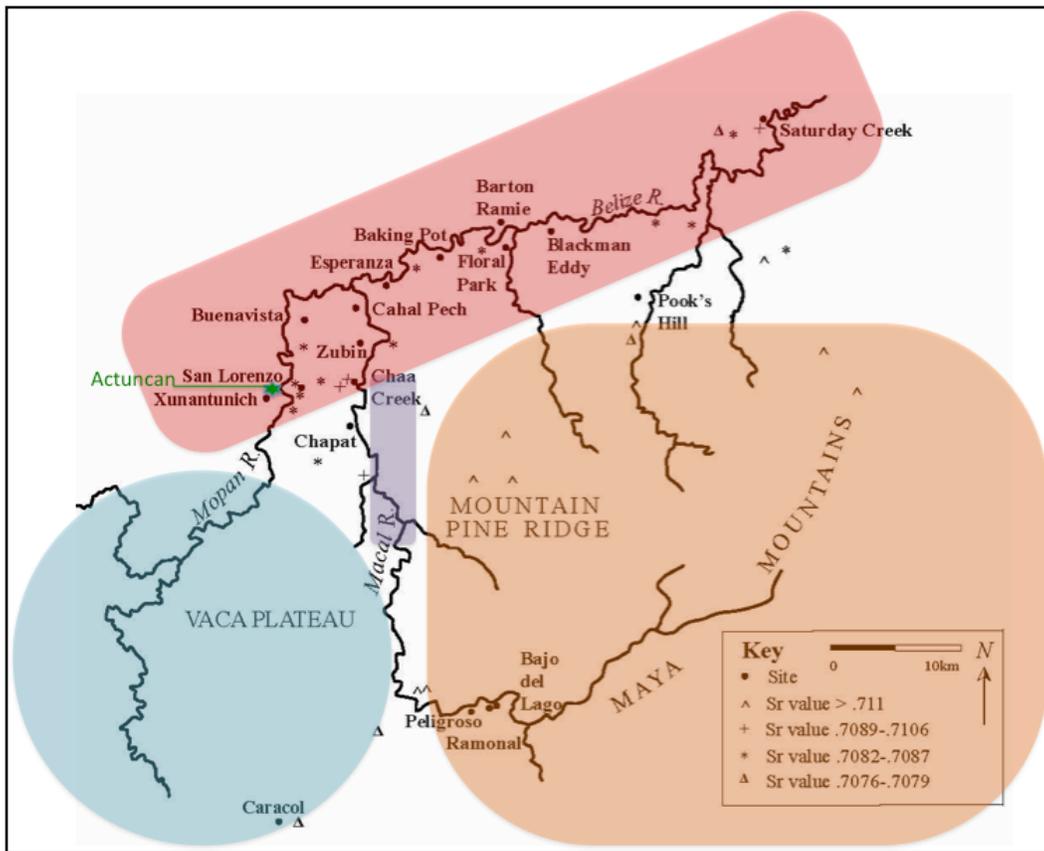


Figure 2.5 Strontium zones of the Belize River Valley and surrounding area. Adapted after Freiwald 2011.

ancient Maya landscape by sampling bedrock, soil, plants, and water. They found that this was a viable method for distinguishing geographic regions and could be used to identify ancient migration. Price and colleagues (2008) performed isotope testing on over 500 tooth enamel, bone and shell samples and verified that this was a valid method for identifying change in residence between childhood residence and interment location. They determined that the variations seen in isotopic values across Mesoamerica and the upper Belize River Valley were

significant and discrete enough to conclude which individuals have nonlocal origins, as well as where they may have lived during childhood.

Several studies have contributed to the creation of a dataset of baseline values for strontium isotope ratios (Freiwald 2011; Hodell et al. 2004; Price et al. 2008, 2010, 2007; Wright et al. 2010). Strontium isotope values have been identified to make up four zones in central Belize (Freiwald 2011) (Figure 2.5). The Vaca Plateau zone has a range of 0.70763-0.70786 with a mean value of 0.7077, the Belize River zone has a range of 0.7082-0.7091 with a mean of 0.70850, the Macal River zone has a range of 0.7089-0.7107 with a mean of 0.7100, and the Maya Mountain zone is characterized by a range of 0.7114-0.7255 with a mean of 0.7179 (Freiwald 2011:85). Actuncan is located in the Belize River zone. Other strontium zones have been identified across the Maya lowlands including the Northern, Central, Western, and Southern Lowland zones, as well as the Metamorphic zone, Volcanic Highland zone, and Pacific Coast zone (Hodell et al. 2004). These values are consolidated and presented in Freiwald (2011) and will be used for comparison of results obtained in this study. Although the values for strontium isotope measurements appear to be very similar to each other, the differences are significant on a geological scale and exceed mass spectrometer measurement error (Price et al. 2000:906).

Oxygen

Oxygen (O) isotopes are found in ground water and exist in different concentrations across geological regions based on rainfall and other types of precipitation. Oxygen is ingested via drinking water in two forms, ^{18}O and ^{16}O . The mathematically transformed ratio of the isotopes, designated $\delta^{18}\text{O}$, is largely a measurement of an individual's body water (Luz and Kolodny 1985; Luz et al. 1984), which is determined primarily by rainfall at place of residence during skeletal tissue development. In addition to drinking water, oxygen isotopes are incorporated into the human body via food sources and water vapor from the surrounding environment (Longinelli 1984; Luz and Kolodny 1985), which are bound into both phosphate and carbonate groups in skeletal tissues. $\delta^{18}\text{O}$ is reported in relation to one of two standards; the VSMOW (Vienna Standard Mean Ocean Water) for phosphates or the PDB (Pee Dee Belemnite) for carbonates in tooth enamel apatite. Oxygen isotopes in phosphate and carbonate groups produce comparable results that can be discussed together by applying a conversion factor.

Several factors affect the concentration of oxygen isotope levels in ground water across geographic regions including elevation, latitude, seasonality, and temperature. Inland rain contains less ^{18}O than coastal rain since the heavier element falls in precipitation as clouds move over land. Additionally, drinking water at higher latitudes and elevations has a lower ^{18}O to ^{16}O ratio because the

lighter isotope remains suspended in vapor longer. These oxygen level variations across the landscape can be used to identify migration and support or further refine strontium analyses (Schwarcz et al. 1991; Wright 2012). The use of oxygen isotopes to identify the origins of nonlocal juveniles has not yet been proven to be effective for use as a solo technique, but it serves well in conjunction with strontium studies (Price et al. 2010), with the exception of studies done at Teotihuacan (White et al. 2000).

As with strontium isotope values, multiple studies have identified baseline values for oxygen isotope ratios in tooth enamel at sites such as Copán, Calakmul, and Kaminaljuyú (Price et al. 2007; Wright and Schwarcz 1999; Wright et al. 2010; Wright et al. 2000 cited in Wright 2012). Human oxygen phosphate values in Mesoamerica are positive and fall between 10‰ and 20‰_{VSMOW}, while carbonate oxygen values are typically negative and span from 0‰ to -10‰_{PDB} (Price et al. 2010:22).

Carbon

Carbon (C) isotope levels found in skeletal tissues are a direct reflection of the isotopic makeup of the type of plant consumed in an individual's diet. Plants contain different amounts of stable carbon isotopes, ^{12}C and ^{13}C , based on leaf structure and the type of photosynthetic pathway utilized for metabolism. The 4-carbon metabolic pathway used by C4 (Hatch-Slack) plants results in organisms that are richer in ^{13}C than C3 (Calvin) plants, which contain lower levels of ^{13}C as

a result of their 3-carbon processing system. CAM (Crassulacean Acid Metabolism) plants utilize an alternative photosynthetic design based on the C4 pathway, but are responsive to light/dark cycles. This pathway results in values intermediate to those of C4 and C3 plants, but can be variable depending on conditions. The average $\delta^{13}\text{C}$ of all C4 plants grouped together is -12.5‰, while C3 plants exhibit an average $\delta^{13}\text{C}$ of -26.5‰ (Van der Merwe and Vogel 1978) in reference to the Peedee belemnite (PDB) standard. As these isotope ratios are incorporated into the human body via plant consumption, childhood nutrition is recorded in tooth enamel. This allows for the archaeological identification of early dietary input through tooth enamel sampling.

In the study of the ancient Maya, carbon isotope analyses are most useful for determining the amount of maize consumed as part of the standard regional diet (Wright et al. 2010). This is aided by the fact that maize was the only C4 plant that was ingested in large amounts, while the majority of other plant resources were C3 plants. Since different regions across the Maya landscape relied on maize in varying degrees for nutrition (Gerry 1993), it is possible to infer migration from diet zone, which serves as excellent supporting evidence for strontium and oxygen isotope studies. For example, individuals residing in the Belize River Valley relied less on maize as a primary food source than those living in Tikal or Copán (Gerry 1993). Carbon isotope analysis thus provides further means to tease out geographic location of childhood residence. By

comparing dietary information obtained from carbon testing with that of the region in which an individual was interred, it can be determined whether childhood diet is consistent with that of burial location. The proportion of carbon isotopes can be used in conjunction with strontium and oxygen values to provide a more nuanced understanding of migration (Wright et al. 2010).

Conclusion

Freiwald's (2011) extensive analysis of 19 sites across the Belize River Valley and other Maya regions compared the strontium isotope values of 178 individuals to evaluate migration in conjunction with carbon and oxygen isotope ratios and burial practices. Freiwald's study forms the backbone to a pan-Maya approach to understanding the identification of population movement. In my thesis I am extending Freiwald's study by presenting isotope values of those interred at the Group 1 plaza of Actuncan, as well as providing an analysis of how burial practices of these individuals compares to others from the Belize River Valley.

Chapter 3

Materials And Methods

Isotopic analysis was performed to identify whether any of the individuals interred in the patio near the eastern structure in Actuncan's Group 1, Structure 60, were nonlocal. Skeletal strontium isotope levels were compared to regional values in an attempt to determine if Actuncan or the Belize Valley were the natal residence of these individuals. Oxygen and carbon isotope ratios were obtained to elucidate migration status by investigating whether childhood water and dietary inputs were consistent with those of Actuncan or elsewhere in the Belize River Valley. Additionally, the burial position and grave inclusions of Burial 13 were examined for continuity with the other burials associated with Structure 60, the remainder of the Belize River Valley, and the Maya region across Mesoamerica to determine if the unique features of this individual may indicate nonlocal status.

The sample size for this project was seven individuals, all of whom were excavated from the Group 1 patio adjacent to Structure 60. This number represents all of the individuals with associated dentition who have been excavated from this burial space.

The Maya's reuse of the patio for burial from the Early Classic to the Late or Terminal Classic periods created an area containing multiple graves in various conditions (Freiwald and Micklin 2013; LeCount and Blitz 2005; Rothenberg 2012; Scopa Kelso 2005). A number of these skeletons were comingled and are

missing assorted skeletal elements, or have additional ones present within the archaeologically defined grave space. Kara Rothenberg and Carolyn Freiwald excavated burials 6-10 in the 2011 field season, and I excavated Burial 13 with team members Felix Uck and Elmer Cocum in 2012, with Freiwald and Keller's assistance.

We excavated Burial 13 using 1x1 meter units and expanded the excavation area until the extent of the burial was identified. I mapped, photographed, and recorded the skeletal remains and their position within the grave prior to removing them from the soil. Artifacts found in proximity to the skeletal material were also thoroughly documented prior to excavation. I performed a macroscopic osteological analysis of the skeletal elements recovered from this burial in the field laboratory and cataloged which bones and teeth were preserved. With the exception of the teeth that were exported for analysis, the remainder of the skeletal material is curated in Belize by the Actuncan Archaeological Project.

Dr. Lisa LeCount, the primary investigator at Actuncan, presented the project to the Institute of Archaeology (IOA) in Belize in summer 2013 to obtain permission for exportation of dental material and destructive analysis. With the approval of the IOA and Dr. LeCount, two teeth were exported in 2013 for use in this thesis project. Tooth #2, the upper left canine, from Burial 13 was exported for isotope testing, as was an alternate specimen, Tooth #5. Although Burial 13

did not have a cranium present, Tooth #2 was excavated closer to the head/neck region, making it the more likely of the recovered teeth to have belonged to the individual in Burial 13. The back up sample, Tooth #5, was excavated closer to the thorax region of Burial 13, but was still associated with this individual and could have been used for testing in the instance that Tooth #2 was a poor specimen.

Samples were preferentially tested from the same type of tooth for each individual; however, this process was limited by which teeth were present at excavation. Ideally, enamel chips from the third molar would be used for testing in order to allow for the greatest detection of maize intensification in the diet. In absence of the third molar, premolars would be sampled. When neither third molars nor premolars were available, then first molars would be sampled. Sampling of the canine tooth provides isotope data on residence during early to middle childhood years, while sampling of the third molar reflects location of habitation during later childhood and adolescence (Table 3.1).

The right upper canine from Burial 6, the upper left canine from Burial 9-1, and the upper left canine along with an additional tooth #5 from Burial 13 were sampled for radiocarbon dating (Freiwald personal communication October 2013). In order to reduce the number of teeth that were damaged for testing, these previously sampled dental materials would ideally be used for isotope analysis in this project when possible. However, this was only possible in some cases.

Table 3.1 Ages at which dental enamel calcification occurs for mandibular and maxillary teeth. Data from Hilson 1996.

| | First Incisor | Second Incisor | Canine | First Premolar | Second Premolar | First Molar | Second Molar | Third Molar |
|------------------------------|----------------------|----------------|------------|----------------|-----------------|-------------|--------------|-------------|
| | Maxillary Dentition | | | | | | | |
| Beginning of Calcification | 3-4 months | 10-12 months | 4-5 months | 1.5-1.75 years | 2-2.25 years | Birth | 2.5-3 years | 7-9 years |
| Crown Calcification Complete | 4-5 years | 4-5 years | 6-7 years | 5-6 years | 6-7 years | 2.5-3 years | 7-8 years | 12-16 years |
| | Mandibular Dentition | | | | | | | |
| Beginning of Calcification | 3-4 months | 3-4 months | 4-5 months | 1.5-2 years | 2.25-2.5 years | Birth | 2.5-3 years | 8-10 years |
| Crown Calcification Complete | 4-5 years | 4-5 years | 6-7 years | 5-6 years | 6-7 years | 2.5-3 years | 7-8 years | 12-16 years |

The upper right 2nd molar was selected for testing from Burial 6 (Table 3.2). The lower right canines were sampled from Burial 7-1 and 7-2, while the upper canines were tested from Burial 9-1 (left), 9-2 (right), and Burial 13 (left). Burial 8-3 was the only individual who had a lower left 3rd premolar sampled.

Table 3.2 Summary of tooth sampled by burial number.

| BURIAL NUMBER | UPPER/ LOWER | SIDE | TOOTH TYPE | C-14 DATE |
|---------------|--------------|-------|--------------|---------------|
| Burial 6 | Upper | Right | 2nd Molar | Yes on canine |
| Burial 7-1 | Lower | Right | Canine | No |
| Burial 7-2 | Lower | Right | Canine | No |
| Burial 8-3 | Lower | Left | 3rd Premolar | No |
| Burial 9-1 | Upper | Left | Canine | Yes |
| Burial 9-2 | Upper | Right | Canine | No |
| Burial 13 | Upper | Left | Canine | Yes |

Sample Preparation

The dental material from Actuncan is curated by Dr. Carolyn Freiwald at the University of Mississippi, who supervised recording of the teeth and prepared them for analysis. Prior to sampling, the teeth were examined, photographed, and recorded at the University of Wisconsin-Madison T. Douglas Price Laboratory for Archaeological Chemistry (LARCH). Freiwald first photographed the occlusal surface and each side of all teeth to be processed. Qualitative traits of the dentition were measured and recorded by two separate researchers: Anna Novotny from Arizona State University examined those excavated prior to 2011

and Nicolas Billstrand from the University of Mississippi recently re-studied all of the teeth from Actuncan. Freiwald then made polysiloxane replicas of each tooth to capture dimensions and potentially make casts of the teeth. Photographing, measuring, recording, and casting the dental material are all done to capture and preserve as much information as possible prior to subjecting the specimens to destructive analysis.

Strontium

Sample preparation was completed following the techniques described in Freiwald 2011, by Freiwald at LARCH. Teeth were first sonicated for 15 minutes in Millipore purified water, and then mechanically cleaned of impurities and surface enamel from the sample site using a Microlab 350/450 dental drill with a diamond burr. In most instances, removal of 0.5mm of tooth enamel is adequate to eliminate a majority of surface contamination (Schoeninger et al. 2003). A sample area that is free of pits or mottling was selected to ensure that impurities below the tooth surface were minimized.

Additionally, the chosen site was large enough to ensure there was adequate surface to cut the enamel with minimal damage to the tooth. After initial debris removal, the enamel was separated from the tooth, while avoiding cutting into the dentin, using a diamond saw and dental drill. The enamel was then examined under a microscope to determine if more cleaning or dentine removal was required to ensure that no impurities remained to contaminate the

sample. An enamel chip measuring approximately 5-10 mg was then sent to the University of North Carolina (UNC) at Chapel Hill for strontium sample processing.

The Geochronology and Isotope Geochemistry Laboratory at UNC, located in the Department of Geological Sciences, is directed by Dr. Drew Coleman. The samples were processed by Professor Emeritus Paul Fullagar. The facility where sample testing is performed is a class-1000 clean lab that houses a VG Instruments Sector 54 thermal ionization mass spectrometer (TIMS). The TIMS instrument evaporates and ionizes a sample off a rhenium filament and provides “flat-topped” peaks for isotope masses that negate any instrument drift that may affect relative ion intensities. Flat-topped peaks are necessary for obtaining high-precision isotope ratios, as is concurrent collection of all isotopes being studied to prevent variations in the condition of the source from causing fluctuations in ion beams that can affect data. This type of mass spectrometer measures absolute ratios since the strontium samples are in solution form (University of Wisconsin-Madison Department of Geology and Geophysics 2013).

The technique for sample processing is explained in Freiwald (2011:107-108). The Geochronology and Isotope Geochemistry Laboratory used Sr-Spec ion exchange resin in micro columns to isolate strontium in the samples after which they were put into a solution of tantalum chloride and phosphoric acid and

loaded in single filaments of rhenium. The triple dynamic multicollector mode was used for sample analysis and exponential fractionation behavior was assumed with $^{88}\text{Sr}=0.1194$. Strontium analysis laboratory standard is NBS-987 and analytic uncertainty is estimated using the long-term reproducibility of this standard, which for the ratio of ^{87}Sr to ^{86}Sr computes to 0.710268 ± 0.000020 , 2σ for 134 samples. Strontium analysis standard error is typically greater than 0.000011 , 2σ .

Several steps are involved in ensuring that sample processing is considered successful. Multiple checks for contamination are performed, including visually inspecting the sample during mechanical cleaning, dissolution in nitric acid to remove impurities, and verifying that the standard error is within an acceptable range, less than 0.0016 . The sample can be rerun in the event that contamination is detected. The TIMS produces useable data by running each sample through thousands of cycles, which are then grouped into batches. A minimum of eight batches of useable data is required to achieve a successful sample.

After isotope testing was complete, the values were compared to other published isotope studies in an attempt to identify individuals who are migrants and the impact they had on Actuncan burial practices at the eastern structure. Strontium, oxygen and carbon isotope values were analyzed individually for initial impressions of migration status, then in concert with each other for the

Table 3.3 Strontium isotope values across the Maya region. Data from the Northern and Southern Maya Lowlands, Volcanic Highlands, and Metamorphic Province from Hodell et al. 2004. Remaining data, with the exception of Actuncan, from Freiwald 2011.

| GEOGRAPHIC REGION | STRONTIUM VALUES | MEAN | STANDARD DEVIATION |
|--|-------------------|----------|--------------------|
| Maya Mountains and Mountain Pine Ridge | 0.7114-0.7255 | 0.716325 | 0.0055 |
| Belize River Valley | 0.708208-0.709077 | 0.708503 | 0.00026 |
| Macal River Valley | 0.70894-0.71065 | 0.709989 | 0.00092 |
| Vaca Plateau | 0.707630-0.707863 | 0.707743 | 0.000098 |
| Northern Maya Lowlands | 0.70775-0.70921 | 0.70853 | 0.00043 |
| Southern Maya Lowlands | 0.70693-0.70845 | 0.70770 | 0.00026 |
| Volcanic Highlands | 0.70380-0.70492 | 0.70415 | 0.00023 |
| Metamorphic Province | 0.70417-0.72017 | 0.70743 | 0.00286 |
| Actuncan Test Sample (Belize River Valley) | 0.70841* | | |

*Sample from Actuncan consists of a single value.

most thorough picture of population movement and possible place of origin.

Strontium isotope values were compared to data from multiple sources (Table 3.3).

The strontium isotope value for Actuncan was obtained from a single modern shell submitted for analysis. This value provides a point of reference on the landscape for one place in Actuncan specifically, but is combined with other local values to obtain a range of strontium levels for evaluation of local versus nonlocal individuals (See Chapter 4).

Carbon and Oxygen

Carbon and oxygen isotope ratios were obtained from the same tooth enamel samples as the strontium isotopes. An additional 1-3 mg of powdered tooth enamel was collected during sample preparation and sent for carbon and oxygen isotope analysis to the University of Arizona Environmental Isotope Laboratory in the Department of Geosciences under the direction of Dr. David Dettman. A mortar and pestle was used to pulverize the enamel into a fine powder which was processed in an automated Finnigan Delta S VG602C that has an analytical precision of 0.11 with 2 standard deviations equaling 0.08. Oxygen isotope ratios have two standards, the Standard Mean Ocean Water (SMOW) and the PeeDee Belemnite (PDB), the marine carbonate standard. The Standard Mean Ocean Water value for the sample is determined by:

$$\delta^{18}\text{O}=1000 \times \left\{ \left[\frac{(^{18}\text{O}/^{16}\text{O})_{\text{sample}}}{(^{18}\text{O}/^{16}\text{O})_{\text{SMOW}}} \right] - 1 \right\}$$

Carbon isotope ratios are measured in relation to a standard that is calculated as:

$$\delta^{13}\text{C}=1000 \times [(R_{\text{sample}} - R_{\text{standard}})/R_{\text{standard}}]$$

where $R=^{13}\text{C}/^{12}\text{C}$ and the standard is the PeeDee Belemnite (PDB) standard for marine carbonate.

Oxygen isotope baseline data are reported in $\delta^{18}\text{O}_{\text{PDB}}$ and were published by Price and colleagues in 2010 (Table 3.4) and Freiwald (2011). Freiwald organized her oxygen isotope data by strontium isotope zone for consistency in determining population movement (Table 3.5). By presenting the data in this manner, a decrease in variability of $\delta^{18}\text{O}$ was observed in the Belize Valley sites.

Table 3.4 Oxygen isotope values across the Maya region by site. Data published for sites in Price et al 2010:Table 1, pg 23. Oxygen isotope values expressed as permil (‰).

| SITE | TOOTH ENAMEL ‰ |
|--------------------------------|----------------|
| Calakmul | -1.2 |
| Campeche | -2.9 |
| Tikal | -3.2 |
| Palmajero Valley | -3.7 |
| Palenque | -3.9 |
| Maltrata on the Gulf Coast | -3.9 |
| Copán | -4.1 |
| Kaminaljuyú | -4.8 |
| Tzintzantzun in Central Mexico | -5.4 |

Table 3.5 Oxygen isotope values across the Maya region by strontium zones. Data from Freiwald 2011:Table 6.9, pg 268. Isotope values expressed as permil (‰).

| LOCATION BY STRONTIUM ZONE | MINIMUM | MAXIMUM | AVERAGE | S.D. |
|----------------------------|---------|---------|---------|------|
| Chiapa de Corzo site | -10.78 | -4.23 | -6.07 | 2.44 |
| Pacific Coast | -6.78 | -5.02 | -5.91 | 0.46 |
| Caracol site | -4.35 | -2.55 | -3.43 | 0.71 |
| Maya Mountain zone | -4.44 | -2.87 | -3.55 | 0.58 |
| Southern Lowland zone | -4.27 | -3.27 | -3.77 | 0.71 |
| Central Lowland zone | -2.36 | -0.32 | -1.37 | 0.87 |
| Belize River zone | -4.37 | -0.91 | -2.99 | 0.87 |
| Macal River zone | -4.61 | -2.20 | -3.20 | 0.65 |

Carbon isotope data were compared to data compiled from a multitude of sources and compiled in Freiwald (2011) (Table 3.6). Carbon isotope values from several archaeological sites were grouped together by the same regions used to discuss strontium isotope values. This method of categorizing samples refines analysis by decreasing the difference between the mean and median by half and significantly narrowing the range of values (Freiwald 2011).

Isotope values that are enriched in ^{13}C reflect a higher C4 input and indicate a variety of dietary choices. One of the most important of these is the consumption of maize, which is viewed as the primary source of C4 plants in the

Table 3.6 Carbon isotope values expressed as permil (‰). Values from Belize Valley are assigned to strontium zones. Data from Freiwald 2011:Table 6.6, pg 265-266. Citations for values reported from other publications in table.

| SITE LOCATION | MINIMUM | MAXIMUM | AVERAGE | S.D. |
|--|---------|---------|------------------------------------|------|
| Chiapa de Corzo site | -4.03 | -1.84 | -3.00 | 0.97 |
| Pacific Coast sites (Paso de la Amada and Cantón Corralito) | -9.74 | -2.13 | -7.16 | 1.77 |
| Caracol site | -5.56 | -3.26 | -4.03 | 0.78 |
| Maya Mountain zone/Mountain Pine Ridge | -6.10 | -3.76 | -4.74 | 0.75 |
| Southern Lowland zone | -3.64 | -3.07 | -3.36 | 0.40 |
| Central Lowland zone | -5.83 | -2.40 | -3.87 | 1.45 |
| Belize River zone (Baking Pot, Chaa Creek, Blackman Eddy, Esperanza, Floral Park, San Lorenzo and Xunantunich) | -7.89 | -2.65 | -5.40 | 1.49 |
| Macal River zone | -8.97 | -3.58 | -6.41 | 1.47 |
| Kaminaljuyú (Wright et al. 2010) | * | * | -3.6 (M1) -3.4 (P) -3.2 (M3) | * |
| Cuello (Tykot et al. 1996) | * | * | -8.4 | 1.5 |
| Altun Ha (White et al. 2001) | * | * | -8.4 | 1.9 |
| Chac Balam (Ritchie-Parker 2011) | -8.9 | -4.3 | -6.8 | 1.1 |
| San Juan (Ritchie-Parker 2011) | -7.8 | -4.9 | -6.4 | 1.0 |

*Values for minimum and maximum or SD not provided in literature.

Maya diet (Gerry 1993; Tykot 2002; White et al. 2001). This is particularly useful in tracking population movement in Mesoamerica due to differences in levels of maize intake by region. Individuals at Tikal and Copán were noted to have higher levels of maize consumption than people residing in the Belize River Valley who generally had depleted carbon isotope ratios (Gerry 1993). Additionally, carbon isotope values that are enriched in ^{13}C can be an indicator of marine food consumption. This is reflected most in sites that are closer to the coast and is less common at inland locations.

Central to the discussion of isotope analysis and identification of people who have relocated on the landscape is how to determine “local” versus “nonlocal”. Because geologic formations, not political boundaries, direct isotope levels, migration in the ancient Maya is defined in a regional manner, not by city-state. Across Mesoamerica, strontium isotope signatures form predominately distinct regions that can generally be identified, although some overlap does exist (Price et al. 2008). For example, the Central and Southern Lowlands have a strontium isotope range (0.70693-0.70845) that includes values identified in the Belize River Valley (0.708208-0.709077). However, comparison of values found in human populations at sites suggests that population movement from one to the other can be identified with reasonable confidence. Similarly, the range of values for the Maya Mountains (0.7114-0.7255) is beyond that for the Belize River Valley (Freiwald 2011). Additionally, the Pacific Coast, the Guatemalan

Highlands, and the Motagua Valley and Copán possess strontium ratios distinctly different from those of the Belize River Valley, allowing for the visualization of migration in isotope levels (Freiwald 2011).

A greater challenge is identifying whether any of the individuals from Group 1 at Actuncan relocated locally within the Belize River Valley. Due to differences in strontium ratios found along the Macal River floodplain and those identified near the Mopan River and Belize River, some local population movement can be identified within the region (Freiwald 2011). While the similarities in the Mopan and Belize River areas differentiate them from the Macal River floodplain, there is overlap between them, as well as with those of the Northern Lowlands. This overlap presents difficulty when attempting to identify individuals who migrated between these regions within the Belize River Valley itself. Other areas of overlap occur in the Central Lowland zone and across the Petén, further confounding identification of migrants.

Under my parsimonious hypothesis, I expected to find that individuals sampled in this study would exhibit strontium isotope values within the range of 0.7082-0.7091, consistent with childhood residence within the Belize River Zone. I anticipated that the carbon and oxygen isotope analyses would support natal residence at Actuncan by demonstrating that the individuals of the Group 1 patio ingested drinking water and had a diet consistent with that of the Belize River Valley. Additionally, I expected that any unique features observed in Burial 13's

interment method would be consistent with practices seen elsewhere in the Belize River Valley.

Chapter 4

Results

In order to attempt to identify which of the individuals excavated to date from the *plazuela* at Group 1 were migrants, seven samples were submitted to the T. Douglas Price Laboratory for Archaeological Chemistry at the University of Wisconsin-Madison for strontium, carbon and oxygen isotope testing. The samples were then sent to The University of North Carolina at Chapel Hill Department of Geological Sciences, the lab that performed the strontium isotope portion of the analyses, and The University of Arizona, the lab running the carbon and oxygen isotope testing (See Chapter 3). All of the samples submitted for strontium, carbon, and oxygen isotope analysis produced successful results.

Strontium Isotope Results

The strontium isotope values for the seven burials with successful results are presented in Table 4.1. Strontium isotope levels are discrete in general, with some overlap between zones. Areas of Maya occupation that have not yet been tested may later present challenges in interpretations of place of origin if these values overlap with established baselines in other geographic regions. Additionally, some regions, like the Metamorphic Province (0.70417-0.72017), have a very wide range from minimum to maximum strontium isotope values due to variation in exposed rocks and geologic composition.

Table 4.1 Strontium isotope values by burial number.

| BURIAL NUMBER | STRONTIUM ISOTOPE VALUE |
|---------------|-------------------------|
| B6 | 0.708901 |
| B7-1 | 0.708501 |
| B7-2 | 0.708988 |
| B8-3 | 0.708806 |
| B9-1 | 0.708701 |
| B9-2 | 0.708946 |
| B13 | 0.708898 |

Strontium isotope values for the Belize River Valley were divided into upper, central, and coastal by Freiwald (2011). Even though strontium values show an increasing trend along the Belize River, these changes are not adequate to definitively determine movement along the Valley; however, they allow for a slightly more nuanced examination of strontium distribution in the area (Freiwald 2011). Within these categories, the archaeological site of Actuncan has a single test result of 0.70841, consistent with that of other upper Belize River Valley baseline measurements. This value was obtained from a shell submitted for analysis by Freiwald with the samples for this thesis to provide a specific value for Actuncan, which was not included in the original batch of samples used to create the baselines.

Testing performed in this thesis reveals that all of the strontium isotope results from the Group 1 patio fit into the same statistical dataset. Even though some variability exists, the values from these individuals are consistent with others identified in the human and baseline data for the Belize River Valley. This leads me to conclude that none of the individuals can clearly be identified as foreign to this area. The following section explores strontium values for each burial, as well as any regional overlap that may exist.

The strontium isotope value for Burial 6 was 0.708901. This is consistent with childhood residence within the Belize River Valley. Movement among Belize Valley sites was a likely occurrence for the ancient Maya, and there is considerable overlap between the upper and central river valley results, although higher values tend to be found nearer the coast. This result indicates an individual whose childhood residence was likely not near the Actuncan test sample (0.70841) or the upper portions of the river valley (0.708208-0.708719). Additionally, this individual could have had childhood residence in the Northern Maya Lowlands (0.70775-0.70921) or the Metamorphic Province (0.70417-0.72017). Strontium isotope values for the Metamorphic Province have a very wide range that span isotope levels for all of Mesoamerica, and therefore is province not a good candidate for identification of possible natal homeland.

Burial 7-1 has a strontium isotope value of 0.708501, consistent with natal residence in the central or upper portions of the Belize River Valley, which have

baselines of 0.70822-0.70908 and 0.70821-0.70872, respectively. The value for Burial 7-1 is slightly higher than that of the test sample for Actuncan (0.70841), but has the closest strontium isotope result of the Group 1 *plazuela* burials. This individual could also have had childhood residence in the Northern Maya Lowlands (0.70775-0.70921).

Burial 7-2 has a strontium isotope value of 0.708988, which has overlap with two different zones in central Belize. The Macal River Valley (0.70894-0.71065) and the central Belize River Valley (0.708208-0.709077) are both candidates for natal origin of this individual, as is the Northern Maya Lowlands (0.70775-0.70921). This strontium result fit statistically within other human populations excavated along the Belize and Macal Rivers.

The strontium value from Burial 8-3 is 0.708806. This result is consistent with childhood residence in the Belize River Valley and Northern Maya Lowlands. While this individual could have been a natal resident of the Belize River Valley, her/his value is higher than that of the test sample from Actuncan.

Tooth enamel from Burial 9-1 returned a strontium isotope value of 0.708701, consistent with early childhood dental development that occurred along the Belize River Valley. While this individual could have originated from anywhere in the Belize River Valley, her/his strontium ratio is higher than the test sample from Actuncan. Since mobility from site to site within the Belize Valley was likely common, it is not possible to further define an exact origin.

Burial 9-2 has a strontium isotope value of 0.708946, which is between those of Burials 6 and 7-2. This individual likely originated in either the central Belize River Valley or the Macal River Valley. This result possibly indicates that the individual may not have resided at Actuncan during childhood dental development.

The strontium isotope ratio from Burial 13 is the median value among the results from these samples. With a $^{87}\text{Sr}/^{86}\text{Sr}$ value of 0.708898, the individual in Burial 13 was likely not living in the Maya Mountains and Mountain Pine Ridge, the Macal River Valley, the Vaca Plateau, Southern Maya Lowlands, or the Volcanic Highlands while tooth enamel formation was occurring. The Belize River Valley and the Northern Maya Lowlands are likely possibilities for the childhood home of this individual.

Many of the individuals sampled have strontium isotope values that indicate possible natal residence in the geographic regions with overlapping isotope ranges. Carbon and oxygen analyses are used in an attempt to better delimit these results.

Carbon and Oxygen Isotope Results

Evaluation of dietary choices and water intake through carbon and oxygen isotope analyses is used to further define areas of childhood residence during dental enamel development. Carbon isotope analysis is useful in determining geographic origin since Maya in different areas of Mesoamerica consumed maize

in varying amounts. For example, occupants of Tikal in Guatemala and Copán in Honduras relied on greater amounts of maize in their diet than those who resided in the Belize River Valley (Gerry 1993). Oxygen isotope values can provide a more nuanced understanding of geographic regions like the Central Maya Lowlands, a large area with very little strontium isotope variability, but more discrete changes in oxygen isotope levels (Freiwald 2012). The carbon and oxygen isotope values for the Actuncan population are presented in Table 4.2.

Table 4.2 Carbon and Oxygen isotope values with standard deviations. Results expressed as permil (‰).

| BURIAL NUMBER | $\delta^{13}\text{C}_{\text{PDB}}$ | $\delta^{18}\text{O}_{\text{PDB}}$ | CARBON STANDARD DEVIATION | OXYGEN STANDARD DEVIATION |
|---------------|------------------------------------|------------------------------------|---------------------------|---------------------------|
| B6 | -5.79 | -3.10 | 0.011 | 0.044 |
| B7-1 | -6.27 | -3.12 | 0.007 | 0.009 |
| B7-2 | -5.84 | -2.88 | 0.021 | 0.047 |
| B8-3 | -3.15 | -3.07 | 0.040 | 0.015 |
| B9-1 | -4.54 | -2.96 | 0.024 | 0.026 |
| B9-2 | -4.04 | -2.86 | 0.013 | 0.077 |
| B13 | -5.78 | -3.21 | 0.013 | 0.025 |

Oxygen isotope ratios are higher on the coast, at lower altitudes, and closer to sea level (Luz and Kolodny 1989; Schwarcz et al. 1991). Sites in the Belize Lowlands or the Petén have higher $\delta^{18}\text{O}_{\text{PDB}}$ than sites like Kaminaljuyu in the Southern Highlands (Wright et al. 2010) or Chapantongo in Mexico (Price et al. 2010). The oxygen isotope ratios sent for analysis have $\delta^{18}\text{O}_{\text{PDB}}$ between -2.86 and -3.21, which are consistent with the Belize River zone baselines (-4.37 to -0.91). These oxygen isotope ratios further support possible natal residence of the two individuals with strontium values indicative of the Upper Belize River Valley, Burials 7-1 (-3.12) and 9-1 (-2.96). Burial 9-2 has the highest $\delta^{18}\text{O}_{\text{PDB}}$ at -2.86, while Burial 13 has the lowest at -3.21. In addition to the Belize River zone, the $\delta^{18}\text{O}_{\text{PDB}}$ of Burial 13 overlaps with isotope values from Tikal in the Petén (-3.2), as does the value for Burial 9-2 with sites in the Northern Lowlands like Campeche (-2.9) and the Macal River Zone (-4.61 to -2.20).

Carbon isotope ratios for the burials in the Group 1 patio range from -6.27 to -3.15. The range for $\delta^{13}\text{C}_{\text{PDB}}$ of the Belize River zone is -7.89 to -2.65. All of the burials have $\delta^{13}\text{C}_{\text{PDB}}$ results consistent with the amount of maize consumption in the Belize River zone. Burial 8-3 exhibited the highest $\delta^{13}\text{C}_{\text{PDB}}$ of -3.15, while Burial 7-1 had the lowest at -6.27.

Burial Position and Grave Inclusions

Details on burial positioning and grave inclusions from my excavation of Burial 13 are published in Freiwald and Micklin (2013). Burial 13 is that of a

single individual interred in a partial cist that was prepared by reusing stones from the existing construction fill and walls to make an incomplete lining to surround and cover the body (Figure 4.1).



Figure 4.1 Burial 13.

The skeleton was oriented with the torso to the south and lower body to the north, with all extremities fully extended. Unlike the other burials associated with the eastern structure, this individual was interred supine. Although lacking a cranium, the remainder of the skeleton was mostly present and well articulated.

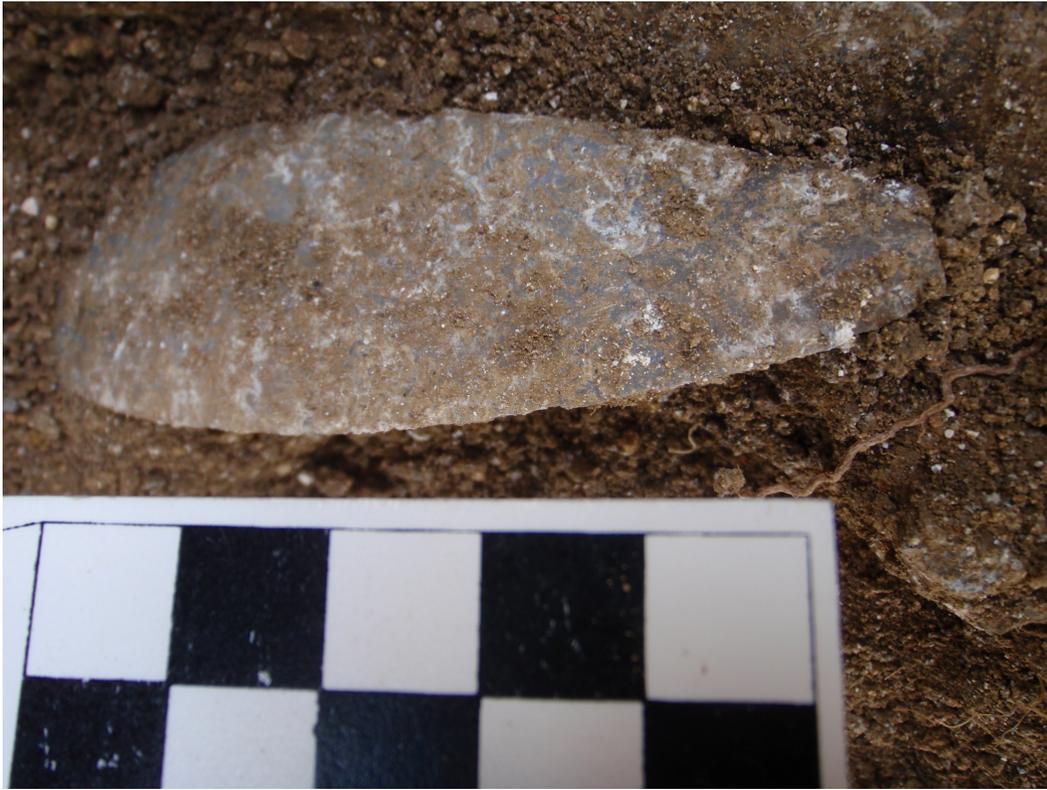


Figure 4.2 Chert point associated with Burial 13.

Several artifacts were found in proximity to the burial including a large chert point (Figure 4.2), several obsidian blades, and an undecorated ceramic vessel containing a distal manual phalanx (Figure 4.3), although their exact relationship to this individual is unclear. Several pathologic changes were observed on many of the long bones including periostitis, active and healed lesions, and arthritis that indicate a level of inflammatory and infectious processes not identified on any other individual at Actuncan to date.



Figure 4.3 Ceramic vessel with human phalanx.

Findings on grave inclusions and burial position from Burials 6-10 were provided in the literature review section. They are summarized in Table 4.3. Examination of this table makes more visible the differences between Burial 13 and the other burials. The differences in burial position, grave preparation, and increased number of material inclusions are clearly different than those of the other individuals associated with Structure 60 and may indicate this person was from an area outside of Actuncan and the Belize River Valley.

Table 4.3 Summary of burial details.

| BURIAL | PRONE/ SUPINE | POSITIONING/ DIRECTIONALITY | GRAVE PREPARATION | GRAVE GOODS |
|--------|------------------|---|----------------------|--|
| B6 | Prone | Head south. Extended with right arm flexed behind back. | Simple pit | None |
| B7-1 | Prone | Head south. Extended with right arm flexed behind back. | Simple pit | None directly; drilled shell bead & bird bone near by. |
| B7-2 | Unknown | Unknown | Unknown | Unknown |
| B8-1 | Prone | Head south. Extended with right arm flexed behind back. | Simple pit | None |
| B8-2 | Unknown | Head north. Extended. | Unknown | Unknown |
| B8-3 | Unknown | Head south. Right arm extending to north. | Unknown | Unknown |
| B9-1 | Prone | Unknown | Crypt | Speleothem, obsidian, miniature bottle at same level. Carved antler possibly associated. |
| B9-2 | Prone | Unknown | Crypt | Shell ear ornaments. |
| B10-1 | Prone | Torso south. Extended. | Simple pit | None |
| B10-2 | Unknown | Extended. | Unknown | Unknown |
| B13 | Supine | Head south. All extremities fully Extended. | Partial cist | Associated chert point, several obsidian blades, ceramic vessel with distal phalanx. |

Chapter 5

Discussion

Strontium, oxygen, and carbon isotope values for the individuals associated with Structure 60 were analyzed to identify the presence of migrants in the burial space. These data will be discussed in relationship to burial practices in attempt to better understand if foreign individuals were buried at the eastern structure and if changes in burial practices could signal interment of nonlocals.

If one views the strontium results narrowly from Actuncan and its immediate environs, Burials 7-1 and 9-1 might be considered the only locally born individuals interred here. However, due to variations in geologic formations across the terrain, strontium isotopes are more often reported by region than as site specific values. When examining the data under this lens, all of the individuals interred at the eastern structure could have had natal residence within the Belize River Valley. Although the isotope signatures also fit into the range for the Northern Maya Lowlands, it is a common, and more parsimonious, assumption in isotope analyses that the geographically closer strontium zone was the individual's homeland. The parsimonious hypothesis of local residence is not rejected based on the strontium and oxygen isotope results from this study.

Isotope Analysis

Strontium

When examining the strontium isotope data for the eastern structure burials, several noteworthy things are apparent. All of the isotope ratios fall between 0.708501 and 0.708988 with an average of 0.708820 ± 0.00017 , providing a range around the mean of 0.70865 to 0.70899 at ± 1 s.d. (Figure 5.1). This indicates less likely childhood residence for any of the Group 1 individuals in the Maya Mountains and Mountain Pine Ridge (0.7114-0.7255), the Vaca Plateau (0.707630-0.707863), the Southern Maya Lowlands (0.70693-0.70845), and the Volcanic Highlands (0.70380-0.70492). Some of the sample values (B6, B9-2, and B7-2) are consistent with the Macal River Valley (0.7089-0.7107), while all of them are contained in the ranges of the Belize River Valley (0.708208-0.709077), Metamorphic Province (0.70417-0.72017) and the Northern Maya Lowlands (0.70775-0.70921).

Actuncan's strontium isotope ratio baseline was obtained from a single specimen, and so exists as only one data point for the entire site. When combined with other values from the area, a better idea of the expected human strontium levels can be formed. Three baseline values sampled by Freiwald (2011) are within 3 km of Actuncan and range from 0.708477 to 0.708719 (Table 5.1). When including the value from Actuncan, the range becomes 0.70841 to 0.708719 with an average of 0.708559 ± 0.0001 $^{87}\text{Sr}/^{86}\text{Sr}$.

Table 5.1 Strontium isotope values near and including Actuncan. All values except Actuncan from Freiwald (2011:412-413).

| LOCATION | STRONTIUM ISOTOPE RATIO |
|---------------------------------|-------------------------|
| Actuncan Archaeological Site | 0.70841 |
| San Lorenzo Archaeological Site | 0.708629 |
| Modern Town of Succotz | 0.708477 |
| Local Business near Succotz | 0.708719 |
| | |
| Average of Collection Locations | 0.708559 ± 0.0001 |

While all the individuals sampled in this thesis could have originated from the Belize River Valley zone, only two fall within the expected human range directly surrounding Actuncan, Burial 7-1 and Burial 9-1, the former being closest to the Actuncan value.

The individual in Burial 7-1 has a strontium isotope value that is farthest from the rest of the values; however, the 2 SD range from the mean calculated here indicates that this is not a significant outlier (Figure 5.1). The bar chart in Figure 5.1 demonstrates the clustering of values closer to the 0.7089 end of the spectrum, with that of Burial 7-1 more separated from the others. Interestingly, this burial has one of the two isotope values most similar to the area directly surrounding Actuncan.

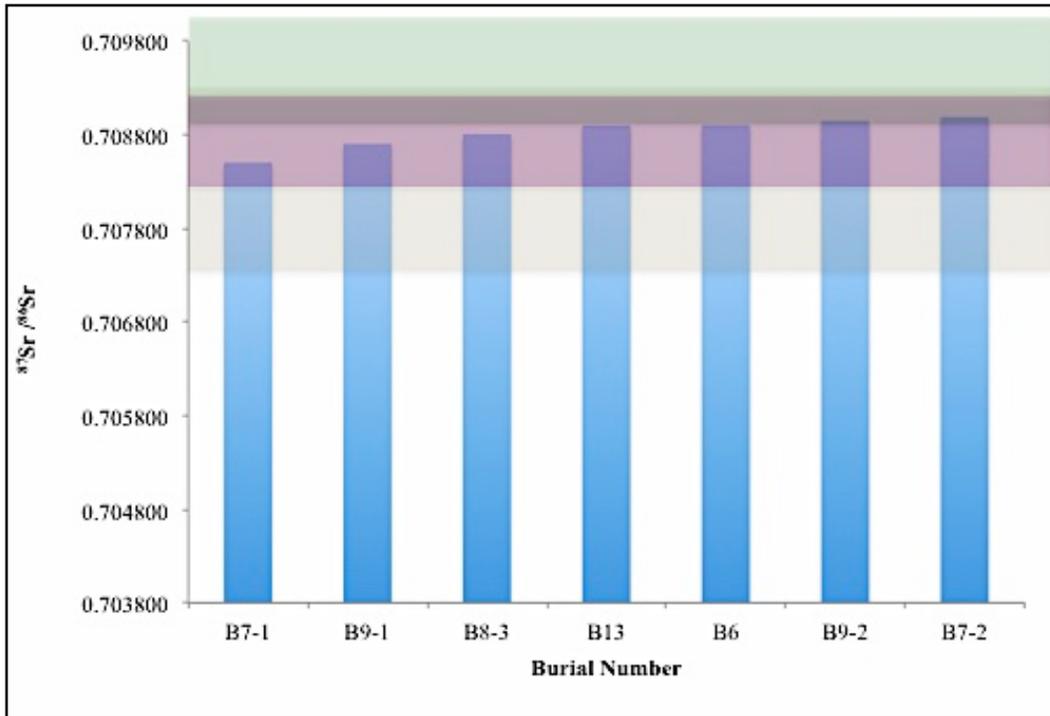


Figure 5.1 Strontium isotope ratios from Structure 60 burials. Belize River Valley shaded in purple, Macal River Valley shaded in green, and Northern Maya Lowlands shaded in tan.

Oxygen

Oxygen isotope values are examined in conjunction with strontium isotope ratios to further elucidate migration status. In order to visualize the relationship between the two isotope values, $\delta^{18}\text{O}_{\text{PDB}}$ is plotted against strontium ratios, with circles representing the individuals whose strontium scores were within the 2 SD range for Actuncan and its immediate environs and squares representing individuals with values similar to the greater Belize River Valley faunal baselines (Figure 5.2).

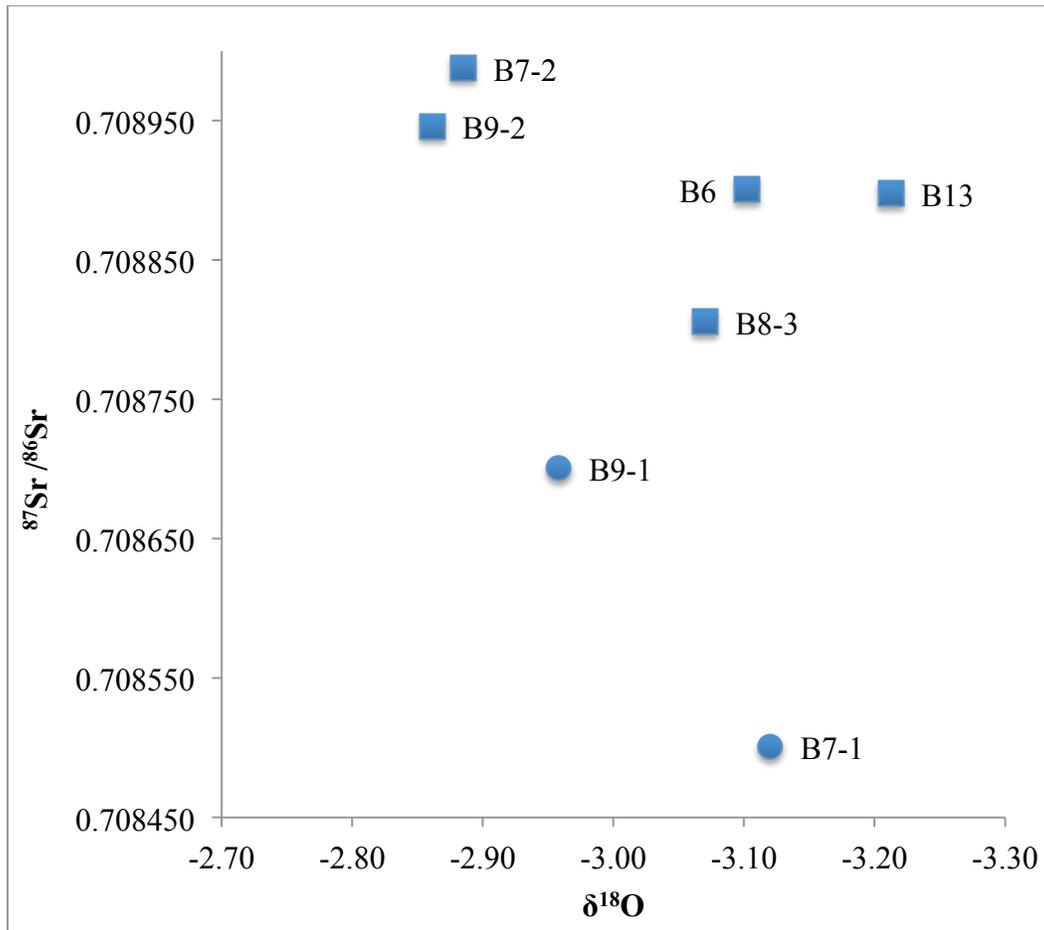


Figure 5.2 Scatterplot of oxygen vs. strontium isotope ratios.

The sampled oxygen isotope values range from -2.86‰ to -3.21‰, with an average of $-3.03\text{‰} \pm 0.131$. The data form a fairly tight range with two rough groupings around -2.8‰ and -3.1‰ and one individual, Burial 13, most separated from the others. Although Burial 13 (-3.21‰) has the lowest oxygen isotope ratio, it is not a significant outlier (i.e. it lies within 2 SDs of the mean value). Examining the strontium and oxygen in concordance with each other (Price et al.

2010, 2014) reveals that the greater variation in values is among the strontium isotopes (Figure 5.2). The tighter clustering of oxygen isotope ratios indicates that all the individuals originated in an area that had similar oxygen levels in their water source, most likely the Belize River Valley.

The oxygen values for the individuals at Structure 60 coincide with values reported for Campeche (-2.9‰), Tikal (-3.2‰), and Caracol (-3.43‰), as well as the Maya Mountain zone (-4.44‰ to -2.87‰), the Macal River zone (-4.61‰ to -2.20‰) and the Belize River zone (-4.37‰ to -0.91‰). A baseline for oxygen isotope ratios has not been obtained specifically for Actuncan, but we can determine a range of values by using data from tooth enamel obtained for Xunantunich and San Lorenzo by Freiwald (2011:425-428), both within 3 km, as a proxy. Oxygen ratios for Xunantunich range from -0.32‰ to -3.98‰ with an average of $-2.43‰ \pm 1.03$ and those for San Lorenzo range from -2.2‰ to -3.74‰ with a mean of $-2.89‰ \pm 0.78$. All of the individuals sampled in this project have $\delta^{18}\text{O}_{\text{PDB}}$ within the ranges of both Xunantunich and San Lorenzo, consistent with natal residence at Actuncan or elsewhere in the local region. This further supports the likelihood of childhood residence at or near Actuncan of Burials 7-1 and 9-1 that was observed from strontium isotope analysis. As with the strontium values, if we assume that the closest geographic location has the highest likelihood of being their homeland, none of the individuals interred at the eastern shrine would be considered probable migrants from outside the Belize River Valley. These

individuals likely spent the years during their tooth enamel formation at Actuncan or in close proximity elsewhere in the Belize River Valley.

Carbon

Carbon isotope ratios were examined to provide supporting evidence on migration based on dietary inputs. Across the Maya region, $\delta^{13}\text{C}_{\text{PDB}}$ range from -9.74‰ to -1.84‰. As a whole, carbon isotope ratios tend to be lower in Belize than elsewhere in the Maya region, which is likely to be a product of lower maize intake than for other settlements (Freiwald 2011; Gerry 1993). Carbon isotope ratios for the Structure 60 burials range from -3.15‰ to -6.27‰ with an average of $-5.06\text{‰} \pm 1.16$. When carbon and oxygen are placed on a scatterplot together, we can see that several of the carbon samples are clustered around -6‰ (Figure 5.3). The value for Burial 8-3 (-3.15‰) appears farthest away from the other data points, but it is not a significant outlier (2 SD range). Burial 7-1 has the lowest carbon isotope ratio, consistent with the depleted values typically observed in Belize.

Carbon ratios are consistent with those found at the Pacific Coast (-9.74 to -2.13), indicating a similar diet rather than location of natal residence. The Actuncan individuals have carbon values that are similar to those reported from the Central Lowland zone (-5.83 to -2.40), with the exception of Burial 7-1. More importantly, all of the values are consistent with childhood origin in the Belize

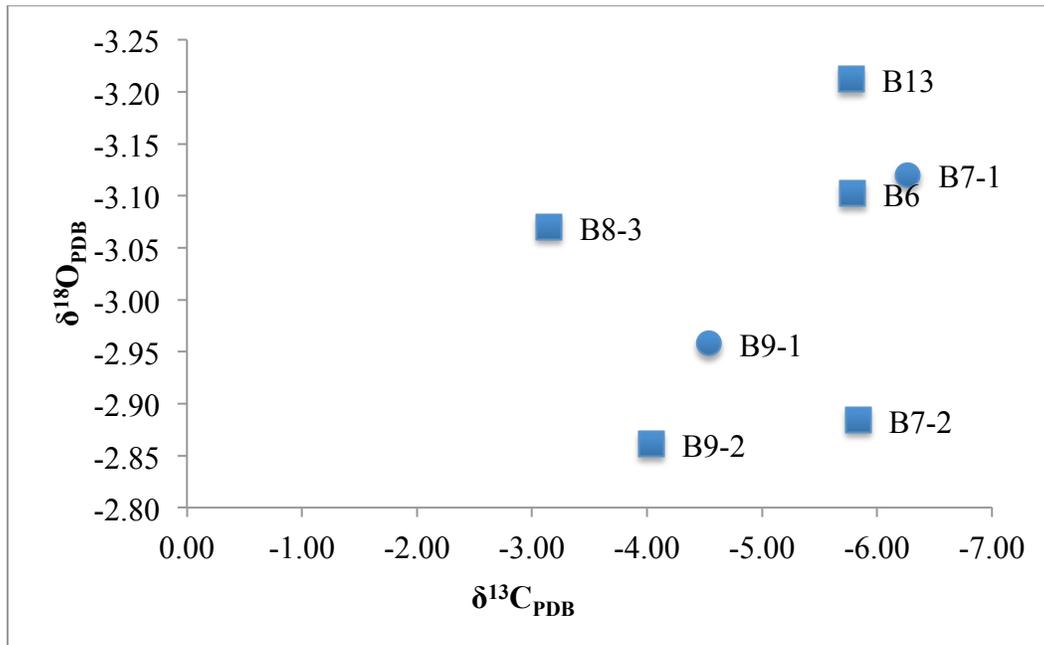


Figure 5.3 Scatterplot of carbon vs. oxygen isotope ratios. Circle and square symbols follow designations in Figure 5.2.

River zone (-7.89 to -2.65). This finding is also consistent with the strontium and oxygen isotope results.

Strontium and oxygen isotope values indicate that all of the individuals interred at the Structure 60 patio of Group 1 could have had a childhood residence in the Belize River Valley. This is confirmed by carbon isotope ratios, likely a result of the overall lower maize consumption common in the area. Two individuals, those from Burials 7-1 and 9-1, had strontium signatures most consistent with the 3 km area surrounding Actuncan. Using oxygen isotope levels from Xunantunich and San Lorenzo as a proxy for Actuncan provides further

support to the local origin of Burials 7-1 and 9-1. None of the individuals were clearly identified as foreign to the Belize River Valley.

Burial Analysis

Distinct patterns have been observed in the Belize River Valley regarding burial practices and positioning. Throughout the Middle Preclassic to the Postclassic periods, the extended prone position was one of the most common burial positions in the Belize River Valley (Weiss-Krejci 2006). By the Late Classic period, a preponderance of burials were interred with their heads oriented to the south and the body in an extended prone position (Welsh 1988; Willey et al. 1965; Yeager 2003). During this same time period, individuals in other regions of the Maya landscape were interred most commonly in an extended supine position (Weiss-Krejci 2006).

This pattern of extended prone placement was further refined by isotope analysis where Freiwald (2011:317) discovered that 89% of burials with a strontium isotope signature consistent with the Belize River Valley were interred with their heads to the south. Although there are sometimes differences in body positioning like an arm crossed behind the back, legs crossed or being placed supine instead of prone, almost all extended burials are positioned with the head to the south (Freiwald 2011). While the extended prone position does occur in other sites, it is found in a small number of burials scattered across the landscape.

Because of these consistencies, body positioning and head orientation can be used to identify individuals from different regions (Freiwald 2011).

Wide fluctuations in other burial practices make them a less reliable indicator of origin. Some interments contain rich burial deposits, while others contain sparse to no grave goods. In addition to changes in the number of grave goods included in a burial, it is frequently difficult to discern whether an artifact is actually associated with the burial since it is often placed in the structure or grave fill surrounding the burial instead of in contact with it. This is especially complicated when graves are re-accessed or interrupted for the interment of subsequent individuals. Vast differences are apparent in the amount of grave preparation, from a simple pit, to cists, to tombs. The number of individuals interred in a space or grave is also widely variable. Many burials contain only a single individual and others contain multiple corpses in a burial area that are not divided by status, while some consist of a central individual surrounded by servants or slave sacrifices.

Intrasite comparisons of the burials at Structure 60 show some differences in grave preparation, material inclusions and burial position. Of the 11 individuals with information on burial practices, two were not fully excavated. Burials 6, 7-1, 8-1 and 8-3 were all extended burials with right arm flexed behind the back. Six of these burials were prone, while only Burial 13 was interred supine. Most of the graves included no grave goods, however Burials 9-1, 9-2,

and 13 are noteworthy in this regard. Burial 9-1 was a crypt burial and Burial 9-2 was possibly cut through during creation of the crypt (Freiwald 2012). Burial 9-1 had a speliiothem, obsidian and a mini bottle excavated at the same level; however, the relationship of these items with the skeleton is unknown. Additionally, a carved antler was recovered during the final stages of excavating the body. However, since it was identified in the screen, the exact association with the skeletal remains is not clear. Burial 9-2 had shell ear ornaments associated with it.

Burial 13 had the largest number of grave goods possibly associated with the individual. These included several pieces of obsidian, a chert point and a plain ceramic vessel that included the distal phalanx of another individual. Finger pots like this one have been observed at other sites across the Maya region, but this is the only one excavated at Actuncan to date.

Two burials at the group 1 patio show different levels of grave preparation than the others. Burial 9-1 has the most formal grave construction, which consisted of a stone lined crypt with several capstones. Burial 13 was excavated from a stone lined cist that was covered by a capstone. The number of grave inclusions, grave preparation, and burial position leads me to believe that this individual could have been non-local to Actuncan. However, this individual's strontium, oxygen, and carbon isotope values reflect natal residence within the Belize River Valley. Most noteworthy of the unique aspects of Burial 13 was

that the individual was placed supine, inconsistent with burial patterns of the Belize River Valley. Without isotope analysis this individual would have possibly been identified as a migrant, when in fact chemical analysis indicates local origin.

Chapter 6

Conclusion

The goal of this thesis project was to attempt to discern whether the individuals interred in the patio of the eastern structure of Group 1 at Actuncan were local or nonlocal by using isotopes of strontium, carbon, and oxygen derived from tooth enamel. Burial practices added supporting data. Examination of the individuals interred at Structure 60 indicates that Burial 13 could have been a migrant to Actuncan based on supine body positioning, grave preparation, and materials associated with the grave. However, isotope analyses are consistent with a childhood residence within the Belize River Valley. Results of all the other isotope analyses likewise supported the parsimonious hypothesis that everyone interred at the eastern structure was local to the region. Since there are burials that have yet to be excavated from the patio at Structure 60, these results do not provide a comprehensive understanding of burial practices at this ritually significant space, but they do provide some data on whom the Maya of Actuncan interred here.

The small sample size is problematic for drawing definitive conclusions about migration on a large scale, but this thesis sample does add useful data to existing isotope analysis studies on individuals buried in the Maya region. While many patterns exist in the Belize River Valley regarding burial location and positioning of the dead, each site has unique features. The findings from this

study contain all of the samples excavated to date from the eastern structure of the Group 1 patio and therefore represent all of the information currently available for this location.

At this time it is difficult to determine if the identification of burial practices for locals versus nonlocals at the eastern structure is a widespread pattern for Actuncan, the Belize River Valley, or the Maya region, or if this represents a unique situation to Actuncan. For example, Freiwald (2011) identified that more than 20% of the individuals interred in burial shrines excavated at Zubin had nonlocal strontium isotope values. All of those individuals were interred in a manner consistent with burial practices of the Belize River Valley and Macal River Valley zones; namely head to the south in an extended prone position (Freiwald 2011). Because migration identified using isotope testing is based on geologic differences instead of political boundaries, it is difficult to discern whether the individuals interred in ritual structures at Zubin would have been identified as nonlocals by members of the community. Further excavation and testing is needed to make more broadly based conclusions about burial practices at the eastern structure of Actuncan and whether migrants were interred at such a ritually significant space.

It is likely that rate of population movement and variations in burial practices changed over time. With the long-term use of the patio as a burial space beginning in the Early Classic period, it would be beneficial to identify whether

the changes observed here represent a temporal evolution of practices or new ideas and values brought in as nonlocals moved into the site. Some of the burials examined in this thesis have been sampled for carbon dating which may lead to a more nuanced understanding of the actions of the ancient Maya that utilized the Group 1 patio as a burial space.

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Destiny began her academic career at Baylor University where she earned a Bachelor of Science in Nursing. She then worked as a registered nurse in the Neonatal Intensive Care Unit for more than 10 years before enrolling at the University of Texas at Arlington to continue her education. Pursuing her love of learning, Destiny completed several courses in biology and chemistry before shifting her focus to anthropology and archaeology. Destiny earned her Master of Arts in Anthropology from the University of Texas at Arlington in 2015, while working as a graduate teaching assistant. Her research interests include bioarchaeology, osteology, underwater archaeology, and Irish and Mesoamerican archaeology. While attending UTA, Destiny worked on archaeological projects in Poland, Belize, and Ireland, as well as an underwater archaeology project in the Mediterranean Sea off the coast of Menorca. After graduation, Destiny plans to present and publish her research on Actuncan and pursue work in archaeology.