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Geographic Origins, Status, and Identity at Paquimé, Northwest Chihuahua, Mexico

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by

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Abstract

This thesis examines migration at Paquimé, an important prehistoric site in northwest Mexico that is widely recognized for its mix of Mesoamerican and Southwestern traits. The presence of foreign objects and ideology has stimulated debate over whether Medio Period (A.D. 1200-1450) culture change was due to the arrival of foreign elites in the Casas Grandes region or to local developments. A crucial step in addressing this debate is to determine if high status immigrants were indeed present at Paquimé, which is the goal of this study. This is accomplished by using radiogenic strontium and stable oxygen isotope analyses to determine the geographic origins of a large sample of individuals from Paquimé and the Viejo Period Convento site. Comparative samples from sites within and outside the Casas Grandes region were analyzed to identify potential geographic origins of non-local individuals. Mortuary analyses were then conducted to assess social status and identity. Finally, two bioarchaeological case studies from mortuary contexts with suspected human sacrifices are presented to examine the relationship between geographic origins and ritual violence, and to explore the impacts of migration on Medio Period social dynamics.

The results indicate that ~87% of Paquimé individuals were born locally or came from within the Casas Grandes region, while 13% migrated from neighbouring regions, including the American Southwest and other parts of northwest or west Mexico. At Convento, ~92% were local to the Casas Grandes region. Although the Medio Period was characterized by migration from more distant locations when compared to the preceding Viejo Period, none of the immigrants from neighbouring regions received high status mortuary treatment. Instead, the most elaborate burials at Paquimé belong to locally-born individuals, whose status was likely linked to ritual authority. Furthermore, most of the sacrificial victims were non-locals. These results suggest that Medio Period culture change was driven primarily by internal stimuli, including population aggregation from within the Casas Grandes region and sociopolitical maneuvering by local elites. The results also indicate that social tensions and competition for status, power, and/or resources led to asymmetrical power dynamics between locals and immigrants, which sometimes played out in ritually-charged contexts.

Dedication

"I want to echo others who in recent years have found Chihuahua an exciting and rewarding place to work. As I bow out, I hope that the effort will continue."

- Jane Holden Kelley

This thesis is dedicated to the memory of Jane Holden Kelley (1928 – 2016), who introduced me to Casas Grandes archaeology

I have found it deeply rewarding and look forward to continuing the effort. My heartfelt gratitude to Jane, and others, for paving the way

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Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

Migration is a deep-rooted and enduring aspect of human behaviour. From the initial diaspora of our species out of Africa to present day globalization, human movement has shaped our biological, cultural, and linguistic landscape for thousands of years. As such, the study of migration is essential for reconstructing both the biological and cultural evolution of our species. However, migration is not just a process, it is also an agent of social change; it can stimulate the development of new social institutions that promote cohesion and collaboration, or it can lead to conflict, violence, and population collapse (Cabana and Clark 2011). Thus, understanding the impacts of human movement and aggregation is relevant to anyone living in our increasingly globalized modern world.

This thesis examines the role of interregional interaction in the cultural trajectory of Paquimé, a prehistoric archaeological site located in northwest Chihuahua, Mexico. The transition from the Viejo (A.D. 800 – 1200) to Medio Period (A.D. 1200 – 1450) in this region is characterized by substantial population growth and aggregation at Paquimé (also known as Casas Grandes), which in turn was accompanied by increasing sociopolitical complexity and the adoption of new ritual practices. Particularly notable is the abundance of foreign objects and cultural attributes from neighbouring regions, which has led some scholars to argue that Medio Period culture change was due to the arrival of elite foreigners in the Casas Grandes region (Di Peso 1974: vol. 2; JC Kelley 2000; Lekson 1999, 2015). Various external stimuli models have been proposed, but all involve direct and sustained contact with sophisticated foreigners from either the American Southwest (Lekson 1999, 2015), West Mexico (JC Kelley 2000), or Mesoamerica (Di Peso 974: vol. 2). Proponents of local development models, on the other hand, view intraregional population dynamics as the primary catalyst for culture change (Cruz Antillón et al. 2004; Douglas and Quijada 2005; JH Kelley et al. 1999, 2012; Phillips 1989; Whalen and Minnis 2001b, 2003, 2009). These scholars acknowledge that external forces played a role in shaping Paquimé's cultural trajectory but see such influences as secondary to local catalysts. More specifically, local elites or sociopolitical entrepreneurs likely used foreign connections, ideology, and goods to enhance/legitimize their status within the community (Rakita 2001, 2009; Whalen and Minnis 2003, 2009). Thus, there is consensus that the people of Paquimé had contact with outside groups, but disagreement over the nature and extent of those interactions.

A critical step in addressing this ongoing debate is to distinguish between migration and other forms of cultural transmission, such as emulation or exchange. This is difficult based on material evidence alone because the presence of non-local cultural attributes can be due to either direct or indirect contact (e.g., down-the-line trade) with outside groups. Instead, it is necessary to determine whether non-local *individuals* (i.e., immigrants) were present at Paquimé, which is the goal of the present study. This is accomplished by determining the geographic origins of a large sample of individuals (N=95) from the Casas Grandes burial assemblage through the isotopic analysis of dental enamel that forms at birth. The relationship between geographic origins and social status is then examined through a mortuary analysis of the study sample and two case studies. The second stage of analysis is essential to comprehensively evaluate competing cultural development models because those invoking external stimuli involve the direct and sustained presence of important or elite foreigners at Paquimé. Thus, if these models are correct, we should expect to find individuals that have both non-local isotope signatures and mortuary treatment that indicates elevated social status. Finally, two case studies from mortuary contexts containing elite burials and suspected human sacrifices are presented to better understand the impacts of migration on social dynamics between locals and immigrants in this prehistoric aggregated community.

1.1 Theoretical Framework

Opposing views on the role of migration in culture change often stem from disparate theoretical frameworks. At one extreme are culture historians, who have used migration as an ad hoc explanation for culture change by attributing abrupt shifts in material culture to the arrival of new "cultures" (i.e., people) (Cabana 2011). Processualists are at the opposite extreme and emphasize a systems-based approach to cultural evolution, whereby cultures are largely governed by *internal* processes that can be understood through universal laws with predictive/explanatory power (Trigger 1989). In this framework, migration cannot be the primary catalyst for culture change because it is an external force that is complex, unpredictable, and difficult to identify archaeologically (Anthony 1990).

Meanwhile, post-processualists employ a more moderate and flexible framework that does not rely on unified theories or specific methodological approaches. They do not use universal laws to explain cultural phenomena like processualists, but instead emphasize contextualized interpretations of archaeological data at various scales of analysis, including individual-level approaches that address topics such as identity, status, and agency (Cabana 2011; Cordell and McBrinn 2012; Hodder 1999). Importantly, the shift to post-processualism has led to a resurgence in archaeological studies of migration, which in turn provide a useful framework for the present study.

During the early stages of the post-processual movement, Anthony (1990) published a highly influential paper critiquing processualists for their outright dismissal of migration as an explanatory mechanism for culture change. In it, he argues that while some aspects of migration, such as its causes, are multifactorial and therefore difficult to identify and interpret archaeologically, migration itself is a patterned process that tends to progress in broadly similar ways once the decision to move has been made. Thus, it can and should be considered as a mechanism for change. Anthony (1990) highlights several key principles concerning the geographic structure (i.e., form) of migration that have implications for how migration can be examined in archaeological contexts. First, migrants generally have some knowledge about their destination prior to moving, which is typically obtained from previous contact (e.g., intermarriage, exchange networks). As such, migration from a specific region is more likely if there is archaeological evidence for long-term connections between that region and the site in question. Furthermore, most migrations today consist of short-distance movements related to post-marital residence or economic opportunities and occur between social groups that interact on a regular basis. Anthony (1990) argues that short-distance migration was likely the norm for prehistoric populations as well. This type of movement is difficult to detect using traditional archaeological methods because material culture does not typically change as the result of intraregional interaction (Anthony 1990), however, isotopic approaches have been successfully used to detect this type of interaction (e.g., Ezzo and Price 2002).

Long-distance migration, on the other hand, produces more distinct changes in the archaeological record and is inherently more complex in its structure because migratory groups must cross an ecological or cultural boundary (Anthony 1990). Traversing large distances may entail leap-frogging, whereby less desirable locations are bypassed in favour of more appealing destinations. This type of movement can produce vast expanses of unsettled territory and is often associated with scouts (typically young adult males) who gather information on prospective destinations prior to the rest of the group moving (Anthony 1990). Long-distance movement can also take the form of migration streams along previously-defined routes. Knowledge of these paths is often controlled by kin-groups, which sometimes results in the earliest migrant groups emerging as "apex families" that have gained status from their role in community formation and integration (Alvarez 1987). In this way, migration can contribute to the development of status differentiation within a society (Anthony 1990).

Bernardini (2005) has also coined the term "serial migration" to refer to the smaller moves, or segments, that make up long-distance migrations. This form of movement is particularly relevant to the present study because it was commonplace during the late prehistoric period in the American Southwest, which was characterized by repeated cycles of aggregation and dispersal (Arakawa 2012; Bernardini 2005; Clark 2011; Schachner 2010). In fact, movement was so frequent in this region that archaeologists have come to view migration as a form of population "circulation" (Schachner 2010) or "mixing" (Clark 2011) as opposed to population replacement. According to Bernardini (2005), both ethnographic and archaeological evidence suggests that most prehistoric Southwesterners moved at least once during their lifetime. Cameron (2013) has also emphasized that migration in the Southwest (and elsewhere) was not always voluntary. Unplanned or coerced relocation, such as captive taking during raids or the fissioning and fusing of social groups, was likely common amongst small-scale societies in this region (e.g., Cameron 2013; Kohler and Turner 2006). In fission-fusion situations, certain segments of a community (e.g., social or kin units) split away from the larger group and migrate to a different location. Common reasons for this include disputes, succession struggles, competition between social factions, and resource scarcity, which result in the departure of lower status groups or the losers of disputes (Benson et al. 2006; Cameron 2013; Schelgel 1992). Meanwhile, captives may consist of individuals or small groups, but they are typically women and children that are taken by more powerful groups during raids (Cameron 2013). These individuals often occupy low status position within their captor's community, but sometimes may be taken as wives or adopted children (Cameron 2011). Non-voluntary forms of migration are important to consider in the context of the present study not only because they were common in the prehistoric Southwest, but also because they can have significant impacts on the cultural developments and social dynamics of non-state societies (Cameron 2013).

While archaeologists have traditionally focused on migration as an explanation for culture change, there has been a recent shift toward also examining the impacts of migration (e.g., Cabana and Clark 2011; Klaus and Tam Chang 2009; Knudson and Blom 2009). One particular area of interest is the emergence of new social strategies and/or institutions that arise as a result of the aggregation of disparate groups (Cabana 2011; Clark 2011; Herr and Clark 1997; Rakita 2001, 2009). These social mechanisms may involve cooperation, competition, or both. For example, symmetrical power dynamics between locals and immigrants can lead to new religions and ethnic identities, such as the Katsina cult that developed in the Southwest, which is thought to have served integrative purposes for culturally diverse communities (Adams 1991; Crown 1994; Herr and Clark 1997). Conversely, asymmetrical relationships can lead to conflict, displacement, and/or assimilation (Clark 2011). Herr and Clark's (1997) survey of migration among protohistoric Southwest groups indicates that the integration of migrants into existing communities is not only difficult, but often unsuccessful. Migrants may not always be welcome at existing settlements, which can result in subjugation by their hosts or marginalization within the community (Cameron 2013; Herr and Clark 199). Such situations are more likely to arise in cases of non-voluntary migration, like captive taking, where individuals or small groups may have been brought to a settlement as coerced or forced labourers.

Although social dynamics can be difficult to reconstruct in past populations, various lines of evidence can be used to elucidate local-immigrant interactions. For instance, cultural assimilation and integration of immigrants into their recipient community is often signaled by co-habitation, while resistance to assimilation and/or conflict can result in spatial segregation of distinct social groups (Batiuk 2013; Herr and Clark 1997). Similarly, the adoption of local mortuary practices by immigrants may signal assimilation and shared beliefs, while the maintenance of foreign practices may represent a form of resistance (Knudson and Blom 2009). Osteological evidence for violence and/or poor health can also be used in conjunction with archaeological evidence to identify potential cases of subjugation and abuse of suspected captives or marginalized groups (Baustian et al. 2012; Cameron 2013; Martin 2008; Martin and Harrod 2015). It is important to emphasize that migration is an inherently social process that involves human agents. Thus, at the level of the individual, one's status as an immigrant can impact their social status, health, access to resources, and identity (Batiuk 2013; Clark 2011). As such, the study of the migratory individuals, in conjunction with the material and iconographic evidence they leave behind, provides important insights into social dynamics of aggregated communities.

In this study, migration is defined as a one-way change in residence from one site or region to another by at least one individual (adapted from Cabana and Clark 2011). This definition highlights the individual-level scale of analysis that can be applied to the study of migration when using isotopic methods. Individuals with non-local isotope signatures are referred to as *immigrants* or *non-locals,* while individuals with local isotope signatures are called *locals*. The non-local (immigrant) classification is further divided into *regional* and *extraregional* subgroups, following Ezzo, Price and colleagues (Ezzo and Price 2002; Ezzo et al. 1997; Price et al. 1994). *Regional immigrants (non-locals)* have isotope values that are outside the local isotope range at Paquimé but consistent with other sites in the Casas Grandes region. *Extraregional immigrants (non-locals)* have isotope values that are not consistent with either the local or regional isotope ranges.

1.2. Methods

Stable isotope analysis has become a common method for detecting prehistoric migration because of its ability to directly identify non-locally born individuals within archaeological skeletal assemblages (e.g., Bentley 2006; Katzenberg 2008; Knudson and Price 2007; Price et al. 2008; CD White et al. 1998). The advantage of using isotopic methods in addition to other archaeological approaches is that individuals, as opposed to objects, serve as the units of analysis. Thus, data derived from human skeletal remains can provide empirical evidence of migration. Furthermore, bioarchaeological analyses that use isotopic methods in concert with contextual data are ideal for examining the structure and scale of migration in terms of who was moving and how substantial the proportion of non-local individuals within the population was, respectively (Knudson 2011). This multifaceted approach can also provide insight into the potential impacts of migration on both the host community and the immigrants themselves. As such, stable isotope analysis has significant potential for examining the role of foreign influences in the cultural trajectory of Paquimé.

In this study, radiogenic strontium ($^{87}Sr/^{86}Sr$) and stable oxygen ($\delta^{18}O$) isotopes are used to identify migratory individuals in the Casas Grandes burial assemblage. Strontium and oxygen isotopes are geologically and environmentally variable, respectively, and can therefore be used as geographic tracers. Furthermore, isotope ratios present in human skeletal tissues reflect the isotope ratios of the plants, animals, and water that were consumed during life (Dansgaard 1964; Ericson 1985; Longinelli 1984; Price et al. 1994). Thus, individuals who exhibit strontium and/or oxygen isotope values that are distinct from the location in which they were buried are inferred to be immigrants. In this study, isotope analysis is conducted on two teeth per individual; one tooth that formed at birth or during early childhood and another that formed during adolescence. This sampling strategy was employed for several reasons. First, it provides data on residential mobility during an individual's life, which can help to differentiate between short- and long-distance migration. This is an important component of this study because external stimuli models invoke long-distance migration from neighbouring regions, whereas internal development models predict short-distance migration from within the Casas Grandes region. Mobility profiles can also provide information on the demographic structure of migration in terms of who was moving. For example, if an individual has a non-local isotope signature in a tooth that formed at birth and a local isotope signature in their tooth that formed during adolescence, it indicates that they migrated to Paquimé as a child. Non-local signatures in both teeth would indicate that they migrated post-adolescence. As such, this data tells us whether migratory units consisted of children, adults, or both. In this study, I use the term *mobility profile* to refer to the pair of isotope values derived from a single individual. Elsewhere, the isotopic analysis of multiple tissues per individual has been referred to as a *life history approach* to paleomobility (e.g., Marsteller et al. 2017; Sealy et al. 1995).

1.3 Research Objectives

The primary goal of this study is to examine whether Medio Period culture change was due to the arrival of foreign elites in the Casas Grandes region or local developmental processes stemming from the existing population base. If Medio Period culture change was the result of direct influences from foreign elites it is expected that: (1) extraregional non-locals will be present in the Paquimé burial assemblage and there will be an increase in the proportion of non-locals when compared to the preceding Viejo Period (signaling the influx of foreigners); and (2) they will have isotope signatures consistent with isotope values from the geographic regions predicted by these models (Mesoamerica, West Mexico, or the American Southwest); and (3) they will exhibit mortuary treatment that indicates elite social status. In addition, individuals who migrated to Paquimé from outside of the Casas Grandes region are likely to have different isotope values in their early- and late-forming teeth because long-distance migration is often characterized by a series of shorter distance moves (e.g., Bernardini 2005).

Alternatively, if internal stimuli were the primary catalyst for Medio Period culture change, most individuals in the Paquimé sample should have local or regional non-local isotope signatures. This would indicate local/regional population aggregation. Migration from within the region represents short-distance migration, therefore mobility profiles of regional non-locals may differ from those of extraregional non-locals by showing less isotopic variation between teeth from the same individual. Additionally, local development models argue that Medio Period culture change was driven by the social and political initiatives of locally-born individuals, who used foreign connections, objects, and ideologies to enhance and legitimize their status within the community. Under this scenario, locals and regional non-locals should exhibit mortuary treatment indicative of elevated social status, while extraregional non-locals may be characterized by either “typical” or low-status mortuary treatment, depending on social dynamics between locals and immigrants. For example, assimilation into the local culture would likely manifest as similar mortuary treatment between the average Paquimeño and immigrants to the community. Meanwhile, conflict arising from the coalescence of disparate groups could result in mortuary treatment characteristic of low status or marginalization. Thus, examining the relationship between mortuary treatment (social status) and geographic origins will shed light on how migration may have impacted social dynamics between locals and immigrants.

1.4 Organization of Thesis

This thesis is organized into six chapters. Chapter 2 provides a background on the archaeological context in which this study is situated, beginning with an introduction of Paquimé and an overview of the Viejo and Medio Periods in the Casas Grandes region. The Casas Grandes interaction sphere is then discussed, followed by a review of the various cultural development models that have been proposed to explain Medio Period culture change. A summary of studies that have used the Casas Grandes skeletal assemblage to examine biological affinity between Paquimé and neighbouring populations is then presented. The final section of Chapter 2 introduces the Paquimé mortuary program and provides a review of mortuary studies that have been conducted on the Casas Grandes burial assemblage. This background serves as the foundation for evaluating social status in the present study.

Chapter 3 examines interregional interaction at Paquimé using isotope analyses to determine the occurrence, scale, and structure of migration, as well as the potential geographic origins of migratory individuals. The chapter begins with a discussion of the theoretical principles and archaeological applications of radiogenic strontium and stable oxygen isotope methods. The sampling strategy and laboratory methods are then presented. The main study sample includes burials from Paquimé (N=82), which represents the Medio Period, and the nearby Convento site (N=13), which was occupied during the Viejo Period. Comparative human and faunal samples from four sites in the Casas Grandes region, two sites from central Mexico, and one site from the American Southwest were also analyzed. The results of the isotope analyses are then presented, beginning with the establishment of the local and regional isotope ranges. This is followed by the classification of Convento and Paquimé individuals as locals, regional non-locals or extraregional non-locals based on their isotope signatures. The chapter concludes with an evaluation of the research objectives, as well as a discussion of the potential geographic origins of the non-local individuals.

Chapter 4 integrates the isotope results from Chapter 3 with mortuary data from the Casas Grandes skeletal assemblage to reconstruct the social identities of the individuals examined in this study. The primary goal of this chapter is to determine whether high status immigrants are present at Paquimé. If this is the case, extraregional immigrants should be afforded elaborate mortuary treatment when compared to their local or regional non-local counterparts. This chapter also examines how an individual's geographic origins may have impacted their status within the community. The chapter begins with an overview of the mortuary theory used in this study, followed by a summary of the findings from previous mortuary studies that have been conducted on the Casas Grandes burial assemblage. The methods used to assess social status are then presented. First, mortuary treatment is examined by group to determine if variation exists based geographic origin. Next, diversity scores were used to estimate social status for each individual in the study sample to determine if locals or non-locals received more elaborate mortuary treatment. Finally, a spatial analysis of burial location was conducted to examine community integration. The results of the various analyses are then presented and discussed at the population-level by group (i.e., locals, regional non-locals, extraregional non-locals), then at the level of the individual. A detailed discussion of high status burials and extraregional immigrant burials follows. The chapter concludes with an evaluation of whether the combined isotope and mortuary results support local or external development models.

In Chapter 5, two bioarchaeological case studies from mortuary contexts that contain suspected human sacrifices are presented. These case studies were conducted to further examine the role of geographic origins in Medio Period social dynamics and ritual practices. The first case study is an elaborate burial tomb that contained seven primary burials, as well as the disarticulated and fragmentary remains of at least five individuals. It has been suggested that the primary interments belong to an elite lineage, while the fragmentary remains represent a sacrificial offering to the elite individuals (Casserino 2009; Di Peso et al. 1974: vol. 8; Rakita 2009; Ravesloot 1988). The second context is a ceremonial ball court, beneath which seven individuals classified as human sacrifices were found (Di Peso et al. 1974: vol. 8). These contexts were chosen because they represent two extremes of mortuary treatment, elites and sacrifices, and were also important ritual loci at the site (Di Peso 1974: vol. 2; Rakita 2009). The chapter begins with a brief background on human sacrifice and its osteological and archaeological correlates, followed by an overview of the two mortuary contexts and their associated burials. The methods used in this study are then presented. This multifaceted bioarchaeological approach includes demographic, paleopathological, trauma, and taphonomic analyses. The results of these analyses are combined with the isotope and mortuary data presented in Chapters 3 and 4 to examine the identities of these individuals, particularly their experiences during life (e.g., disease, trauma) and treatment after death. The chapter concludes with a discussion of the relationship between geographic origins, social status, and ritual/religious practices and what these data reveal about sociopolitical relationships between Paquimé and its neighbours.

Chapter 6 provides a synthesis of the previous three chapters. This summary is used to evaluate the competing cultural development models that have been proposed for Paquimé and to discuss how migration impacted Medio Period social dynamics at the site. This is followed by an overview of ongoing research and a few suggestions for future studies. The chapter concludes by highlighting the main contributions of this thesis.

Chapter 2

Paquimé and the Casas Grandes Phenomenon

2.1 Introduction

The goal of this chapter is to provide a review of the two main topics addressed in this thesis; the Casas Grandes interaction sphere and mortuary practices at Paquimé. The chapter begins with an overview of Paquimé, including its cultural and environmental context. Additional background information of this kind is provided in each of the subsequent chapters. For example, a more comprehensive review of the local ecology and subsistence practices is included in Chapter 3 when considering the expected range of isotope values at the site. The next section begins with a summary of the Casas Grandes interaction sphere, which describes how the primate centre of Paquimé was connected to other Medio Period sites in the region. This is followed by a discussion of interaction with neighbouring regions and the various cultural development models that have been proposed. The section concludes with a summary of genetic and biological distance studies that have been conducted on the Casas Grandes skeletal assemblage[1], which is important for understanding the long-term population dynamics in the region. The final section of this chapter describes the burial assemblage and mortuary practices at Paquimé and Convento. This includes burial data from the original site report (Di Peso et al. 1974: vol. 8), as well as the two mortuary analyses of the Casas Grandes burial assemblage that have been conducted (Rakita 2001, 2009; Ravesloot 1988).

2.2 Overview of Paquimé

2.2.1 Environment and Subsistence

Paquimé, also known as Casas Grandes (CHIH:D:9:1), belongs to the Casas Grandes culture complex[2], which is based in northwest Chihuahua, Mexico and extends into eastern Sonora, southern Arizona and New Mexico. Although Paquimé is located south of the present-day border between the United States and Mexico (Figure 2.1), it is

[1] The Casas Grandes skeletal assemblage consists of the skeletal remains that were recovered by the Joint Casas Grandes Expedition during their excavations at Paquimé, the nearby Convento site, and a few other smaller sites in the region. Only the Paquimé and Convento burials were used in this study.

[2] Brand’s (1933) original term for the Casas Grandes region was the Chihuahua culture area and this term has been used by some scholars working in the region (e.g., JH Kelley et al. 2012; Stewart et al. 2004, 2005).

important to emphasize that this delineation did not exist in prehistoric times; the site is very much a part of the traditionally-defined American Southwest during the late prehispanic period, which is more appropriately termed the Greater Southwest or the Northwest/Southwest (NW/SW) (Minnis and Whalen 2015; Nelson et al. 2015). This broader cultural region is now recognized as including archaeological sites from the American Southwest and northwest Mexico.

Figure 2.1. Physiographic map of Mexico and the Southwestern United States with location of Paquimé and comparative sites examined in this study.

Paquimé is located in the eastern foothills of the Sierra Madre Occidental, on a fertile floodplain adjacent to the Río Casas Grandes. The Casas Grandes region is situated in the Basin and Range province of northwest Mexico, though its western and southern peripheries extend into the Sierra Madre and to the east are desert and semi-desert plains. Paquimé is located in a biotically rich transition zone, which would have provided important natural resources, including various plant species and animals for consumption, as well as timber for construction and fuel (Minnis and Whalen 2015). The climate at Paquimé is semi-arid, with a modern annual rainfall average of ~300 mm, most of which occurs during the summer months. Unfortunately, little is known about how the Medio Period climate may have differed from the present day, though available data suggest similar macro-scale environmental conditions, punctuated by seasonal and decadal climate fluctuations (Minnis and Whalen 2015).

The Casas Grandes river valley is widely noted as being one of the best locations for agriculture in the region and indeed, farming was at the heart of Paquimé's domestic economy and possibly part of its political economy as well (Di Peso 1974: vol. 1; Hammond and Rey 1928; Minnis and Whalen 2015; Whalen and Minnis 2001a, 2003). For example, Minnis and Whalen (2015) have argued that based on the agricultural productivity of the immediate area surrounding the site, agricultural surpluses were probably a source of wealth for the people of Paquimé. The primary cultigens grown at the site were maize, squash, gourds, cotton, beans, and possibly agave (Di Peso et al. 1974: vol. 8; Minnis and Whalen 2010). Canal irrigation was used for lowland river valley farming, while terraces were used for upland farming (Whalen and Minnis 2001). In addition to agricultural crops, the people of Paquimé also supplemented their diet with various types of wild plants (e.g., piñon nuts, juniper berries, cacti) and animals (e.g., rabbits, deer, bison).

2.2.2 Cultural Context

Paquimé and several other sites in the Casas Grandes region, including Convento, were excavated by the Joint Casas Grandes Expedition (JCGE), a collaboration between the Amerind Foundation of Dragoon, Arizona and the Instituto Nacional de Antropología e Historia (INAH) of Mexico. The project, which spanned three years (1958-1961), was led by Charles Di Peso of the Amerind Foundation and Eduardo Contreras of INAH. The work of the JCGE culminated with the publication of a massive eight volume series, which included an interpretive narrative of the origin, development, and demise of Paquimé and the Casas Grandes phenomenon (Di Peso 1974: vols. 1-3), as well as raw data and detailed analyses (Di Peso et al. 1974: vols. 4-8). At Paquimé, excavations focused on the western portion of the site, which contained domestic room blocks, as well as public and ceremonial structures including platform and effigy mounds, three ball courts, an extensive water distribution system, and large pit ovens used for feasting (Di Peso 1974: vol. 2). In addition to these impressive architectural features, over 1.5 tons of shell, hundreds of macaw remains, turquoise and other exotic stones, copper, and beautiful polychrome ceramics imbued with rich ideological symbolism were recovered from the site (Di Peso 1974: vol. 2; Van Pool and Van Pool 2007). Also significant is Paquimé's unique blend of Southwestern and Mesoamerican traits. Finally, although less than half the site was excavated, Paquimé's adobe ruins may have contained over 2,000 rooms and housed a population of between 2,000 - 5,000 individuals (Di Peso 1974: vol. 2; Whalen et al. 2010).

The densely populated community that emerged at Paquimé during the Medio Period (ca. A.D. 1200 – 1450) represents a seemingly radical departure from the earlier Viejo Period (ca. A.D. 800 – 1200) communities in the region (Di Peso 1974: vols. 1-2). Much of what is known about the Viejo Period in the immediate Casas Grandes area comes from the Convento site, which is located 5 km north of Paquimé (Figure 2.1). In general, Viejo Period sites are characterized by sedentary (or semi-sedentary) pithouse communities that practiced intensive maize agriculture and produced plainware ceramics (JH Kelley and Searcy 2015). Mortuary practices include primary, single interments in plazas or communal areas, with few, if any, grave inclusions (Di Peso et al. 1974: vol. 8). The transition from the Viejo to Medio Period is marked by a shift from small, pithouse settlements to above-ground pueblo communities. In addition to changes in architectural style, the Medio Period at Paquimé is also characterized by population growth, increased trade and inter-regional interaction, a more diversified ceramic inventory, and extensive canal irrigation (JH Kelley and Searcy 2015; Stewart et al. 2005; Whalen and Minnis 2001a, 2001b, 2009; Phillips 1989). A complex mortuary program that included elite burial tombs, multiple interments, secondary burials, suspected human sacrifices, and corpse processing also emerged during the Medio Period (Di Peso 1974: vol. 8; Rakita 2009; Ravesloot 1988).

Paquimé is considered to be a mid-level or middle-range society, characterized by an intermediate level of sociopolitical complexity, but lacking bureaucratic hierarchy (Pailes 2017; Whalen and Minnis 2001b). The site is at least six times larger than other settlements in the Casas Grandes region; rapid population growth and aggregation likely created scalar stress, which in turn required adaptive responses, including the development of a more hierarchically organized social structure (Rakita 2009). The construction of various architectural features at Paquimé, such as the elaborate irrigation system feeding water into the city, large platform mounds, and multi-storied residential units, would have required at least some degree of centralized leadership that had decision-making authority (Schaafsma and Riley 1999). Medio Period mortuary practices at Paquimé have also been cited as a primary line of evidence for emergent social complexity, particularly when compared to the preceding Viejo Period (Pailes 2017; Rakita 2001, 2009; Ravesloot 1988).

2.3 Interaction at Paquimé

2.3.1 The Casas Grandes Interaction Sphere

During the Medio period, Paquimé was at the core of the Casas Grandes regional system, which was connected through a variety of social, ritual, economic, and political relationships (Fish and Fish 1999; Whalen 2013; Whalen and Minnis 2001a, 2009). Whalen and Minnis (2001a, 2001b, 2009) have conducted extensive survey and excavation in northwest Mexico over the past three decades and as a result, have divided the Casas Grandes region into three 'zones' of interaction; the Core, Middle, and Outer zones, which are located within a 0 to 30 km, 30 to 60-80 km, and 60-80 to 100-150 km radius of Paquimé, respectively. The Core Zone is further divided into an Inner Core (~0 to 15 km) and an Outer Core (15 to 30 km), the former of which represents the approximate distance one can travel by foot from Paquimé within a day. Sites in the Core Zone, particularly those within a 15 km radius of Paquimé, appear to have be largely controlled by the primate centre (Whalen and Minnis 2001a, 2001b, 2009). For example, Whalen and Minnis (2009) argue that the abundance of trincheras (low terraces for upland farming) in the Core Zone when compared to the Middle and Outer Zones indicates that these communities were required to contribute labour and agricultural resources to Paquimé. Sites beyond a 30 km radius of Paquimé were less integrated than those in the Core but had varying degrees of interaction with the primate centre (Cruz Antillón et al. 2004; JH Kelley et al. 2012; Stewart et al. 2005; Whalen and Minnis 2001a, 2001b, 2009). More specifically, Paquimé's closest ties appear to have been with sites to the north/northwest, including communities in the San Pedro valley and the El Cuervo drainage near the modern city of Janos and to a lesser extent, communities in the Animas region of southwestern New Mexico (Douglas and MacWilliams 2015).

There is also abundant evidence for a larger interaction sphere beyond the Casas Grandes region, as materials and ideology from neighbouring regions are present at the site (e.g., Bradley 1999; Di Peso 1974: vol. 2; Whalen and Minnis 2003). The most notable non-local items recovered from Paquimé include over a ton of marine shell, copper artifacts, foreign ceramics, turquoise, and other exotic minerals (e.g., ricolite, pyrite) (Bradley 1999; Di Peso 1974: vol. 2; Vargas 2001). Most of the marine shell recovered from Paquimé has been sourced to the Gulf of California and was likely imported to the site as finished products (e.g., beads, pendants) since there is no evidence of shell working at Paquimé (Rakita and Cruz 2015). While shell items may have been acquired from coastal groups, exchange with Sonoran desert farming communities, particularly the Cerro de Trincheras site, is a more likely origin (McGuire et al. 1999; Punzo and Villalpando 2015). Similarly, Paquimé's copper bells have been sourced to West Mexico, but they too may have arrived at Paquimé via an east-west exchange axis through Cerro de Trincheras (Punzo and Villalpando 2015; Vargas 1995). Cerro de Trincheras is located approximately 340km due west of Paquimé, on the western side of the Sierra Madre Occidental. Further ties to Mesoamerica are evident in the presence of ball courts, platform mounds, and religious iconography (e.g., plumed serpent), but again, these traits likely made their way to Paquimé via West Mexican channels (Punzo and Villalpando 2015; Van Pool and Van Pool 2015). Scarlet macaws, which are native to the tropical lowlands of Mesoamerica, were also bred and raised at the site (Di Peso 1974: vol. 2; Somerville et al. 2010). At Paquimé, these birds were sacrificed for their colourful plumage, which was likely used for ceremonial or ritual purposes (VanPool and VanPool 2007). Finally, turquoise, Gila polychrome vessels, and other non-local ceramics indicate interaction with the American

Southwest, particularly groups in southern Arizona and New Mexico (Crown 1994; Rakia and Cruz 2015). The presence of foreign objects and cultural attributes from surrounding regions has stimulated significant debate over the role of outside forces in shaping the cultural trajectory of the site. The following section summarizes the various cultural development models that have been proposed for Paquimé[3].

2.3.2 Cultural Development Models: External Stimuli

Di Peso (1974: vol. 2) attributed the origins and development of Paquimé to an influx of Mesoamerican merchant-priests from an unspecified location, which he modeled after the Aztec *Pochteca*. According to Di Peso (1974: vol. 2), these *Pochteca* traders came to the Casas Grandes river valley in search of raw materials and settled at Paquimé because of its fertile environment and strategic location between Mesoamerica and the American Southwest. This small group of sophisticated merchants transformed the existing Viejo Period community into a Mesoamerican trade outpost. Based on the copious amounts of exotic materials recovered from the site, Di Peso (1974) argued that the *Pochteca* elites controlled all facets of trade throughout the Casas Grandes region and the American Southwest. Not only were exotic materials found in abundance at Paquimé, they were also fairly limited in terms of their distribution throughout the site, which he interpreted as stockpiling for trade purposes.

In addition to establishing a complex mercantile system, Di Peso (1974) suggested that these foreigners also introduced new social, political, and belief systems to the region. Mesoamerican religious ideology was particularly pervasive, as evidenced by iconography on ceramic vessels (e.g., feathered serpents), platform mound shapes, the introduction of the ball game, and the breeding and sacrifice of scarlet macaws and turkeys for ritual purposes. The manipulation of human remains in the form of trophy skulls, secondary burials, and human sacrifices was also cited as evidence of Mesoamerican ritual influences.

Di Peso (1974) was not alone in his view that Mesoamerican influences helped to shape the Casas Grandes world. JC Kelley (1995, 2000) has argued that the Aztatlán

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[3] It is important to note that a consideration of all possible sources of foreign objects or cultural attributes is beyond the scope of this study; only the primary, well-formulated cultural development models that have been proposed for the site are presented here.

mercantile system was responsible for stimulating the florescence of Paquimé. This model is based on the Aztatlán tradition of West Mexico, which was an elaborate pan-regional exchange system that spanned the coastal regions of West Mexico, from northern Sinaloa down to Jalisco (Nelson et al. 2015). JC Kelley (2000) argued that by Late Aztatlán times (ca. A.D. 1150 - 1350/1400), the Aztatlán tradition had become a highly developed, West Mexican expression of the Mixteca-Pueblo tradition of central Mexico, which then spread to the highlands of Durango and the Casas Grandes valley. Mobile traders introduced a variety of Mesoamerican attributes to the people of Casas Grandes, including exotica such as copper, marine shell, and macaws, as well as architectural traits and city planning, including platform mounds, ball courts, and the elaborate water distribution system. JC Kelley (2000) viewed the Medio period florescence in the Casas Grandes region, and Paquimé's place as the economic hub of Northwest Mexico and the American Southwest, as the result of direct contact with mobile Aztatlán traders/merchants.

Like JC Kelley, Foster (1999) also attributes Medio Period culture change to Paquimé's incorporation into the Aztatlán system. He argues that Casas Grandes first became integrated into the Aztatlán system by participating in either direct trade, down-the-line exchange, or both, during the early Aztatlán period. Local leaders acquired increasing wealth, authority, and prestige resulting from their economic and administrative involvement in the exchange network. According to Foster (1999), long-distance traders reached the Casas Grandes region during the Late Aztatlán period and established more direct ties with the local leaders, thereby enabling them to gain further power as Mesoamerican influence increased in the surrounding region. This in turn led to the emergence of a *local* elite (emphasis mine). Foster's (1999) adaptation of the Aztatlán hypothesis represents a more conservative estimation of the role of external stimuli in Paquimé's cultural trajectory. He sees Mesoamerican/West Mexican stimuli as the primary source of culture change, but with local elites as active participants in the process.

The final model that invokes exogenous influences is Lekson's (1999, 2015) Chaco Meridian hypothesis, the name of which refers to the north-south alignment of three major NW/SW archaeological sites; Chaco Canyon, Aztec Ruins, and Paquimé. Lekson (1999, 2015) has argued that when Chaco Canyon was depopulated in the twelfth century (ca. A.D. 1125), a group of Chacoan nobles migrated due north to the site of Aztec Ruins, where they sparked cultural developments during the period of A.D. 1110 – 1275 before migrating again, this time over 700 km due south, to the Casas Grandes region of northwest Chihuahua, Mexico during the late thirteenth century. This group of several hundred elites and their retainers found a sparsely-populated landscape consisting of small agricultural communities with relatively low levels of social complexity. According to Lekson (1999, 2015), these elites legitimized their authority through the memory of Chaco; although Chaco Canyon and Casas Grandes were not contemporaneous, Medio Period Casas Grandeans would have remembered Chaco because they were descended from Mimbres populations that *were* contemporaneous with Chaco. Thus, the extant population provided the labour necessary to build the city of Paquimé and the Southwestern elites further enhanced their status and authority through the acquisition and control of West Mexican exotica (i.e., macaws, copper, and shell), which formed the basis of a political-prestige economy.

In addition to the geographic alignment and sequential chronology of the three sites, Lekson (1999, 2015) has argued that Paquimé, Chaco Canyon, and Aztec Ruins share several distinct architectural elements that are unique in the NW/SW and therefore provide further support for his model. These include colonnades, room-wide platforms, and stone disk foundations. All three sites have room-wide platforms and large stone disks beneath important architectural features. Platforms, which may have been used as storage spaces or sleeping platforms, were located within rooms and were therefore private, while stone disks were hidden and would have only been known to planners and builders. Based on this exclusive access to knowledge, Lekson (1999, 2015) believes that these shared traits were due to the migration of nobles, as opposed to the diffusion of ideas. The final feature, colonnades, are Mesoamerican forms and have only been found at Paquimé and Chaco Canyon. Lekson (1999, 2015) posits that these features were built by elites to impress visiting elites.

2.3.3 Cultural Development Models: Local Stimuli

According to Whalen and Minnis (2003), external stimuli models generally stem from two fundamental assumptions: first, that the Casas Grandes region was a largely unpopulated and empty geographic niche; and second, that there was little, if any, cultural continuity between the Viejo and Medio Periods. Prior to the twenty-first century, few Viejo or Medio Period sites had been excavated, thus leading to a paucity of information on what existed in the Casas Grandes region prior to Paquimé. Fortunately, archaeological survey and excavation over the past several decades have produced new data on both the Viejo and Medio Periods in the Casas Grandes region (Cruz Antillón and Maxwell 1999; Cruz Antillón et al. 2004; JH Kelley et al. 1999, 2012; JH Kelley and Phillips 2017; Stewart et al. 2005; Whalen and Pitezel 2015; Whalen and Minnis 2001a, 2001b, 2003, 2009). First, these studies have revealed a more sizeable Viejo Period population than had previously been assumed (e.g., Di Peso 1974: vol. 1; Lekson 1999, 2015), as 50+ sites in the Casas Grandes region, including Paquimé, contain Viejo Period pithouses directly beneath Medio Period settlements (Di Peso et al. 1974: vol. 4; JH Kelley et al. 2012; Whalen and Minnis 2001a, 2003, 2009). These data provide clear evidence for continuous occupation over time. Furthermore, the Casas Grandes river valley is an exceptionally good location for agriculture because of its fertile floodplain, reliable water, and ample natural resources (Minnis et al. 2006; Whalen and Minnis 2003). As such, it is likely that this area has been occupied continuously since at least Viejo Period times (Whalen and Minnis 2003).

Second, a variety of Medio Period traits have been found at late Viejo/early Medio Period sites throughout the region, indicating some degree of cultural continuity between the two periods (JH Kelley et al. 2012; Whalen and Minnis 2009). In particular, late Viejo Period changes in architecture, burial practices, and material culture foreshadow Medio Period developments. During the earlier stages of the Viejo Period, called the Convento and Pilón phases, Casas Grandes sites were considered part of the Mogollon culture phenomenon, centred in Arizona and New Mexico. During this period, people lived in small, agricultural pithouse villages and buried their dead beneath house floors with few (if any) grave accompaniments (Di Peso 1974: vol. 1). While the presence of non-local trade wares indicates exchange with groups from the American Southwest (e.g., Mimbres), the early Viejo Period was not characterized by large-scale inter-regional interaction (Di Peso 1974: vol. 1; Phillips 1989; Stewart et al. 2005). During the terminal (i.e., Perros Bravos) phase of the Viejo Period, the people of Casas Grandes began building above-ground, rectangular adobe structures in small clusters of two or three[4] (Phillips 1989). They also began burying their dead with a variety of grave goods, including both decorative and utilitarian objects (Di Peso 1974: vol. 8). In addition, there is an increase in the amount and diversity of trade goods from distant regions in both burial and residential contexts (Di Peso 1974: vol. 8; Whalen and Minnis 2003). This shift in mortuary practices indicates an increasing concern with social status and differentiation (Rakita 2001, 2009; Whalen and Minnis 2003). Though nowhere near the scale of Paquimé, these patterns appear to be the incipient stages of pronounced culture change that is characteristic of the Medio Period.

Although most scholars currently working in the Casas Grandes region favour local development scenarios (e.g., Cruz Antillón and Maxwell 1999; Cruz Antillón et al. 2004; JH Kelley et al. 1999, 2012; JH Kelley and Searcy 2015; Rakita 2001, 2009; Stewart et al. 2005), Whalen and Minnis (2003) have provided the most detailed model of Paquimé's Medio Period cultural trajectory. Their extensive survey of the Casas Grandes region has resulted in the identification of 120+ sites within a 30 km radius of Paquimé, most of which are small or medium in size (i.e., less than 8x the size of Paquimé) (Whalen and Minnis 2001a, 2001b, 2003). They suggest that Paquimé's superior environmental conditions (when compared to other parts of the region) likely resulted in agricultural surpluses, which in turn created an ideal situation for aspiring elites to gain political currency through resource sharing during times of subsistence stress (e.g., drought). These individuals also began to develop other aggrandizing strategies, including the use of foreign connections, ideologies, and trade goods to gain sociopolitical favour with their peers. Thus, Mesoamerican, West Mexican, and Southwestern cultural attributes, such as architectural styles, design motifs, and ritual practices, were utilized by local elites to establish and enhance their power within a society undergoing the incipient stages of social hierarchy. Whalen and Minnis (2003) also emphasize that foreign elements were adopted, sometimes transformed, and integrated into a broader panoply of largely local traits. In short, the authors argue for indirect non-local influences, rather than direct and sustained contact with foreign individuals at Paquimé.

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[4] Viejo Period architecture in the southern zone of the Casas Grandes region is distinct from the late Viejo sites near Paquimé, as they are characterized by round, single-room structures with adobe wall bases (JH Kelley et al. 2012).

Finally, Whalen and Minnis (2003, 2009) have also suggested that Medio Period population growth at Paquimé may have resulted from the absorption of regional populations. To explore this scenario, the authors compared occupational histories and settlement patterns of several large sites in the Casas Grandes region with that of Paquimé. Significantly, they found that peak population growth at Paquimé (ca. A.D. 1300) corresponded with a period of population decline at a 200-room pueblo located ~20 km west of Paquimé, called the Tinaja site (Site 204). The Tinaja site also has an I-shaped ball court, a large oven for public feasting, copper artifacts, T-shaped doorways, and a macaw burial. The authors argue that these traits are clear antecedents to some of the Medio Period hallmarks typically associated with Paquimé and their occurrence at the onset of the Medio Period (as opposed to its apogee) provides evidence for the localized development of complex traits. While evidence from additional sites would certainly strengthen this argument, Whalen and Minnis (2009) aptly note that it would be surprising if population growth at Paquimé *did not* involve population aggregation of surrounding communities from within the Casas Grandes region.

2.3.4 Biological Distance Studies & Genetic Evidence for Interaction

Several studies have examined the biological relationship of Paquimé to neighbouring populations through the analysis of human skeletal remains recovered from the site. Butler (1971) compared frequencies of discrete morphological traits in skeletons from the Viejo, Medio, and Spanish Periods to examine genetic continuity at Casas Grandes over time. Discrete (non-metric) traits are heritable, therefore significant differences in trait frequencies between time periods could signal the introduction of new genes into the population (i.e., geneflow via migration). Butler (1971) found that 10% (4/40) of cranial traits and 29% (7/24) of dental traits (17% combined) exhibited statistically significant differences between the Viejo and Medio Period samples, which she interpreted as relative genetic homogeneity over time. She concluded that Medio Period population growth was not due to a major influx of new populations to the site. Instead, these findings are consistent with models that invoke local developments or scenarios in which a small group of immigrants became integrated into the Paquimé breeding population.

Turner (1993, 1999) utilized dental non-metric traits to examine genetic relationships between various populations in the American Southwest and Mexico, including Casas Grandes. His analysis included over 4,600 individuals from 75 sample populations, making it one of the most extensive studies of biological affinity in this region. A Mean Measure of Divergence (MMD) analysis revealed that individuals from Casas Grandes (N=179) were phenotypically most similar to a historic sample from Sinaloa, followed by samples from prehistoric Mimbres and Coahuila. In another study, Turner (1999) compared Casas Grandes to 23 other samples from the American Southwest and southern, central and northwest Mexico and again found that Casas Grandes was most similar to Sinaloa and Mimbres groups. Interestingly, Casas Grandes clustered more closely with these groups than to other skeletal samples from Chihuahua. Walker's (2006) craniometric analysis produced similar results; crania from Paquimé were morphologically more similar to crania from Rio Grande Ancestral Pueblo sites located in north-central New Mexico than they were to a Sierra Tarahumara sample from southwest Chihuahua. Finally, LeBlanc and colleagues' (2008) discrete dental trait analysis of samples from the American Southwest, northwest Mexico, and central Mexico also revealed that Casas Grandes was most similar to NAN Ranch and other Mimbres sites.

Most recently, Morales-Arce and colleagues (2017) conducted ancient DNA analysis on fourteen individuals from Paquimé to examine the ancestry of the site's inhabitants. Among the individuals sampled, they found four distinct mitochondrial haplogroups, which were present in the following frequencies: B (45%), A (27%), C (18%), and D (9%). Haplogroups B, C, and D are prevalent in Southwest groups, while Haplogroup A is the most common haplogroup found in Mesoamerica. The results were also compared to aDNA data from various Southwest and Mesoamerican samples, including sites in the Mimbres Valley (Swartz Ruin, NAN Ranch, Cameron Creek, Harris Site, Treasure Hill, unprovenienced Mimbres), the Middle San Juan region of northwest New Mexico (Tommy and Mine Canyon sites), and the Basin of Mexico. Results of the comparative analysis revealed that the Paquimé sample was most similar to Mimbres sites, followed by the Tommy Site. The results of this study accord well with the findings of Turner (1993, 1999) and LeBlanc et al. (2008), and indicate that Paquimeños show closer genetic affinity to Southwest groups than to Mesoamericans. Unfortunately, no comparative samples from northern or west Mexico were available for this analysis, so models invoking West Mexican influence cannot be evaluated with the ancient DNA data at this time.

In summary, biological distance studies that have been conducted on the Casas Grandes skeletal assemblage do not support external stimuli models that involve a significant influx of Mesoamerican immigrants during the Medio Period at Paquimé (LeBlanc et al. 2008; Morales-Arce 2017; Turner 1993, 1999). Instead, they suggest that the people of Paquimé exhibit the strongest genetic affinity with populations from the American Southwest and West Mexico. As such, local development models that involve migrants from these regions (e.g., Lekson 1999, 2015; Foster 1999; JC Kelley 2000) are more plausible scenarios for Medio Period culture change than are models that involve direct and sustained contact with Mesoamerican groups (i.e., Di Peso 1974: vol. 2).

2.4 The Casas Grandes Skeletal Assemblage

2.4.1 Overview of Mortuary Practices

Most of what is known about Viejo Period mortuary practices comes from the Convento site, which dates to approximately A.D. 900 – 1200 and has been divided into three phases; Convento, Pilón, and Perros Bravos (Di Peso 1974: vol. 1)[5]. The following discussion is summarized from Di Peso et al. (1974: vol. 8). A total of 76 individuals were recovered from Convento. The Viejo Period mortuary program is extremely homogenous, particularly during the two earliest phases (Convento and Pilón). All individuals were buried in simple pits and placed in plazas or over older, abandoned pithouses. Both burial locations represent the intentional placement of the deceased away from habitation spaces, but within the village. Most of the burials were single interments (76%), some were double burials (21%), and one interment contained three individuals. Most individuals (81%) were placed on their right or left sides, but during the later phases, supine burials were

[5] Di Peso's (1974: vol. 2) original Medio Period chronology for Paquimé has been revised due to errors in calculating tree ring dates. In addition, Di Peso's (1974: vol. 2) Viejo Period phase divisions have been critiqued by JH Kelley and Searcy (2015), who suggest that the presence of Mimbres pottery throughout the sequence at Convento suggests that the entire Convento site may date to the late Viejo Period. However, since the dates have not yet been revised, I follow Kelley and Searcy (2015) and use the original phase designations here, but without the chronological dates assigned by Di Peso (1974: vol. 2).

introduced, and a few individuals were placed in sitting (N=1) or prone (N=1) positions.

Approximately one-third of the individuals at the Convento site were interred with burial goods. The practice of placing items with the dead became more common over time, with the frequency of burial inclusions increasing from 0% in the Convento phase to 28% in the Pilón phase and peaking at 51% in the Perros Bravos phase. Most of the mortuary offerings were (non-polychrome) ceramic vessels (N=16 individuals) and/or shell jewelry (N=13 individuals). The remaining burial accompaniments were utilitarian objects (N=4 individuals) or rare inclusions (N=3), the latter of which consisted of a dog, pyrite mosaic stone plaque, and quartz crystal. The presence of shell jewelry in many of the Pilón and Perros Bravos phase burials, as well as a turquoise bead with one of the Perros Bravos burials, indicates exchange with neighbouring regions during the late Viejo Period (Di Peso et al. 1974: vol. 8; Rakita 2001).

In contrast to the Viejo Period mortuary program where the majority of individuals were interred in a similar fashion, the Medio Period mortuary assemblage exhibits both a wide range of burial treatments (28 variants; see Appendix A) and the appearance of new mortuary practices, such as secondary burials, post-mortem corpse processing, human sacrifice, and interment in elaborate burial tombs and ceramic urns (Casserino 2009; Di Peso et al. 1974: vol. 8). There is also a conspicuous shift from burial in public spaces during the Viejo Period, to private, domestic contexts during the Medio Period, as 63% of the 447 deliberate interments were sub-floor room burials. Multiple interments become more common over time and there is greater variability in the types and quantities of burial accompaniments during the Medio Period, as some individuals are interred with no grave goods and others have large quantities and varying types.

Another significant difference between the Viejo and Medio Period mortuary assemblages is the presence of what Di Peso and colleagues (1974: vol. 8) classify as Type 2 "unburied bodies". These fragmentary and scattered remains were recovered from room floors or fill/debris. According to Di Peso and colleagues (1974: vol. 8:337), "these individuals, who represented 16.7% of the total body count, had apparently been killed and left to die where they had fallen on the day the city was destroyed…". A detailed examination of the mortuary data, however, reveals a more complex situation than the authors acknowledge in this passage. For example, several of the "unburied bodies" were recorded as articulated burials placed in room fill and found in positions that are consistent with formal interment (e.g., on side, legs flexed to chest). As such, it seems likely that at least some of these Type 2 burials represent formal interments that were placed in abandoned areas of the site and should perhaps instead be incorporated into the Type 7 category, "Burials Superimposed on Older, Abandoned Architecture" (Di Peso et al. 1974: vol. 8). I would also suggest that some of the fragmentary remains found on floor surfaces and in room fill might be due to taphonomic or anthropogenic disturbances. Finally, some of these fragmentary and disarticulated remains exhibit cut marks, burning, and breakage patterns characteristic of intentional post-mortem processing (Casserino 2009).

Casserino (2009:56) has argued that these unburied bodies, which he calls "non-interred specimens (NIS)", should be separated into four distinct sub-types: 2A (floor surface, articulated), 2B (floor surface, disarticulated), 2C (fill, articulated), 2D (fill, disarticulated). Type 2E refers to burials that had no provenience or were recovered from test trenches. Furthermore, fluorine and AMS radiocarbon dating have demonstrated that the Type 2 burials were deposited throughout the ~250-year occupation of the site (Casserino 2009), not during a single calamitous event, as Di Peso and colleagues (1974: vol. 8) had asserted. These data and observations indicate that the Type 2 burials likely represent a variety of different mortuary practices. However, until a comprehensive skeletal and taphonomic analysis of all 126 non-interred remains is conducted, our understanding of this burial category will remain incomplete.

2.4.2 Mortuary Studies

Ravesloot (1988) was the first to thoroughly examine the Medio Period mortuary program at Paquimé in his study of social organization at the site. In particular, he was interested in determining whether there was evidence for vertical social ranking at Paquimé. To accomplish this, Ravesloot (1988) employed a dimensional approach, which uses qualitative distinctions in mortuary treatment (e.g., type of burial facility, methods for corpse disposal) as indicators of the different social positions or identities of the deceased. Importantly, these indicators should occur as a suite of covarying attributes that represent symbols of rank and authority (Braun 1981). *Status* was defined as "all positions that vary by gradation such as wealth, prestige, power, and administrative authority" and *ranking* was defined as “managerial levels within formal decision-making hierarchies” (Ravesloot 1988:20). Differences in social status were considered to reflect different positions within the decision-making hierarchy at Paquimé.

Ravesloot (1988) hypothesized that if Paquiméan society was hierarchically organized on the basis of ascriptive ranking, status differentiation should be reflected in the mortuary treatment of the individuals buried at the site. He generated four expectations from this hypothesis, all of which were informed by the findings of previous mortuary studies (Tainter 1975, 1978; Braun 1977, 1981):

- One or more qualitative mortuary attributes should be identified within the mortuary program. These included the location, type, and size of the burial facility, processing and disposal of the corpse, and the burial goods placed with the deceased. Furthermore, the relative cost of these burial attributes in terms of energy expenditure on the grave, processing of the body, acquisition of raw material, and manufacture of grave goods should be highest among those ranking at the top of the social hierarchy;
- Grave accompaniments that functioned as symbols of rank or authority should be present;
- Qualitative attributes that represent symbols of authority and social rank should covary within the Paquiméan mortuary program, such that distinct dimensions of status differentiation could be defined from this suite of mortuary traits; and
- Access to the qualitative distinctions of power and authority should crosscut demographic categories (i.e., age and sex).

Ravesloot (1988) identified a total of 280 distinct burial attributes from the mortuary data presented in Di Peso et al. 1974: vol. 8, most of which (N=248) were grave goods. The author divided burial accompaniments into nine categories, which were intended to differentiate artifacts that served as symbols of rank and authority from those that represented more functional purposes (e.g., utilitarian objects). He based this typological system on the findings of previous studies that had examined symbols of rank and authority (e.g., Braun 1977, 1979; Peebles 1974; Peebles and Kus 1977). Other categories used to examine mortuary differentiation included treatment of the body, burial facility attributes, burial location (i.e., architectural unit) and the demographic profile of each individual. Ravesloot (1988) postulated eight symbols of rank and authority based on increased energy expenditure required for each and/or their rarity at the site. These symbols included secondary burial, legs frogged (thighs rotated laterally with legs flexed at the knees), burial in a vault, burial in a subfloor tomb, and association with ceramic handdrums, polychrome ceramics, jewelry manufactured from non-local material, and rare artifacts.

The author computed frequencies of all mortuary variables and found that the majority (55%) of deliberate interments were multiple burials, fully flexed (68%), and placed in simple earthen pits below room floors (58%). Grave orientation could only be determined for approximately 70% of all burials, of which most were oriented to the west. Most individuals at Paquimé (~56%) were not interred with grave goods. Of the 195 interments that had burial accompaniments, specific grave goods could only be directly associated with 143 individuals due to the ambiguity of associating artifacts with specific individuals in some of the multiple interments. Ravesloot's (1988) univariate assessment of the Paquimé burial assemblage revealed that a small portion of the population received the following burial treatment:

> …a few of the deceased were interred with a large diversity and quantity of grave accompaniments that included composite necklaces of turquoise, shell, ricolite, and slate ornaments; utilitarian items; socioreligious objects such as minerals and pigments; and numerous different types of ceramic vessels. Some of these burials were housed in subfloor tomblike graves that had been covered with board planks or cribbed log roofs. These specially prepared facilities also contained single and multiple burials. Decorated and undecorated ceramic handdrums were frequently found lying on top of these tombs, suggesting their use in the ritual burial of the deceased. Occasionally, disarticulated skeletons, interpreted by the excavators to represent secondary burials, were interred within these tombs in association with primary inhumations. The association of elaborate grave furnishings and specially prepared tombs suggest that these people may have belonged to a higher status group than those previously described. (Ravesloot 1988:56).

Principal components analysis (PCA) largely confirmed Ravesloot's (1988) proposed symbols of rank and authority, revealing statistically significant covariance between the following attributes: Burial Vault, Multiple Burial, Room Subfloor Tomb, Legs Frogged position, Secondary Burial, Polychrome Ceramics, Ceramic Handdrums (associated with grave facility), and Rare Accompaniments. Ravesloot (1988) argued that wealthy burials, or those containing both a large quantity and high diversity of grave goods, represent the economic standing of the deceased and/or their family and also symbolized rank and authority. As such, these individuals likely had more prestige than other Paquimeños and occupied higher status positions in the community. On the other end of the spectrum, individuals interred beneath plaza floors received less elaborate burial treatment than individuals placed beneath room floors, which may indicate that lower status individuals were interred in plazas.

Finally, the analysis identified four architectural units (Units 4, 13, 14, and 16) that may have served as formal disposal areas for high ranking segments of the population given their association with many of the indicators of rank and authority. In particular, Unit 4 (The Mound of the Offerings) contained two vaults in which three secondary burials were found. The post-cranial remains of these individuals were placed in two abnormally large Ramos Polychrome vessels and several rare artifacts, mostly fashioned from human bone, were placed with the urns. The burial goods included a musical rasp, a necklace made from human hand and foot bones, and two unworked human long bones. It has been suggested that the skeletal remains placed inside these urns belong to Paquimé's highest ranking individuals (Di Peso 1974: vol. 2). Units 13, 14, and 16 also contained subfloor tombs, a few of which held multiple burials and were associated with rare or socioreligious accompaniments. As such, the construction of each of these burial facilities would have required significantly more energy expenditure than the average interment at Paquimé.

Ravesloot (1988) also noted that burials were rarely placed in rooms that served public or ritual functions, with the exception of Type 2 unburied bodies. These individuals were recovered from various ceremonial locations throughout the site, including Unit 4 (The Mound of the Offerings), where the elaborate urn burials were located, and room 23 of Unit 14 (The House of the Pillars), which contained four subfloor deposits of ceremonial items. As such, this pattern could indicate that Type 2 "burials" were placed in these locations long after their use as ceremonial loci. Based on the results of the univariate and multivariate analyses, Ravesloot (1988) concluded that social organization during the Medio Period consisted of a system of social rank based on inheritance (i.e., ascription) and that positions of power likely derived from the control over agricultural resources and exchange items.

Rakita (2001, 2009) also studied the Paquimé mortuary assemblage to examine emerging social complexity, but with a focus on the relationship between social organization and religious/ritual transformation. More specifically, he posited that changing ritual practices and their associated ritual practitioners played an important role in the emergence and maintenance of institutionalized inequality at Paquimé. According to Rakita (2001, 2009), the evolution of religious organization was one of the ways in which Paquimeños adapted to scalar stress caused by population aggregation during the Medio Period. To evaluate this hypothesis, he conducted a diachronic comparison of Viejo versus Medio Period mortuary practices to look for changes in the mortuary variability over time, as indicated by increased energy expenditure and mortuary elaboration. Artifact counts and richness were used to measure energy expenditure and served as proxies for status distinctions. Rakita (2001, 2009) constructed histograms of these measures for each phase of the Viejo and Meido Periods to look for patterning that would differentiate between mortuary elaboration representing the social status of the dead versus mortuary elaboration resulting from graveside status negotiations amongst the living. Post-processual scholars view this as an important distinction that can substantially impact interpretations of mortuary behaviour in past populations (e.g., Hodder 1982; Parker Pearson 1982, 1999). The author also examined various archaeological correlates of ritual practices including religious paraphernalia, ritual architecture, human and non-human sacrifices, and ceramics with ritual iconography or associations, to determine whether changes in social organization were accompanied by shift in religious organization.

Rakita (2001, 2009) found that both artifact count and richness increase from the Viejo to the Medio Period, with the most drastic changes occurring during the Perros Bravos phase of the Viejo Period and during the late Medio Period. These results indicate an increasing number of status distinctions over time, which in turn suggests increasing levels of social differentiation and emerging hierarchy. Rakita (2009) argues that these data likely represent an increase in the level of status negotiations amongst the living (i.e., the individuals involved in funerary rites) since the dead do not bury themselves. He further suggests that status distinctions during the Perros Bravos phase of the Viejo Period are conveyed through personal adornments made from exotic materials, namely shell from the west coast of Mexico and non-local ceramic types. These items signaled access to and control over important prestige items, which played a key role in status negotiations (Rakita 2001, 2009).

Rakita (2001, 2009) also noted the conspicuous shift from public to private burial contexts during the Viejo to the Medio Period transition and suggests that it signals an increasing concern over the privacy of mortuary rites and access to ancestors. He posits that Medio Period population aggregation likely involved the movement of kin-based groups to Paquimé and that these factions may have used exclusive mortuary rituals as one means to maintain their group identity. Importantly, Rakita (2001, 2009) found that during the early Medio Period, individuals interred in private room contexts had significantly richer graves in terms of both the quantity and types of burial goods than individuals interred in public (plaza) contexts. He suggests that burial location is either an indicator or social status or that the richness of private burials means that that graveside status negotiations were occurring amongst some members of the community. However, the private nature of these burials means that only small segments of the population could witness these status displays. As such, Rakita (2001, 2009) suggests this pattern represents increased competition for high status positions within kin groups. These private mortuary rituals stand in stark contrast to the Viejo Period practice of interring the dead in public spaces, where mortuary rituals could be observed by all members of the community and were likely used to promote social cohesion. These findings accord well with Ravesloot's (1988) suggestion that plaza interment at Paquimé may have been an indicator of low social status within the community.

Rakita (2009) also found that various locations served as important settings for ongoing ritual activity, such as the burial crypt in the Mound of the Offerings, which contained the unique urn burials and a number of associated ritual artifacts, as well as an elaborate tomb found in Unit 13 (Burial Tomb 44-13). This tomb was the most complex burial encountered at the site and contained at least twelve individuals: seven primary, articulated interments and the fragmentary and disarticulated remains of an additional five individuals. The articulated burials are associated with a large quantity of mortuary offerings, many of which were ritually significant objects (e.g., ceramic handdrums and a turkey sacrifice). As well, it has been suggested that the disarticulated and fragmentary remains comprising the uppermost burial layer may represent human sacrifices (Di Peso et al. 1974: vol. 8; Kohn 2011) and ritual anthropophagy (Casserino 2009; Kohn 2011). Furthermore, the tomb was likely covered by a removable wood plank, which would have been conducive to ongoing ritual activity and ancestor veneration. Thus, Paquimé's most elaborate burials are also the most ritually-charged mortuary contexts, which indicates a link between social status and religious/ritual authority.

Rakita (2001, 2009) concluded that increasing social differentiation during the Viejo to Medio Period transition was accompanied by a shift in religious and ritual organization. He argues that rituals were probably conducted by local, part-time shamans during the Viejo Period since there is little evidence for structured religious practices. As small kin-groups migrated to Paquimé, however, clan-based shamanism evolved into cult organizations, which were led by priests. Rakita (2009) argues that two such cults existed at Paquimé: the ancestor/political cult, whose focus was on power negotiations and the maintenance of elite authority, and the fertility cult, which was concerned with social cohesion and communalism. The ancestor cult is characterized by private mortuary rites, human (and non-human) sacrifices, control of access to the ancestors, and exclusivity, while the fertility cult is characterized by public mortuary rites, non-human sacrifices (macaws, turkeys), celestial observation and weather symbolism, and inclusivity. According to Rakita (2001, 2009), these were likely distinct, yet overlapping religious organizations.

Perhaps most relevant to the present study is Rakita's (2001, 2009) suggestion that clan or kin groups originating from the Casas Grandes area would have access to the best agricultural lands and resources stemming from their primacy in the region, thus leading to real (or perceived) ritual success and social superiority over in-migrating clans. These emerging elites would have been ideal candidates for the acquisition of priestly positions within a newly developed ritual system at Paquimé. If Rakita's (2001, 2009) model is correct, we would expect individuals with local and/or regional isotope signatures to occupy the highest ranking positions within the Paquimé social hierarchy. In turn, the high status of these individuals should be symbolized through more elaborate mortuary treatment when compared to individuals with non-local isotope values. Furthermore, status distinctions may be signaled by mortuary treatment or grave goods that have socioreligious significance since these elite social positions were likely tied to ritual authority.

Chapter 3

Interaction at Paquimé: Examining Migration and Mobility through the Isotopic Analysis of Human Skeletal Remains

3.1 Introduction

The goal of this chapter is to determine the occurrence, scale, and structure of migration at Paquimé, which will aid in distinguishing between the various mechanisms that could account for the presence of foreign objects and symbols at the site. Radiogenic strontium and stable oxygen isotope analyses are employed to address the following research questions: (1) Were non-local individuals present in the Paquimé burial assemblage? (2) What is the proportion of non-local individuals at the site and does it vary over time? (3) What is the form/structure of migration at Paquimé? (4) Where did immigrants come from?

This is the first study to employ radiogenic strontium and stable oxygen isotope analyses on an archaeological assemblage from northwest Mexico, therefore, a fundamental component of this study is to establish the expected isotope range at both the local and regional levels. This is accomplished by analyzing faunal remains from Paquimé (local range) and faunal and human remains from various sites within the Casas Grandes area (regional range). As well, human and faunal samples from sites in the American Southwest and central Mexico are analyzed to establish comparative values for neighbouring regions. When combined with previously published isotope data, these results provide comparative information that is useful for pinpointing possible geographic origins of non-local individuals identified in the Casas Grandes skeletal assemblage.

3.2 Isotope Background

Over the past several decades, radiogenic strontium and stable oxygen isotope analyses have become widely utilized methods for examining prehistoric migration and mobility because they provide direct evidence for the movement of people across the landscape, especially at the level of the individual (e.g., Bentley et al. 2002; Evans et al. 2006; Knudson et al. 2004, 2014; Price et al. 1994, 2000; Prowse et al. 2007; CD White et al. 1998, 2002; Wright 2005, 2012). Archaeological applications of isotope analyses stem from two basic principles; first, certain isotopes are geologically or geographically variable and can therefore be used as natural tracers (Dasch 1969; Katzenberg 2008; Price and Burton 2011). Second, the isotope ratios present in human skeletal tissues reflect the isotope ratios of the plants, animals, and water they consume (Ericson 1985; Price et al. 1994; Schwarcz et al. 1991; CD White et al. 1998). Thus, individuals who exhibit isotope values distinct from the location in which they were buried are inferred to be immigrants.

3.2.1 Radiogenic Strontium Isotope Analysis

Ericson (1985) was the first to propose and utilize strontium isotope analysis on human skeletal remains and since his original study, the method has been applied to archaeological and historical contexts around the world (e.g., Bentley et al. 2009; Buzon et al. 2007; Ezzo and Price 2002; Grupe et al. 1997; Knudson et al. 2014; Price et al. 2000, 2017; Scheeres et al. 2014; Wright 2005). Strontium is an alkaline earth metal with three non-radiogenic isotopes (^{84}Sr, ^{86}Sr, and ^{88}Sr) and one radiogenic isotope (^{87}Sr). Although ^{87}Sr is radiogenic, $^{87}Sr/^{86}Sr$ values can be considered "stable" for archaeological purposes because radiogenic β-decay of ^{87}Rb to ^{87}Sr has a half-life of 4.88 x 10^{10} years, therefore $^{87}Sr/^{86}Sr$ values have not changed during the Holocene (Bentley 2006; Dickin 2005). The Rb-Sr system is ideal for geochemical sourcing because the original Rb/Sr ratios in rocks vary based on their composition and age, which in turn result in a wide array of $^{87}Sr/^{86}Sr$ values geographically (Dasch 1969). Rocks that are over 100 million years old, such as granites, typically have high $^{87}Sr/^{86}Sr$ values (>0.710), while recently formed rocks between 1 to 10 million years old, such as basalts, have $^{87}Sr/^{86}Sr$ values of 0.707 or lower (Faure and Powell 1972; Fullagar et al. 1971). Sedimentary rocks exhibit strontium isotope ratios between 0.707 and 0.710 (Dasch 1969; Faure and Powell 1972).

Strontium is released into the soil and groundwater by the weathering of rocks. Although plants reflect the strontium isotope ratio of their substrate, $^{87}Sr/^{86}Sr$ values are said to be *characteristic* of a geological area rather than a direct reflection of it (Burton and Hahn 2016; Price et al. 2002; Sillen et al. 1998). This terminology is used because various inputs with different $^{87}Sr/^{86}Sr$ values can contribute to strontium isotope values in the local food chain. For example, differential weathering rates of minerals can change the $^{87}Sr/^{86}Sr$ values in soil when compared to the underlying bedrock (Beard and Johnson 2000; Faure and Powell 1972). In addition, atmospheric inputs (e.g., dust), surface waters, and erosive forces that transport water and soil from one geological location to another can introduce non-local strontium (Capo et al. 1998; Probst et al. 2000). Sea spray can also be a factor in coastal environments because the current $^{87}Sr/^{86}Sr$ value of sea water (0.7092) may differ from the strontium isotope ratio of the underlying bedrock, thus changing the $^{87}Sr/^{86}Sr$ value of the soil, plants and animals in a given area (Veizer 1989). Similarly, the consumption of marine foods or sea salt can also alter $^{87}Sr/^{86}Sr$ values in human skeletal tissues (Wright 2005).

Strontium initially enters the biosphere through plants and is then passed on to the animals that consume them, including humans. Strontium isotope ratios are not measurably changed (fractionated) as they move through the food chain due to the relatively small mass differences between Sr isotopes (Blum et al. 2000; Faure 1986). Plants obtain strontium directly from the soil and groundwater and exhibit the widest variation of $^{87}Sr/^{86}Sr$ values within an ecosystem (Bentley 2006). Herbivores that consume a variety of plants should therefore represent the average $^{87}Sr/^{86}Sr$ value within a region because they obtain strontium from an array of inputs. In turn, humans acquire strontium through the consumption of plants, animals, and water. Foods vary in the amount of strontium they contain, therefore high strontium foods (e.g., leafy vegetables, grains, legumes) are the primary contributors to dietary $^{87}Sr/^{86}Sr$ ratios. Conversely, low strontium foods, such as maize or meat, generally do not contribute to dietary strontium unless they comprise a significant majority (>90%) of the diet (Burton and Wright 1995; Burton and Hahn 2016).

Strontium is incorporated into human skeletal tissues by substituting for calcium in hydroxyapatite, the mineral component of bones and teeth (Underwood and Mertz 1977). This substitution is possible because calcium and strontium have similar chemical properties. Tooth enamel is particularly useful for tracing human mobility because it does not remodel once formed, thereby retaining the original $^{87}Sr/^{86}Sr$ values that were incorporated during dental development (Hillson 1996). Enamel formation follows a predictable sequence of development, so $^{87}Sr/^{86}Sr$ values in different teeth are representative of the strontium consumed during specific times during life (e.g., birth, adolescence). Although both bones and teeth can be used for stable isotope analysis, bone is highly susceptible to diagenesis, which can result in elemental exchange from the burial environment (Budd et al. 2000). Diagenetic alteration can create a false local signature, whereby immigrants appear local because their skeleton has incorporated isotope values characteristic of the local burial environment. Tooth enamel, on the other hand, is highly resistant to diagenesis because it contains very little organic material (~2%) when compared to bone and has much larger hydroxyapatite crystals, and therefore less surface area subjected to post-depositional alteration (Hillson 1996; Hoppe et al. 2003; Kohn et al. 1999; Lee-Thorp and Sponheimer 2003; Zazzo et al. 2004).

3.2.2 Stable Oxygen Isotope Analysis

The use of stable oxygen isotope analysis to analyze geographic mobility is possible because of global climatic variability and the incorporation of oxygen isotopes into human tissues. The ratio of ^{18}O to ^{16}O, expressed as $\delta^{18}O$, varies based on local geographical conditions, including temperature, latitude, altitude, rainfall, humidity, and proximity to the coast (Longinelli 1984; Luz et al. 1984; CD White et al. 1998). For instance, $\delta^{18}O$ values decrease with increased distance from the coast, higher elevations, and decreased temperatures. This geographical oxygen isotope variation stems from fractionation effects that occur during the transfer of oxygen isotopes through the earth's systems (i.e., hydrosphere, atmosphere); more of the lighter oxygen isotope (^{16}O) is preferentially lost in evaporation, leading to lighter $\delta^{18}O$ values in the atmosphere and heavier $\delta^{18}O$ values in the ocean (Gat and Gonfiantini 1981). Meanwhile, water molecules containing the heavier isotope (^{18}O) condense more readily during precipitation, so as clouds move inland from the coast and to higher elevations, meteoric water becomes depleted in ^{18}O and results in lower $\delta^{18}O$ values. Thus, $\delta^{18}O$ values vary by region and can serve as geographic tracers.

Oxygen is incorporated into the human body primarily through ingested water, but also through water present in consumed food and inhaled atmospheric oxygen (Longinelli 1984). Oxygen exits the body via sweat, urine, and respired CO_2, therefore body water represents an equilibrium of oxygen inputs and outputs (Dansgaard 1964). Oxygen isotope values present in the phosphate and carbonate portions of human biological apatite (bioapatite) reflect the $\delta^{18}O$ of body water, which in turn is strongly, but not exclusively, influenced by the $\delta^{18}O$ of drinking water (Longinelli 1984; Luz et al. 1984). More specifically, oxygen isotope inputs undergo metabolic fractionation through physiological processes, leading to enrichment of ^{18}O in body water. The degree of enrichment depends on biological and behavioural variables including body size and the source and amount of water in the diet (Bryant et al. 1995).

Historic and prehistoric populations would have acquired most of their drinking water from surface waters (i.e., rivers, lakes, and streams), which can have $\delta^{18}O$ values that differ from $\delta^{18}O$ values in precipitation (Daux et al. 2008). The primary reason for this variation is that surface waters generally have extended contact with the atmosphere and are therefore subject to evaporative modification (Darling et al. 2003). As discussed above, the lighter ^{16}O isotope is preferentially lost during evaporation, which leads to higher $\delta^{18}O$ values. Standing waters such as lakes, canals, and slow-moving streams and rivers are more prone to evaporative modification than are rainwater and faster flowing waters.

In addition to environmental factors that lead to differences between $\delta^{18}O$ values in precipitation and drinking water, there are additional processes that can introduce variation in bioapatite $\delta^{18}O$ values, including breastfeeding and water processing methods. Various studies have found elevated $\delta^{18}O$ values in the skeletal remains of infants or in teeth that form during infancy (e.g., first molars, premolars, and incisors), which has been referred to as the breastfeeding (or nursing) effect (Wright and Schwarcz 1998). Human breast milk is more enriched in the heavy ^{18}O isotope, so tissues that form while an individual is nursing exhibit higher $\delta^{18}O$ values, typically by ~0.5 to 0.7‰ (Wright and Schwarcz 1998; CD White et al. 2002). Some studies use a correction factor when a breastfeeding effect is observed, which involves reducing the $\delta^{18}O$ results from early-forming teeth by the estimated degree of enrichment (e.g., Toyne et al. 2014; CD White et al. 2002), though it has also been noted that such adjustments are not necessary because nursing is expected in any population (Wright 2012).

In addition to variation introduced by breastfeeding, an experimental study by Bretell and colleagues (2012) demonstrated that water processing techniques can also lead to higher $\delta^{18}O$ values. The authors found that boiling tea, brewing ale, and slow cooking (stewing), caused $\delta^{18}O$ increases of 0.4‰, 1.3‰, and 10.2‰, respectively, in the end-product liquids being analyzed. For slow cooking, longer stewing times resulted in larger increases in $\delta^{18}O$ values. Thus, water processing methods can have substantial effects on $\delta^{18}O$ values yet are difficult to estimate in past populations where cooking practices may not be accurately reconstructed.

3.2.3 Establishing the Local Isotopic Range at Paquimé

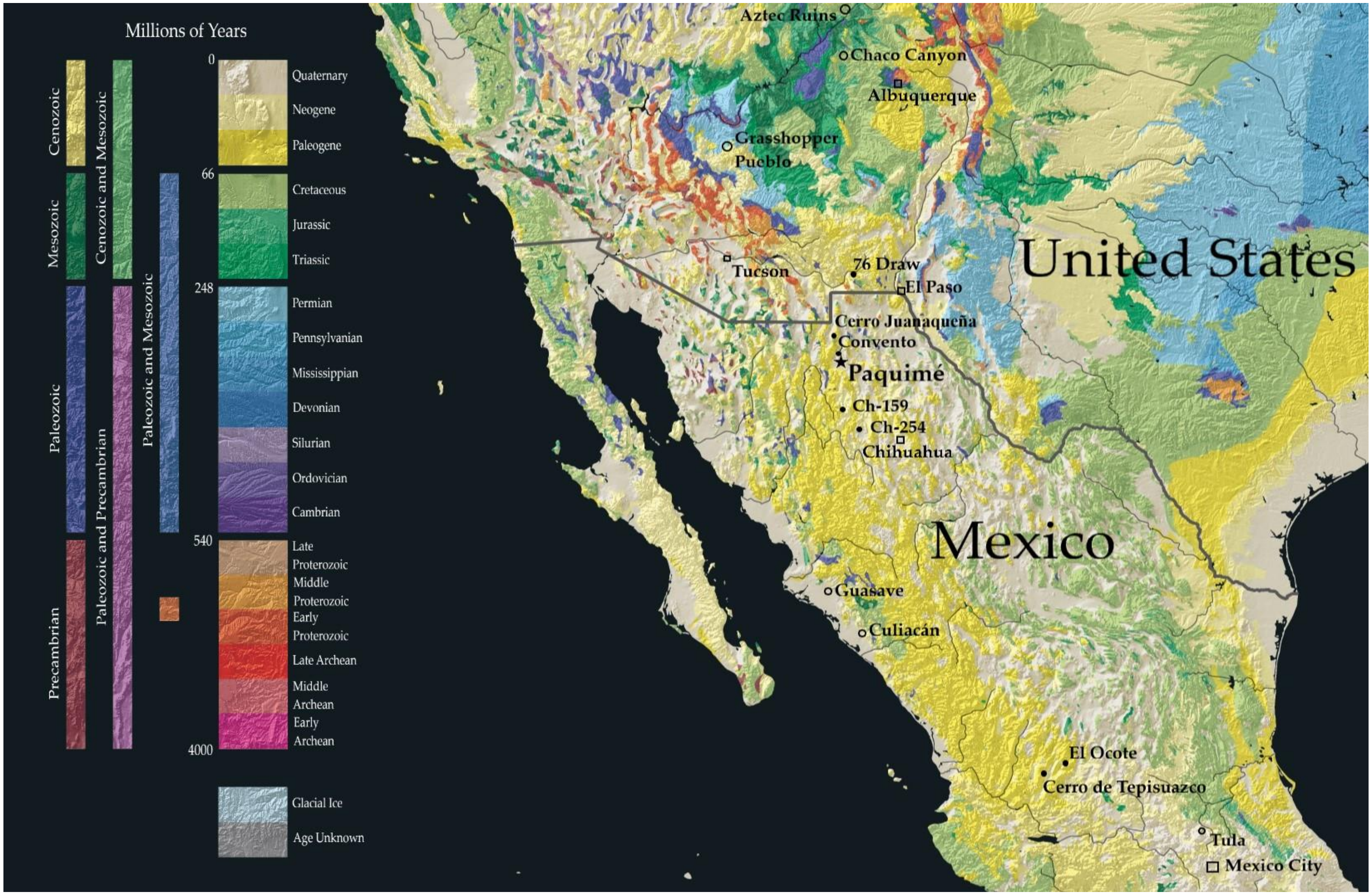
3.2.3.1 Strontium

To differentiate between local and non-local individuals within a population, it is first necessary to determine the expected isotope range at the site being investigated. Traditional approaches to defining local $^{87}Sr/^{86}Sr$ ranges generally involve the use of 1) geological maps; 2) the average $^{87}Sr/^{86}Sr$ value of human samples from the site; or 3) the average $^{87}Sr/^{86}Sr$ value of faunal samples from the site (Ericson 1985; Price et al. 2002). Strontium consumed by humans is not always equivalent to the strontium content of the underlying bedrock, thus geological maps of $^{87}Sr/^{86}Sr$ values are not ideal proxies for defining local strontium isotope values in archaeological studies of human mobility. Instead, the local $^{87}Sr/^{86}Sr$ range at a given site should be determined from the strontium sources available to humans, called biologically available (or bioavailable) strontium (Hodell et al. 2004; Price et al. 2002; Sillen et al. 1998).

The most commonly utilized method for determining the bioavailable strontium isotope range is to calculate the mean $^{87}Sr/^{86}Sr$ value of faunal remains recovered from the local dietary catchment area ± two standard deviations (Bentley 2006; Hodell et al. 2004; Price et al. 2002; Waterman et al. 2014). Faunal samples may include archaeological and/or modern specimens, though small mammals derived from archaeological contexts are ideal because they have limited feeding ranges and are less susceptible to modern contaminants, such as fertilizers (Bentley 2006; Price et al. 2002). When faunal remains are not available for analysis, or when non-local strontium inputs contribute to human dietary strontium (e.g., Wright 2005), the local range can be calculated from the human $^{87}Sr/^{86}Sr$ values. As Slovak and Paytan (2011) aptly note, there is no one method for establishing the local $^{87}Sr/^{86}Sr$ range that can be applied to all studies. Instead, it is important to consider the geological and dietary source(s) of strontium available to the study population to determine how the local range should be established.

Paquimé is located within the Basin and Range physiographic province of northern Mexico, which is comprised of a series of northwest-southeast trending mountain chains and valleys that is bordered by the Sierra Madre Occidental to the west and south (Figure 3.1). This region is considered to be a transition zone characterized by a mix of mid-Tertiary igneous rocks and Cenozoic sedimentary rocks, including shales, limestones, and sandstones (McDowell 2007; Padilla y Sánchez et al. 2013). As such, $^{87}Sr/^{86}Sr$ values between 0.704 and 0.707 are expected (Damon et al. 1983; McDowell 2007; Padilla y Sánchez et al. 2013). Most of the Casas Grandes culture area lies within the Basin and Range province, therefore archaeological sites within this region should be characterized by roughly similar geological $^{87}Sr/^{86}Sr$ values. However, some variation likely exists due to the mixture of volcanic and sedimentary rocks in the area. Thus, establishing the local and regional strontium isotope ranges from bioavailable $^{87}Sr/^{86}Sr$ values is critical in this study because the Casas Grandes region is located within this transition zone of diverse geological inputs. This is the first archaeological study in northwest Mexico to utilize strontium isotope analysis, therefore no previously published human or faunal data exist for this region. As such, faunal remains from Paquimé and other sites in the Casas Grandes culture area will be analyzed to establish local and regional bioavailable $^{87}Sr/^{86}Sr$ ranges.

Figure 3.1. Geological map of Mexico and the Southwestern United States. Legend: Paquimé (star), comparative sites used in this study (filled circles), other archaeological sites (open circles), modern cities (open squares). Adapted from the U.S. Geological Survey (https://pubs.usgs.gov/imap/i2781/).



Animals with small home ranges (e.g., rabbits, rats) are appropriate proxies for establishing the local bioavailable $^{87}Sr/^{86}Sr$ range at Paquimé because the subsistence strategy was based on locally procured foods. Crops were grown on the floodplain immediately surrounding the site, which was one of the most fertile locations for agriculture in the region (Dolittle 1993; Lekson 1999, 2015; Minnis et al. 2006; Whalen and Minnis 2001a, 2001b, 2009). Whalen and Minnis (2001) estimated that there were approximately 2,000 hectares of arable land within 5 km of the site, which would have provided sufficient resources to feed the local population at Paquimé. It has also been suggested that agricultural yields from some sites in the Casas Grandes Core Zone (within ~30 km of Paquimé) may have been controlled and utilized by the elites of Paquimé, perhaps during large-scale feasting events or during times of low agricultural productivity at the primate centre (Minnis et al. 2006). Thus, crops grown in the immediate vicinity of Paquimé were likely the primary contributors to dietary strontium, though some foods may also have been acquired from nearby sites.

Like other NW/SW sedentary agriculturalists, the primary cultigens grown at Paquimé were maize, squash, gourds, and cotton, with a heavy reliance on maize (Minnis and Whalen 2015; Di Peso et al. 1974: vol. 8). Although beans are conspicuously absent from this list, they have been recovered from other sites throughout the Casas Grandes region and were therefore likely cultivated at Paquimé as well but may not have been recovered due to the lack of fine screening and flotation during the excavation of the site (JH Kelley et al. 2012; Minnis and Whalen 2005; Whalen and Minnis 2001a, 2009). In contrast to most of the cultigens grown at Paquimé, maize is lacking in calcium and would therefore not normally contribute to dietary strontium. However, New World populations that rely on maize as a dietary staple typically boil or soak corn in an alkali solution to remove the indigestible pericarp of the kernel before it is prepared for consumption (Katz et al. 1974). According to Katz and colleagues (1974), lime, lye, or wood ashes are commonly used to make the alkali solution, though the burning and slaking of shell has also been documented (e.g., Healy et al. 1990; Nations 1979). This process is called nixtamalization and substantially increases the nutritional value of maize, including its Ca (and Sr) content. Thus, the lime source used for nixtamalization would serve as the primary contributor to dietary strontium and its $^{87}Sr/^{86}Sr$ value would in turn determine the $^{87}Sr/^{86}Sr$ values of the population (Burton and Wright 1995; Wright 2012).

In a recent analysis of dental calculus from Paquimé human skeletal remains, King and colleagues (2017) found that nearly all maize starch granules recovered from the samples exhibited damage characteristic of grinding and heating, both of which are associated with the nixtamalization process. Furthermore, despite the abundance of starch granules, very few maize glume phytoliths were found, which the authors attribute to the disintegration of these silica-based structures by alkali processing (King et al. 2017). Based on these findings, it seems likely that the people of Paquimé used nixtamalization to increase the nutritional value of their staple crop. King and colleagues (2017) also found marine diatoms in 2/110 (1.8%) of the calculus samples that were analyzed from Paquimé, which was unexpected given that the site is located ~400 km from the ocean. The authors posit that the presence of marine diatoms is likely due to either the direct consumption of marine foods or to the use of marine shell for nixtamalization. Over 3.8 million pieces of shell were recovered from the site, so the people of Paquimé certainly had an abundance of this resource (Di Peso et al. 1974: vol. 6). It is important to note, however, that over 99% of the shell recovered from the site was cached in architectural contexts and is believed to have served socioreligious or economic, as opposed to domestic, functions (Di Peso et al. 1974: vol. 6; Bradley 1999; VanPool and VanPool 2007; Whalen 2013). Additionally, the finding that only two samples had marine diatoms, yet most showed evidence for nixtamalization, could indicate that an alternative lime source was used to make the alkali solution. The underlying geology at Paquimé consists of sedimentary rocks, including limestone, which would have provided a readily-available source of lime. Thus, I would suggest that locally-sourced lime, along with locally-grown cultigens that contain Ca, would have been the primary sources of dietary strontium at Paquimé.

In addition to cultivated plants, the people of Paquimé also gathered wild plants from their local environment, including piñon nuts, hackberry and purslane seeds, mesquite pods, and agave, and hunted a variety of animals such as rabbit, antelope, deer, and bison (Di Peso et al. 1974: vol. 8). While the consumption of wild resources could lead to the incorporation of non-local strontium inputs, their contribution to dietary strontium was likely minimal. First, the strontium concentration in meat is extremely low and would contribute very little to dietary $^{87}Sr/^{86}Sr$ values unless it made up the majority of the diet (>90%) (Burton and Wright 1995; Burton and Hahn 2016). A diet consisting primarily of meat is highly unlikely for this population given the extensive evidence for agriculture. Second, based on the agricultural productivity of the Casas Grandes area, it is unlikely that wild plant resources made up a significant portion of the diet at Paquimé. For example, an isotopic study ($\delta^{13}C$ and $\delta^{15}N$) of human remains from sites in west-central Chihuahua (Ch-159, Ch-254, Ch-216) revealed a diet comprised of maize (~72%), beans (~8%), and meat (~20%), with little contribution from wild plant resources (Webster 2001). While these results are not directly applicable to Paquimé, they do provide comparative data on the diets of contemporaneous sedentary agriculturalists from the Casas Grandes region who lived in the same type of environment. Finally, there is no evidence of imported foods at Paquimé or at other Medio Period sites in the Casas Grandes area (Di Peso et al. 1974: vol. 8; Whalen and Minnis 2001a, 2009).

3.2.3.2 Oxygen

Unlike strontium, oxygen is a light element that undergoes fractionation caused by physiological processes, which in turn varies between species due to factors such as metabolism, body size, and body temperature (Bryant and Froelich 1995; Kohn et al. 1996). Furthermore, water sources for animals and humans may differ, therefore, faunal remains are not typically used to determine the local $\delta^{18}O$ range at a site (Gregoricka 2013; Gregoricka et al. 2017; Wright 2012). Instead, local $\delta^{18}O$ ranges are often estimated from the oxygen isotope composition of modern precipitation, groundwater, and/or surface waters (e.g., Bäckström and Price 2016; Buzon et al. 2011; Prowse et al. 2007; Schuh and Makarewicz 2016). A caveat to using such methods is that a correction factor must be applied to compare oxygen isotope values derived from the phosphate portion of human bioapatite ($\delta^{18}O_P$) to values derived from drinking water ($\delta^{18}O_W$) (e.g., Bryant et al. 1996; Chenery et al. 2012; Daux et al. 2008; Levinson et al. 1987; Longinelli 1984; Luz et al. 1984). Pollard and colleagues (2011) have demonstrated that regression equations can introduce errors of between ± 1‰ to ± 3.5‰ in $\delta^{18}O_W$, depending on the conversion that is used. This introduced variation can be greater than the entire expected $\delta^{18}O_W$ range at a site, thereby limiting the ability to identify non-local individuals within an archaeological population.

To avoid this issue, Pollard and colleagues (2011) suggest that the local $\delta^{18}O$ range should be based on published human $\delta^{18}O$ data from the same geographical region as the study population. Unfortunately, human $\delta^{18}O$ data is not available for many areas, so this approach is not always feasible. In such cases, $\delta^{18}O$ values derived from drinking water sources can be used to roughly approximate the expected local range at a site (Chenery et al. 2012). Several recent studies have used statistical analysis of the human $\delta^{18}O$ values themselves to identify outliers, provided a large sample size is available (Gregoricka et al. 2017; Lightfoot and O'Connell 2016; Wright 2012). Stable oxygen isotope analysis has not been conducted on human remains from northwest Mexico, therefore both statistical methods and $\delta^{18}O$ values from local water sources will be used to construct the local $\delta^{18}O$ range at Paquimé. The Casas Grandes region is characterized by a semi-arid (or steppe) climate that has an average annual temperature of approximately 17˚C and average annual rainfall of ~330 mm. This area is characterized by seasonal fluctuations in precipitation, with the majority of rainfall occurring in the summer months. The people of Paquimé built an elaborate water distribution system within their city, which fed water from the Varaleño spring, located ~5 km north of the site, directly into room blocks, irrigation canals, and reservoirs (Di Peso 1974: vol. 2; Minnis et al. 2006; Minnis and Whalen 2015). In addition, water for crop irrigation was likely derived from the Casas Grandes River, which is directly adjacent to the site. Thus, the water consumed by the inhabitants of Paquimé was locally sourced.

The long-term (1962-1988) annual weighted mean $\delta^{18}O_{W(VSMOW)}$ of precipitation measured at the International Atomic Energy Agency's (IAEA) meteorological station in Chihuahua city, Mexico is -6.5‰ ± 2.4‰, with a range of -10.6‰ to -1.3‰ (N=14, 1σ) (IAEA/WMO 2015). Although there is no IAEA station at Paquimé, a geospatial water isotope model constructed from the long-term IAEA/WMO global data yielded an estimated annual mean of $\delta^{18}O_{W(VSMOW)}$ = -6.7‰ at the site (Bowen 2017; Bowen and Ravenaugh 2003; IAEA/WMO 2015). The $\delta^{18}O_{W(VSMOW)}$ range produced by this model for Paquimé (and the Casas Grandes region) is -9.0‰ to -5.1‰. Meanwhile, the range of expected groundwater $\delta^{18}O_{W(VSMOW)}$ values for this region is -8.0‰ to -6.0‰ (Wassenaar et al. 2009). This range is derived from an isoscape model of $\delta^{18}O_{W(VSMOW)}$ values that was constructed from 230+ groundwater samples that were collected throughout Mexico (Wassenaar et al. 2009). Finally, river and spring waters obtained from the Paquimé area for a recent isotopic study of macaw remains yielded a mean $\delta^{18}O_{W(VSMOW)}$ value of -6.3‰ ± 0.53‰ (1σ, N=9) (Somerville et al. 2010)[6]. It is important to highlight that the IAEA/WMO model is based on over two decades-worth of data points per location, whereas the groundwater and surface water estimates are based on a single recorded value per location. Thus, the larger range of $\delta^{18}O_{W(VSMOW)}$ values produced by the IAEA/WMO model accounts for seasonal and annual fluctuations in $\delta^{18}O_{W(VSMOW)}$, which can be quite significant (e.g., -10.6‰ to -1.3‰ in Chihuahua over a 26-year period) (IAEA/WMO 2015). Given that annual fluctuations in $\delta^{18}O_{W(VSMOW)}$ have the potential to impact oxygen isotope values in human tooth enamel, which develops over the span of just a few years, the IAEA/WMO range of $\delta^{18}O_{W(VSMOW)}$ = -9.0‰ to -5.1‰ will be used as the estimated local range for Paquimé.

Oxygen isotope values should be roughly similar throughout the Casas Grandes region; however, some variability is expected because of differences in elevation within this basin and range province. Paquimé and other sites located in Whalen and Minnis' (2001a, 2009) Inner Zone of the Casas Grandes interaction sphere are characterized by a semi-arid grassland environment with minimal rainfall. The elevation at Paquimé is 1,480 m above sea level. The northeastern portions of the Middle and Outer Zones are characterized by similar environmental conditions, with the exception of a few isolated summits that are at higher elevations. Meanwhile, sites in the southern and western portions of the Middle and Outer Zones are located in the Sierra Madre Occidental or in higher-elevation basin valleys (~1,900 to 2,100 m) that are characterized by more rainfall than the

[6] The Paquimé macaw bones had a range of $\delta^{18}O_{AP(VSMOW)}$ = 23.0‰ – 27.0‰ with a mean of 24.8‰ ± 0.9‰ (N=30, 1σ) (Somerville et al. 2010). The authors did not attempt to derive $\delta^{18}O_{W(VSMOW)}$ from $\delta^{18}O_{AP(VSMOW)}$ values because conversion equations for this species have not been developed. While the macaw $\delta^{18}O_{AP(VSMOW)}$ data are not directly comparable to human $\delta^{18}O$ data, they provide a rough estimate of the *range* of $\delta^{18}O$ values that may be expected from water sources at Paquimé.

northeastern parts of the Casas Grandes region (JH Kelley and Searcy 2015). As such, these higher elevation sites may have lower $\delta^{18}O$ values when compared to Paquimé and other sites to the northeast.

3.2.4 Comparative Isotope Values for Surrounding Regions

In addition to determining whether immigrants were present at Paquimé, another objective of this study is to examine the potential geographic origins of non-locally born individuals. Models that invoke external stimuli in the cultural trajectory of Paquimé have proposed direct contact with three different regions; the American Southwest, Mesoamerica, and West Mexico (Di Peso 1974: vol. 2; JC Kelley 2000; Lekson 1999, 2015). The most probable source of extraregional immigrants to Paquimé is the American Southwest given that the outer periphery of the Casas Grandes interaction sphere extends into the southern parts of New Mexico and Arizona, and both cultural and genetic links have been established with this region (Fish and Fish 1999; Leblanc et al. 2008; Morales-Arce et al. 2017; Turner 1993, 1999; VanPool et al. 2017; Whalen and Minnis 2001a, 2001b, 2003, 2009).

Isotope studies in the American Southwest have been conducted at Grasshopper Pueblo (Ezzo et al. 1997; Ezzo and Price 2002; Price et al. 1994), Chaco Canyon (Grimstead et al. 2015; Price et al. 2017), and sites in the Middle San Juan region of northern New Mexico (Waller 2009). The human and faunal $^{87}Sr/^{86}Sr$ ratios reported from these sites range from 0.7083 to 0.7117 (Table 3.1). Although there is intra-regional overlap between sites in the American Southwest, $^{87}Sr/^{86}Sr$ values from this region are distinct from reported geological $^{87}Sr/^{86}Sr$ values in northwest Mexico, which are <0.7080 (Damon et al. 1983; McDowell 2007). Thus, migratory individuals from the American Southwest should have distinct $^{87}Sr/^{86}Sr$ ratios when compared to individuals born at Paquimé or in the Casas Grandes region. In terms of inter-regional oxygen isotope variability, there is continuity across the modern international border, such that the expected $\delta^{18}O_{W(VSMOW)}$ range at Paquimé is similar to sites in the southern halves of Arizona and New Mexico (i.e., -9.0‰ to -5.1‰), but more differentiated from the Four Corners region of northern Arizona and New Mexico, where $\delta^{18}O_{W(VSMOW)}$ values range from -16.8‰ to -12.9‰ at higher elevations and -12.9‰ to -9.0‰ at lower elevations

(Bowen 2017; Bowen and Ravenaugh 2003; IAEA/WMO 2015). Reported oxygen isotope ratios in human tooth enamel carbonate from sites in northwest New Mexico (Mine Canyon, Tommy site, and Pueblo Bonito) range from $\delta^{18}O_{C(VPDB)}$ = -9.3‰ to -2.8‰ (Table 3.1). Comparative isotope values from this area are important for evaluating the plausibility of Lekson's (1999, 2015) Chaco Meridian model because both Chaco Canyon and Aztec Ruins are located in northwest New Mexico.

Table 3.1. Comparative isotope data from archaeological sites in the American Southwest.

Site(s)	Region	$^{87}Sr/^{86}Sr$ Range[a]		Human $\delta^{18}O$ range (VPDB, ‰)	Source(s)
		Human	Faunal		
Tommy Site	Middle San Juan (NW New Mexico)	0.7095-0.7099	0.7089-0.7103	-9.3 to -5.3	Waller 2009
Mine Canyon	Middle San Juan (NW New Mexico)	0.7095-0.7099	0.7089-0.7103	-8.3 to -5.4	Waller 2009
Pueblo Bonito	San Juan Basin (NW New Mexico)	0.7090-0.7094	0.7091-0.7095	-8.3 to -2.8	Price et al. 2017; Grimstead et al. 2015
Grasshopper Pueblo	Salt River drainage (Central Arizona)	0.7096-0.7106[b]	0.7098-0.7105		Ezzo & Price 2002; Ezzo et al. 1997
Cibecue, Carrizo, Kinishba	Grasshopper Pueblo region (East)		0.7088-0.7117		Ezzo et al. 1997
Canyon Creek	Grasshopper Pueblo region (West)		0.7100-0.7114		Ezzo et al. 1997
NAN Ranch, Harris	Mimbres (SW New Mexico)	0.7083-0.7107[c]			Dudás et al. 2016

[a] Isotope values derived from archaeological teeth

[b] Strontium isotope range of individuals classified as "local" to Grasshopper Pueblo

[c] Possible diagenetic alteration was noted for some of these samples, which may have influenced biogenic $^{87}Sr/^{86}Sr$ values

Although Mesoamerican traits are present at Paquimé, there is a general consensus that these attributes arrived in the Casas Grandes region from Mesoamerican outposts in West Mexico, not via a direct north-south route from central Mexico (e.g., Foster 1999; JC Kelley 2001; VanPool et al. 2008). Unfortunately, no isotopic studies on human or faunal remains have been published from sites within much of the Aztatlán region, which extends along the Pacific coast of Mexico from northeast Jalisco to the border of Sinaloa and Sonora (Nelson et al. 2015). Sites along the Sierra Madre Occidental in southeast Chihuahua, northeast Durango, eastern Zacatecas, and throughout Sinaloa have geological $^{87}Sr/^{86}Sr$ values between 0.7039 to 0.7063 (Damon et al. 1983; McDowell 2007). Meanwhile, sites in central and south-central Sonora have $^{87}Sr/^{86}Sr$ ratios between 0.7062 to 0.7070, with a few samples yielding slightly higher $^{87}Sr/^{86}Sr$ values up to 0.7079. In terms of expected oxygen isotope values for West Mexico, there is a general east-west gradient between the coastal areas to the east of the Sierra Madre Occidental, which have higher $\delta^{18}O_{W(VSMOW)}$ ratios of -5.1‰ to -1.2‰ when compared to the Casas Grandes region (-9.0‰ to -5.1‰) (Bowen 2017; Bowen and Ravenaugh 2003; IAEA/WMO 2015). Thus, oxygen isotopes are well suited for identifying migrants from the coastal regions of West Mexico. On the other hand, there is less north-south oxygen isotope variability within the Sierra Madre Occidental, so oxygen isotopes may not be as useful for discriminating between specific sites/areas within the mountains.

Sites in Michoacán and Zacatecas, which are in the west and northwestern areas of Mesoamerica, respectively, have geological $^{87}Sr/^{86}Sr$ values <0.7060 (0.7039 to 0.7055) (Damon et al. 1983). Price and colleagues (2008) have also compiled human and faunal $^{87}Sr/^{86}Sr$ data from many sites throughout Mesoamerica, including two geographic areas that could be potential sources of immigrants to Paquimé; (southern) West Mexico and the Valley of Mexico. The median $^{87}Sr/^{86}Sr$ value reported for West Mexico is 0.7039, with an interquartile range (50% of data) of 0.7039 – 0.7040 (N=15), while the median $^{87}Sr/^{86}Sr$ value for the Valley of Mexico is 0.7047, with an interquartile range of 0.7046 – 0.7051 (N=86). Oxygen isotope ratios in this region are highly variable, with $\delta^{18}O_{W(VSMOW)}$ values of -5.1‰ to -1.2‰ in coastal areas and -12.9‰ to -9.0‰ in the highlands (Bowen and Ravenaugh 2003; Somerville et al. 2010).

To summarize, immigrants from the American Southwest are expected to have distinctly higher $^{87}Sr/^{86}Sr$ values than individuals born at Paquimé. Individuals from the Four Corners region of northern Arizona and New Mexico are expected to have lower $\delta^{18}O$ ratios, while those from the central and southern halves of these states would be similar to individuals born at Paquimé. Immigrants from West Mexico and Mesoamerica should have distinctly lower $^{87}Sr/^{86}Sr$ values than local Paquimeños, and those originating from the coastal regions of West Mexico are expected to also have significantly higher $\delta^{18}O$ values.

3.3 Materials and Methods

3.3.1 Sample Selection

The sample used for this study consists of skeletal remains from Paquimé (CHIH:D:9:1), which dates to the Medio Period (A.D. 1200 – 1450), and the Convento site (CHIH:D:9:2), which was occupied during the preceding Viejo Period (A.D. 800 – 1200). Most of the sample is derived from Paquimé (N=82), as it is the primary focus of this research project. The Viejo Period sample from Convento is significantly smaller (N=13) not only because of the research focus, but because preservation of skeletal materials from this site was poor and a limited number of teeth were available for analysis. The Joint Casas Grandes Expedition excavated 576 individuals from Paquimé and 76 individuals from the Convento site, which means that the sample that was analyzed for this study represents 14.2% and 17.1% of the burial assemblage recovered from each site, respectively. The Casas Grandes skeletal collection is curated by the Museo de las Culturas del Norte in Casas Grandes, Chihuahua, Mexico. The primary goal of the sampling strategy was to obtain a representative sample of the Paquimé skeletal assemblage, as not all architectural units at the site contained equal numbers of burials. For example, approximately 15% of the skeletal assemblage was excavated from Unit 6, so the sample for this study consisted of approximately the same proportion of individuals from that unit. Within architectural units, similar proportions of males and females and individuals from all age categories were selected. An attempt was also made to capture the full range of mortuary treatment at the site, including individuals who were given simple burials (e.g., single interment within a pit, no grave goods) and those who were afforded elaborate burial treatment (e.g., interment in tomb, large quantities of grave goods, rare grave goods). Additionally, both interred and non-interred (Type 2) individuals were sampled to satisfy the goals of the larger research project to which this study belongs. The same demographic and mortuary treatment considerations were employed for the Convento site sampling strategy. Most Convento burials were placed in communal plaza areas within the village, therefore burial location considerations by architectural unit were unnecessary. It should also be noted that poor preservation and/or a lack of teeth necessary for sampling sometimes led to the selection of different burials than were originally planned.

Isotope analysis was conducted on two teeth per individual, representing various developmental periods (Table 3.2). Ideally, one tooth representing infancy or early childhood and one tooth representing adolescence were sampled from each individual[7]. Tooth enamel follows a predictable sequence of deposition and does not remodel once formed (Hillson 1996), thus early-forming teeth, such as incisors, will yield isotope values that are characteristic of an individual's birthplace, whereas late-forming teeth (e.g., third molars) represent an individual's geographic location during late childhood/adolescence. Sampling multiple teeth per individual elicits a record of mobility for each member of the study sample, such that a more refined estimate of *when* an individual moved within their lifetime can be established (Turner et al. 2009). For instance, a difference in isotopic values between the early- and late-forming teeth from the same individual would indicate a change in residence sometime between infancy and adolescence. In contrast, non-local isotope signatures for both teeth would indicate that migration occurred post-adolescence. In this study, the pair of isotope values for each individual is referred to as a *mobility profile*. In this chapter, mobility profiles are used to examine the form/structure of migration to differentiate between short- and long-distance migration, as this is a key difference between internal and external development models. Migration theory suggests that long-distance migration often involves a series of short-distance moves (Alvarez 1987; Anthony 1990; Bernardini 2005). As such, individuals who came to Paquimé from neighbouring regions, such as the American Southwest, should exhibit more variability in their mobility profiles than individuals who migrated from within the region because they must traverse much

[7] Some individuals did not have multiple types of teeth available for analysis. In such cases, only one tooth was analyzed.

longer distances. In the next chapter, data from the mobility profiles will be used to examine the *demographic* structure of migration.

Table 3.2. Tooth categorization by crown formation times[a].

Tooth	Crown Initiation	Crown Completion	Tooth Category[b]
Central Incisor (I1)	3 - 4 mo.	4 - 5 yrs	Infancy/Early Childhood (I/EC)
Lateral Incisor (I2)	3 - 4 mo.	4 - 5.5 yrs	Infancy/Early Childhood (I/EC)
Canine (C)	4 - 5 mo.	6 - 7 yrs	Middle Childhood (MC)
First Premolar (P3)	1.5 - 2 yrs	5 - 7.5 yrs	Middle Childhood (MC)
Second Premolar (P4)	2 - 2.5 yrs	6 - 8.5 yrs	Middle Childhood (MC)
First Molar (M1)	*In utero*	3 - 3.5 yrs	Infancy/Early Childhood (I/EC)
Second Molar (M2)	2.5 - 3 yrs	7 - 8 yrs	Middle Childhood (MC)
Third Molar (M3)	7 - 10 yrs	12 - 13 yrs	Adolescence (AD)

[a] Hillson 1996
[b] Adapted from Turner et al. 2009

Faunal samples from Paquimé were analyzed to establish the local $^{87}Sr/^{86}Sr$ range at the site. These samples consisted of tooth enamel from small mammals (e.g., rats, rabbits) that were recovered during the original site excavation. In addition, faunal samples from several sites in the Casas Grandes region and the American Southwest were analyzed to establish baseline $^{87}Sr/^{86}Sr$ values for the surrounding region (Figure 3.2). These sites include Site 315, Ch-254, and 76 Draw and were chosen because they are located within the established Casas Grandes interaction sphere (JH Kelley et al. 2012; Rakita et al. 2011; Whalen and Minnis 2009). Faunal samples from Cerro Juanaqueña, a late Archaic site located near the modern town of Janos in northwest Chihuahua, were also analyzed. Although Cerro Juanaqueña predates Paquimé by several centuries, samples from the site were analyzed to obtain baseline $^{87}Sr/^{86}Sr$ values for that geographic region, which was eventually home to populations incorporated in the Casas Grandes interaction sphere. This is a particularly good location to establish comparative $^{87}Sr/^{86}Sr$ values because archaeological evidence suggests that Paquimé's interactions were strongest with this area of the Casas Grandes region. Site 315 is ~2 km east of Paquimé and is therefore part of the Inner Zone, while Cerro Juanaqueña is located in the Middle Zone ~60 km northwest of Paquimé. Ch-254 is located in west-central Chihuahua, approximately 150 km south of Paquimé and represents the southern periphery of the Outer Zone. Finally, 76 Draw is located ~180 km north of Paquimé, in the Animas region of southern New Mexico. This site lies at the intersection of the Casas Grandes, Animas, Mogollon, and Salado culture areas and is part of the traditionally-defined American Southwest (Rakita et al. 2011).

Figure 3.2. Locations of comparative sites used in this study.

Tooth enamel samples from human burials at the following sites were also analyzed for comparative purposes: El Ocote (N=13), Cerro de Tepisuazco (N=7), Ch-254 (N=1), and Ch-159 (N=3) (Figure 3.2). Ch-159 (El Zurdo) is a Medio Period site in west-central Chihuahua and is part of the Outer Zone of the Casas Grandes interaction sphere (JH Kelley et al. 2012). El Ocote dates to the Epiclassic Period (ca. A.D. 500/600 – 950) and is located in western Aguascalientes, while Cerro de Tepisuazco dates to the Late Post Classic Period (ca. A.D. 1200 – 1520) and is located in southern Zacatecas (Jimenéz-Betts 2000). These sites represent the southern region of West Mexico along the northwestern periphery of Mesoamerica.

3.3.2 Sample Preparation and Measurement

Prior to destructive analysis, all teeth were photographed, measured, and scored for non-metric dental traits and pathological lesions (e.g., enamel hypoplasia, caries). Casts were made of all teeth that were adequately preserved and returned to the Museo de las Culturas del Norte in Chihuahua, Mexico. After these procedures were complete, dental enamel was extracted in the Bone Chemistry Laboratory, Department of Anthropology & Archaeology at the University of Calgary. First, each tooth was sonicated in double-distilled water for 10 minutes to remove adhering organic material and surface contaminants. The outer layer of tooth enamel (~0.2 - 0.5 mm) was then removed with a Dremel tool equipped with a carbide burr attachment and discarded, as this portion of the tooth crown is potentially susceptible to minor amounts of diagenetic alteration (Schoeninger et al. 2003). Sample enamel was removed from the lateral aspect of the tooth crown using the Dremel tool. Areas with pathological lesions, abnormal tooth wear, or discolouration were avoided. If enamel broke apart during the drilling process, adhering dentine was removed and the remaining pieces of enamel were ground with an agate mortar and pestle. Approximately 50-100 mg of dental enamel was collected from each tooth; 5-7 mg for strontium isotope analysis and the remainder for stable oxygen isotope analysis. Sample enamel was preferentially reserved for strontium isotope analysis when not enough enamel was available for both types of analysis. Archaeological faunal specimens were processed using the same methods.

3.3.2.1 Radiogenic Strontium Isotope Analysis

All human and faunal teeth were prepared in the Isotope Science Laboratory, Department of Physics & Astronomy at the University of Calgary in a clean room that utilizes positive pressure air flow and micro-air filtration to prevent strontium contamination from ambient room air. Samples were dissolved in 500 µL of 5M HNO_3 and 30 µL of H_2O_2 on a hotplate for 24 hours, evaporated to dryness, then reconstituted in 500 μL of 3M HNO_3. Strontium extraction columns were loaded with EiChrom SrSpec resin, rinsed with 500 μL MQ water (twice), and conditioned with 500 μL 3M HNO_3. Samples were then added to the column and rinsed with 1000 μL 3M HNO_3 (twice). Finally, columns were eluted with 500 μL MQ water to release the trapped strontium isotopes from the resin into the clean sample vials below. The vials were placed under a heat lamp to evaporate overnight, then dissolved in 0.1M H_3PO_4 and $TaCl_5$ emitter solutions and loaded onto degassed Re filaments. Finally, strontium isotope ratios ($^{87}Sr/^{86}Sr$) were measured on a Triton thermal ionization mass spectrometer (TIMS), using a SR987 strontium standard. External precision of the measurements is ± 0.000013 for the reported ratio and long-term reproducibility of the standard yielded an average value of 0.710249 ± 0.000010 (1σ).

3.3.2.2 Stable Oxygen Isotope Analysis

Stable oxygen isotope analysis can be conducted on either the carbonate (CO_3) or phosphate (PO_4) components of hydroxyapatite. When analyzing bone samples, phosphate is preferred over carbonate because it is less susceptible to diagenesis than the latter (Lee-Thorp and Sponheimer 2003; Zazzo et al. 2004). Tooth enamel, on the other hand, is more resistant to diagenetic alteration, therefore both carbonate and phosphate portions can be used (Budd et al. 2000; Hoppe et al. 2003). Carbonate analysis is simpler, less expensive, and takes less time than phosphate analysis and also provides $\delta^{13}C$ data, which can be utilized for dietary reconstruction. For these reasons, tooth enamel carbonate was used for this study.

Preliminary preparation of tooth enamel for stable oxygen isotope analysis of hydroxyapatite carbonate ($\delta^{18}O_C$) was completed in the Bone Chemistry Laboratory, Department of Anthropology & Archaeology at the University of Calgary following the methods of Garvie-Lok and colleagues (2004). Powdered sample enamel (50-100 mg) was placed in a centrifuge tube and treated with 2% sodium hypochlorite for 12 hours. The sample was then centrifuged, the supernatant discarded, and fresh solution was added. This process was repeated three times for a total of 48 hours. Samples were rinsed to neutrality, treated with 0.1M acetic acid for 4 hours, and again rinsed to neutrality. All samples were vacuumed at 2 hours into the acetic acid step to completely expose crystal surfaces to the acid solution. Samples were centrifuged, decanted and freeze dried, then sent to the Stable

Isotope Laboratory at the University of Erlangen-Nuremberg (Erlangen, Germany) for analysis. Carbonate powders were reacted with 100% phosphoric acid at 70°C using a Gasbench II connected to a ThermoFisher Delta V Plus mass spectrometer. Reproducibility and accuracy was monitored by replicate analysis of laboratory standards calibrated by assigning $\delta^{18}O$ values of -2.20‰ to NBS19 and -23.2‰ to NBS18. Reproducibility for $\delta^{18}O$ was ±0.06 for both standards. All values are reported in per mil (‰) relative to VPDB (Vienna Pee Dee Belemnite), using the standard formula:

$\delta^{18}O = [(^{18}O/^{16}O_{sample} - {}^{18}O/^{16}O_{standard}) / (^{18}O/^{16}O_{standard})] \times 1{,}000$ (Coplen 1994).

3.3.3 Statistical Methods

As mentioned previously, faunal samples are not appropriate proxies for establishing the local $\delta^{18}O$ range because of variation in isotope fractionation between animals. No previous studies have conducted oxygen isotope analysis on human remains from the Casas Grandes region (or from elsewhere in northwest Mexico), therefore comparative $\delta^{18}O$ data are not currently available. In the absence of human $\delta^{18}O$ data, an alternative approach is to use statistical methods to identify outliers from the sample (Gregoricka et al. 2017; Lightfoot and O'Connell 2016; Wright 2012). A common method for identifying outliers is to calculate the mean ± two standard deviations from the human $\delta^{18}O$ data, which inherently includes both the underlying (local) population, as well as any outliers (i.e., non-locals) (Lightfoot and O'Connell 2016). However, Lightfoot and O'Connell (2016) have argued that conventional measures of scale (e.g., variance, standard deviation) are sensitive to outliers and are therefore less robust for archaeological samples that likely include non-local individuals whose $\delta^{18}O$ values vary significantly from the average at the site. In addition, the sample data must be normally distributed for such measures to work well. In this study, the interquartile range (IQR) is used to determine the local $\delta^{18}O$ range at Paquimé because it is less sensitive to outliers and is better suited for data that is not normally distributed. The IQR is defined as the difference between the third (75th) and first (25th) quartiles (Q3-Q1) of the data set. To determine the upper and lower boundaries of the "local" $\delta^{18}O$ range, the IQR is multiplied by 1.5 and the resulting value is subtracted from the first quartile and added to the third quartile. Individuals with $\delta^{18}O$

values outside of these boundaries are statistical outliers and therefore considered to be non-local to the site (Lightfoot and O'Connell 2016).

The use of statistical methods to construct the "local" isotope range is a more conservative approach for identifying non-local individuals than using an environmental baseline, such as the isotope values from faunal remains. More specifically, such methods are ideal for identifying individuals who migrated from regions with distinct isotope values (i.e., statistical outliers), but are less effective at detecting those who migrated from areas with subtler isotopic differences (e.g., regional immigrants). Although there are various sources of error when using oxygen isotope values from modern meteoric waters to estimate prehistoric local $\delta^{18}O$ values, these data can provide a rough estimate of expected $\delta^{18}O$ values at the site in question (Chenery et al. 2012). Furthermore, human isotope values should be compared to an environmental baseline for the geographic region from which they are derived to ensure that the data (as a whole) are within the expected range of variation for a given area. In this study, oxygen isotope data from human tooth enamel carbonate ($\delta^{18}O_{C(VPDB)}$) will be compared to $\delta^{18}O$ values in modern drinking water ($\delta^{18}O_{W(VSMOW)}$) to identify individuals with potentially anomalous $\delta^{18}O_{C(VPDB)}$ ratios. These comparisons are made by converting $\delta^{18}O_{W(VSMOW)}$ values to $\delta^{18}O_{C(VPDB)}$ using the following equations: $\delta^{18}O_{C(VSMOW)} = (48.634 + \delta^{18}O_{W(VSMOW)})/1.590$ (Chenery et al. 2012) and $\delta^{18}O_{C(VPDB)} = (\delta^{18}O_{C(VSMOW)} - 30.91)/1.03091$ (Coplen et al. 1983).

3.4 Results

The results of the radiogenic strontium and stable oxygen isotope analysis of human tooth enamel from Paquimé, Convento, and four comparative sites are presented in Table 3.3. Strontium isotope analysis is the primary method used to identify non-local individuals in this study because there is less overlap in $^{87}Sr/^{86}Sr$ values between the geographic regions of interest than in $\delta^{18}O$ values. More specifically, the results of previous isotope studies (Table 3.1) indicate that $^{87}Sr/^{86}Sr$ values in the American Southwest are distinct from those of northwest Mexico (based on the local geology), therefore it should be possible to identify immigrants from this region based on their $^{87}Sr/^{86}Sr$ ratios. In contrast, there is significant overlap in expected $\delta^{18}O$ values between these two regions, therefore oxygen will likely be a less effective geographic tracer for identifying immigrants from the American Southwest. Furthermore, oxygen isotope values derived from tooth enamel carbonate are influenced by a number of variables (e.g., climate fluctuations, cooking practices, conversion equation errors) that are generally difficult to estimate and control for in archaeological contexts (e.g., Knudson et al. 2014; Price et al. 2017). The strontium isotope results are presented first, followed by the oxygen isotope results. Data from both analyses will then be considered in tandem to identify non-local individuals from the Paquimé and Convento skeletal assemblages.

Demographic data are included where adequate preservation allowed for such estimates. These data come from Waller (2017) and Di Peso (1974: vol. 8). Waller (2017) utilized transition analysis for age-at-death estimation (Boldsen et al. 2002; Milner and Boldsen 2012) and standard ordinal observation of the cranium, pubic symphysis, and greater sciatic notch for sex estimation (Buikstra and Ubelaker 1994). Sample identification numbers are listed in the standard format that has been used for the Casas Grandes skeletal assemblage; burial number, followed by architectural unit for the Paquimé burials and a single number for the Convento burials. For example, ID# 1-14 is Burial 1 from Unit 14 at Paquimé and ID# CO-4 is Burial 4 from the Convento site. Descriptive statistics for each site are presented in Table 3.4. The Shapiro Wilk test was used to determine if the strontium and oxygen isotope data were normally distributed for each site. Sample means were compared using *t*-tests (two groups) or one-way ANOVA (>2 groups) when data was normally distributed or the Mann-Whitney U-test when data was not normally distributed (McDonald 2014). All statistical analyses were performed in SPSS v.24.

Table 3.3. Human strontium and oxygen isotope results.

Burial ID	Sex[a]	Age Category[b]	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_c$ (VPDB, ‰)
Paquimé						
Unit 1						
1A-1	F	MA	LI^2	I/EC	0.70890	-4.9
8A-1	F	YA	RI^2	I/EC	0.70779	-4.9
			LM^3	AD	0.70766	-5.6
11A-1	M?	I	LM_2	MC	0.70725	-5.8
12-1	M	YA	LC^1	MC	0.70771	-5.3
			RM_3	AD	0.70787	-5.8
14-1	I	AD	LI_2	I/EC	0.70756	-3.3
			LM^3	AD	0.70756	-5.2
19A-1	I	AD	LI^2	I/EC	0.70748	-8.1
			LM^2	MC	0.70711	-5.3
20-1	I	CH	LI^1	I/EC	0.70723	-5.4
27A-1	M	OA	LI^2	I/EC	0.70748	-6.2
			LM^3	AD	0.70729	-4.4
Unit 4						
1-4	M?	YA	RP^3	MC	0.70735	-3.0
			LM^3	AD	0.70754	-
5-4	F?	YA	LI_2	I/EC	0.70735	-2.3
Unit 6						
2-6	F?	MA	LM_3	AD	0.70693	-4.8
3-6	F	AD	RI_1	I/EC	0.70725	-3.9
			LM_3	AD	0.70743	-3.5
6-6	M	YA	LI^1	I/EC	0.70839	-6.4
			LM^3	AD	0.70750	-6.9
10A-6	F	YA	LC^1	MC	0.70726	-6.1
11-6	F	I	LC^1	MC	0.70730	-5.1
17-6	M?	YA	RI_2	I/EC	0.70715	-7.6
			RM_3	AD	0.70732	-4.2
24-6	F	YA	RI^2	I/EC	0.70749	-5.0
			RM^3	AD	0.70741	-5.1
25-6	M	MA	LI_2	I/EC	0.70725	-

Burial ID	Sex[a]	Age Category[b]	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_c$ (VPDB, ‰)
			LM_3	AD	0.70705	-3.6
34-6	F	OA	RI^2	I/EC	0.70953	-4.9
			RM_3	AD	0.70799	-6.4
35-6	F	YA	RC^1	MC	0.70748	-5.1
			LM_3	AD	0.70745	-6.8
Unit 8						
2B-8	I	CH	RI^1	I/EC	0.70727	-4.3
			RP^3	MC	0.70733	-5.8
13-8	F	MA	RI_2	I/EC	0.70696	-4.8
			RM_3	AD	0.70693	-
21-8	I	AD	RI_2	I/EC	0.70705	-3.9
			LM_3	AD	0.70707	-3.7
22-8	I	CH	LI_2	I/EC	0.70705	-
27-8	I	CH	RI^2	I/EC	0.70720	-4.0
42-8	F?	MA	LI_2	I/EC	0.70705	-3.6
			RM^3	AD	0.70731	-4.9
43C-8	I	CH	RI^2	I/EC	0.70702	-3.6
			RM^3	AD	0.70698	-5.5
Unit 11						
1-11	M	YA	RI^2	I/EC	0.70712	-5.7
			LM_2	MC	0.70714	-5.3
8B-11	I	CH	RI^2	I/EC	0.70733	-4.8
			RM^2	MC	0.70714	-5.1
9-11	I	AD	LI_1	I/EC	0.70718	-5.8
			RM^3	AD	0.70715	-5.4
18/19-11	M	YA	LP^3	MC	0.70686	-4.9
			RM^3	AD	0.70641	-5.4
22-11	M	YA	RC^1	MC	0.70811	-6.3
			RM^3	AD	0.70728	-4.4
32-11	F	YA	LI^1	I/EC	0.70739	-
			RM^2	MC	0.70734	-5.9
35-11	F?	YA	RC^1	MC	0.70799	-5.5
			RM_3	AD	0.70775	-6.1

Burial ID	Sex[a]	Age Category[b]	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_c$ (VPDB, ‰)
45-11	F?	YA	LI_2	I/EC	0.70603	-4.6
			RM_3	AD	0.70690	-6.2
54-11	M	MA	RI_2	I/EC	0.70693	-4.0
			LM^3	AD	0.70681	-5.9
Unit 12						
19-12	F	OA	LM_3	AD	0.70675	-5.6
26-12	M	MA	LI_2	I/EC	0.70759	-4.2
			RM^3	AD	0.70736	-4.5
28-12	I	AD	RI^1	I/EC	0.70645	-5.5
			RM_3	AD	0.70628	-5.1
31-12	F	YA	RM^3	AD	0.70718	-5.7
32-12	I	YA	LC^1	MC	0.70735	-4.7
36-12	M	YA	LI_2	I/EC	0.70711	-4.6
			LM_3	AD	0.70712	-5.0
37-12	M	YA	RI_2	I/EC	0.70667	-5.2
Unit 13						
1B-13	I	AD	LI_1	I/EC	0.70736	-4.9
			RM^3	AD	0.70733	-5.8
4-13	M	MA	RI^1	I/EC	0.70672	-4.4
			LM_3	AD	0.70675	-5.5
19-13	F	YA	RI^1	I/EC	0.70728	-4.8
20-13	F?	YA	RI_1	I/EC	0.70993	-4.5
			LM^3	AD	0.70923	-6.0
37-13	M	AD	LM_3	AD	0.70722	-5.0
38-13	M	OA	RI^1	I/EC	0.70764	-4.8
39-13	I	AD	RI^1	I/EC	0.70744	-3.7
			RM_3	AD	0.70725	-5.3
44A-13	M	OA	LP_3	MC	0.70691	-4.3
44F-13	F	MA	RI_2	I/EC	0.70719	-
			RM_3	AD	0.70695	-5.4
44I-13	I	AD	LI_1	I/EC	0.70669	-
			LM_3	AD	0.70673	-5.7
44J-L1-13	I	AD	RI^1	I/EC	0.70713	-5.9

Burial ID	Sex[a]	Age Category[b]	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_c$ (VPDB, ‰)
44J-L2-13	I	AD	RI^2	I/EC	0.70665	-6.4
55-13	M	YA	RI^2	I/EC	0.70742	-5.5
			RM_3	AD	0.70741	-
76-13	F	MA	RI_1	I/EC	0.70702	-4.5
			LM_2	MC	0.70705	-5.1
Unit 14						
2-14	M	YA	LI_2	I/EC	0.70836	-5.6
			RM_3	AD	0.70832	-5.0
6-14	F	OA	RP_3	MC	0.70625	-5.6
			LM^3	AD	0.70626	-6.1
7-14	F	YA	RI_1	I/EC	0.70719	-6.0
			RM^3	AD	0.70712	-6.3
24-14	I	AD	RP^3	MC	0.70709	-5.6
26-14	M	MA	LM_3	AD	0.71020	-6.1
34-14	F	YA	LI^2	I/EC	0.70695	-4.9
			RM^3	AD	0.70685	-5.6
39-14	F	OA	RI^1	I/EC	0.70735	-4.2
			LM^3	AD	0.70733	-5.2
42B-14	I	AD	LI^1	I/EC	0.70718	-4.6
			LM_3	AD	0.70754	-6.1
58-14	F?	YA	RI_2	I/EC	0.70702	-4.1
			LM^3	AD	0.70694	-5.6
Unit 15						
4-15	I	AD	LI^1	I/EC	0.70726	-4.5
			LM^3	AD	0.70725	-6.1
9A-15	F	YA	LI_2	I/EC	0.70720	-5.6
			LM^2	MC	0.70723	-4.9
Unit 16						
1-16	F	YA	LI_2	I/EC	0.70712	-4.9
			LM_3	AD	0.70703	-6.1
2-16	M	YA	LI^1	I/EC	0.70751	-4.6
			LM^3	AD	0.70751	-4.7
9-16	F	YA	RI_2	I/EC	0.70778	-

Burial ID	Sex[a]	Age Category[b]	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_c$ (VPDB, ‰)
			RM_3	AD	0.70781	-6.6
18-16	F	YA	RI^1	I/EC	0.70714	-3.7
			RM_3	AD	0.70707	-4.9
25-16	M?	YA	RI_1	I/EC	0.70737	-6.0
			RM^3	AD	0.70726	-6.1
Units 19-21						
6-19	F	YA	LP3	MC	0.70705	-5.1
			LM^3	AD	0.70703	-5.6
2-20	M	MA	RC^1	MC	0.70638	-5.4
			LM_3	AD	0.70633	-5.5
3-20	M?	YA	RI^1	I/EC	0.70735	-4.4
			RM_3	AD	0.70723	-5.2
7-20	F?	AD	RI^1	I/EC	0.70739	-4.7
1-21	M?	YA	LC^1	MC	0.70651	-5.1
			RM^3	AD	0.70650	-6.1
Central Plaza						
3-CP	M	YA	LI^1	I/EC	0.70704	-5.1
			LM_3	AD	0.70710	-
11-CP	F	YA	RI^2	I/EC	0.70695	-4.2
			RM_3	AD	0.70708	-5.2
19-CP	I	I	LI_2	I/EC	0.70750	-6.3
			RM^3	AD	0.70753	-6.0
20-CP	M?	I	RI_2	I/EC	0.70745	-4.6
			RM^3	AD	0.70733	-5.7
Convento						
CO-1	F	A	RP^4	MC	0.70762	-4.1
CO-4	M	MA	RI^1	I/EC	0.70711	-4.3
			RM_3	AD	0.70691	-5.5
CO-5	F	YA	RI^1	I/EC	0.70729	-4.6
			RM^3	AD	0.70687	-5.7
CO-13	F?	A	M		0.70708	-3.1
CO-16	F?	A	LI^2	I/EC	0.70768	-3.1
CO-18	F	YA	RC_1	MC	0.70653	-4.7

Burial ID	Sex[a]	Age Category[b]	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_c$ (VPDB, ‰)
CO-21	I	A	RM_3	AD	0.70785	-5.3
CO-23	M	A	LM_2	MC	0.70732	-3.8
CO-38	F	YA	RM^3	AD	0.70741	-7.1
CO-45	M	MA	LM^2	MC	0.70739	-4.3
CO-50	M	A	LM_2	MC	0.70719	-4.1
CO-53	I	AD	RM^3	AD	0.70766	-4.5
CO-54	M?	YA	LI^1	I/EC	0.70736	-3.5
			RM_3	AD	0.70688	-4.8
Ch-159						
159-1	I	A	RI_1	I/EC	0.70656	-4.2
			LM_3	AD	0.70652	-5.1
159-2	I	A	LM^3	AD	0.70626	-6.3
159-6	I	A	LP_3	MC	0.70637	-5.1
			LM^3	AD	0.70641	-5.9
Ch-254						
254-3	I	A	RI^2	I/EC	0.70630	-3.8
			LM^3	AD	0.70663	-5.2
El Ocote						
EO-00-1A	M?	A	RM_2	MC	0.70515	-5.0
EO-04-2	M?	A	LM_1	I/EC	0.70485	-4.6
EO-04-4	I	AD	RM_2	MC	0.70433	-5.8
EO-04-6A	M?	A	RM_2	MC	0.70550	-5.8
EO-04-7	I	A	LM^2	MC	0.70516	-6.2
EO-04-8A	M?	A	RM^2	MC	0.70575	-6.3
EO-04-8B	I	AD	LM_3	AD	0.70568	-6.0
EO-04-9	F?	YA	RM_2	MC	0.70519	-5.8
EO-06-1A	I	A	RM^2	MC	0.70415	-4.7
EO-06-1B	I	A	LM^3	AD	0.70493	-4.7
EO-06-2	I	AD	LM^2	MC	0.70464	-6.1
EO-06-3A	F?	A	LM_2	MC	0.70578	-2.8
EO-06-3B	I	A	RM_3	AD	0.70580	-2.2
Cerro de Tepisuazco						
TIV-GW1	I	YA	RM^2	MC	0.70525	-3.3

Burial ID	Sex[a]	Age Category[b]	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_c$ (VPDB, ‰)
TIV-GW2	I	CH	LM_1	I/EC	0.70510	-5.9
TIV-GW3	I	CH	RM_1	I/EC	0.70487	-4.4
TIV-CC2	M?	MA	LM_2	MC	0.70496	-2.6
TIV-CC4	F?	A	RM_2	MC	0.70822	-2.5
TIV-CC5	F?	MA	RM^3	AD	0.70509	-6.0
TIV-CC6	F?	OA	RM_2	MC	0.70413	-5.0
TIV-CC7	I	YA	LM_2	MC	0.70527	-4.0
TIV-CC8	M?	YA	LM^2	MC	0.70476	-4.5

[a] F=Female; F?=Probable female; M=Male; M?=Probable male; I=Indeterminate
[b] CH=Child (3-12); AD=Adolescent (12-20); YA=Young adult (20-35); MA=Middle adult (35-50); OA=Old adult (50+); A=Adult; I=Indeterminate

Table 3.4. Descriptive statistics for human strontium and oxygen isotope results.

	Paquimé	Convento	Ch-159	El Ocote	Cerro de Tepisuazco
Strontium ($^{87}Sr/^{86}Sr$)					
Count (all teeth)	142	16	5	13	9
Mean	0.70729	0.70726	0.70642	0.70515	0.70530
Standard Deviation	0.00059	0.00035	0.00012	0.00055	0.00115
Standard Error	0.00005	0.00009	0.00005	0.00015	0.00038
Sample Variance	3.50E-07	1.30E-07	1.50E-08	3.00E-07	1.30E-06
Minimum	0.70603	0.70653	0.70626	0.70415	0.70413
Maximum	0.71020	0.70785	0.70656	0.70580	0.70822
Range	0.00417	0.00132	0.00030	0.00165	0.00409
Median	0.70724	0.70730	0.70641	0.70516	0.70509
Mode	0.70748	n/a	n/a	n/a	n/a
Kurtosis	7.899	-0.286	-0.956	-0.836	6.968
Skewness	2.093	-0.253	-0.257	-0.442	2.454
Shapiro Wilk statistic	0.813	0.977	0.966	0.927	0.669
p-val	*<0.001*	0.940	0.852	0.309	*0.001*
Oxygen ($\delta^{18}O$)					

	Paquimé	Convento	Ch-159	El Ocote	Cerro de Tepisuazco
Count (all teeth)	132	16	5	13	9
Mean	-5.2	-4.5	-5.3	-5.1	-4.2
Standard Deviation	0.9	1.0	0.8	1.3	1.3
Standard Error	0.1	0.3	0.4	0.4	0.4
Sample Variance	0.79	1.05	0.66	1.68	1.65
Minimum	-8.1	-7.1	-6.3	-6.3	-6.0
Maximum	-2.3	-3.1	-4.2	-2.2	-2.5
Range	5.8	4.0	2.1	4.1	3.5
Median	-5.2	-4.4	-5.1	-5.8	-4.4
Mode	-4.9	-4.1	-5.1	-5.8	n/a
Kurtosis	0.907	1.384	-0.545	1.032	-1.147
Skewness	0.100	-0.876	0.224	1.334	0.016
Shapiro Wilk statistic	0.987	0.943	0.953	0.822	0.937
p-val	0.256	0.383	0.761	*0.013*	0.553

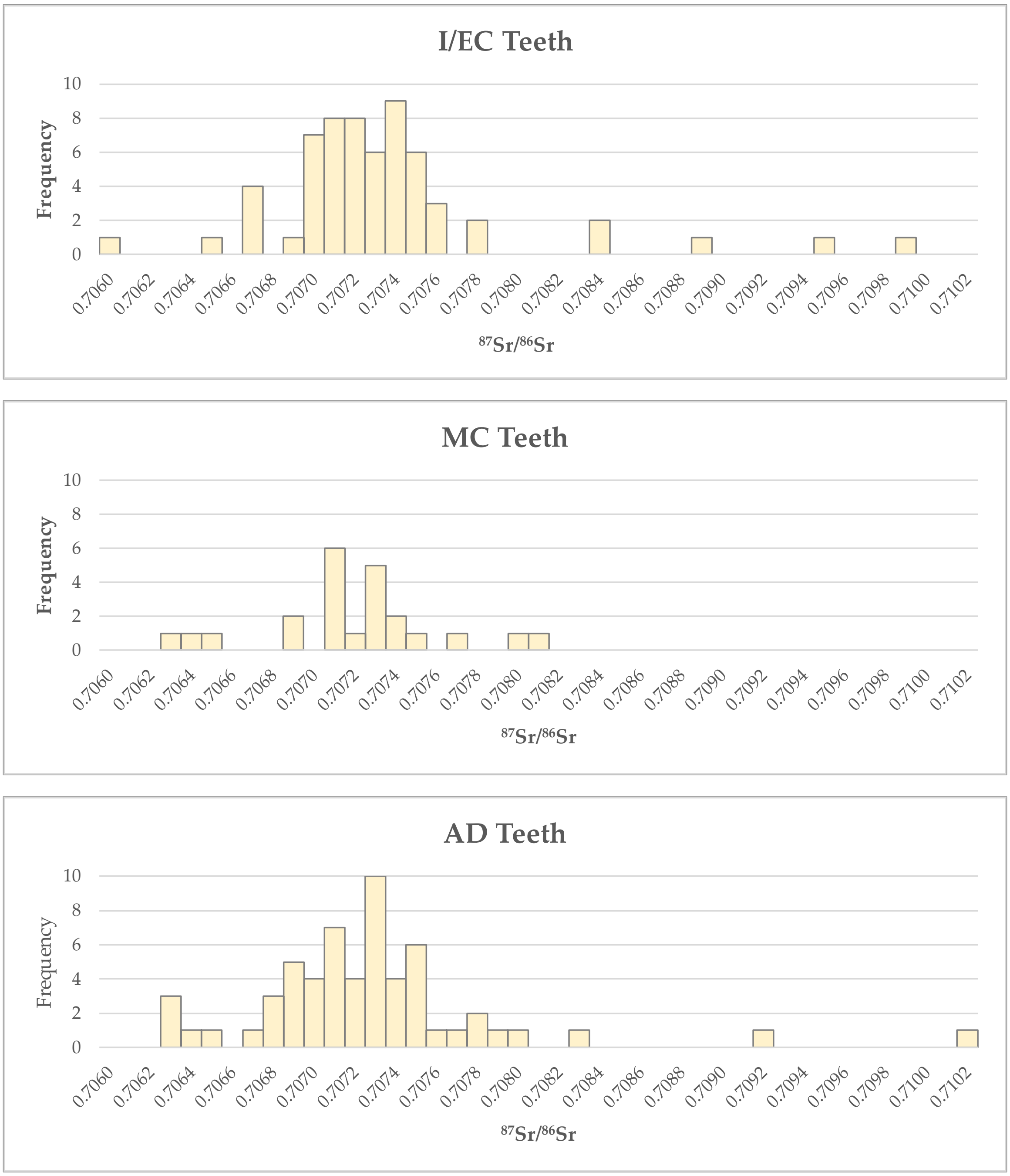
3.4.1 Strontium Isotope Results & Discussion

3.4.1.1 Human Samples

The human $^{87}Sr/^{86}Sr$ values from Paquimé range from 0.70603 to 0.71020, with a mean of 0.70729 ± 0.00059 (N=142). Teeth that formed during infancy/early childhood (I/EC) have a $^{87}Sr/^{86}Sr$ range of 0.70603 to 0.70993, with a mean of 0.70734 ± 0.00062 (N=61), while teeth that formed during middle childhood (MC) have $^{87}Sr/^{86}Sr$ values ranging from 0.70625 to 0.70811, with a mean of 0.70718 ± 0.00044 (N=23). Teeth that formed during adolescence (i.e., third molars) exhibited a $^{87}Sr/^{86}Sr$ range of 0.70626 to 0.71020, with a mean of 0.70727 ± 0.00062 (N=58). The distributions for each tooth category are shown in Figure 3.3. When compared to Paquimé, Viejo Period individuals from the Convento site have a much narrower $^{87}Sr/^{86}Sr$ range of 0.70653 to 0.70785, but a similar mean of 0.70726 ± 0.00035 (N=16). The $^{87}Sr/^{86}Sr$ range for teeth that formed during infancy/early childhood (I/EC) is 0.70711 to 0.70768, with a mean of 0.70736 ± 0.00024 (N=4), while teeth that formed during middle childhood (MC) have $^{87}Sr/^{86}Sr$ values ranging from 0.70653 to 0.70762, with a mean of 0.70721 ± 0.00041 (N=5). The $^{87}Sr/^{86}Sr$

range for teeth that formed during adolescence is 0.70687 to 0.70785, with a mean of 0.70726 ± 0.00044 (N=6)

Figure 3.3. Distribution of human $^{87}Sr/^{86}Sr$ values at Paquimé by tooth category. I/EC Teeth = incisors; MC Teeth = premolars, canines, second molars; AD Teeth = third molars.



Human $^{87}Sr/^{86}Sr$ data from comparative sites are presented in Table 3.3 above. A total of four individuals from sites in the southern Outer Zone of the Casas Grandes region were analyzed. At the El Zurdo site (Ch-159), the three burials have a range of $^{87}Sr/^{86}Sr$ = 0.70626 to 0.70656, with a mean of 0.70642 ± 0.00012 for all tooth types (N=5). The single burial from Calderón (Ch-254) has $^{87}Sr/^{86}Sr$ values of 0.70630 and 0.70663 in their early- and late-forming teeth, respectively. Twenty-one individuals from sites along the northwestern periphery of Mesoamerica/southern West Mexico were also analyzed. The range of $^{87}Sr/^{86}Sr$ values at El Ocote is 0.70415 - 0.70580, with a mean of 0.70515 ± 0.00055 (N=13). Cerro de Tepisuazco burials have $^{87}Sr/^{86}Sr$ values ranging from 0.70413 to 0.70527, with a mean value of 0.70493 ± 0.00037 (N=8).[8] These data are consistent with both geological $^{87}Sr/^{86}Sr$ data from this region ($^{87}Sr/^{86}Sr$ = <0.7060; Damon et al. 1983) and reported human $^{87}Sr/^{86}Sr$ values from archaeological sites in the Valley of Mexico (0.7046 to 0.7051; Price et al. 2008). Mann-Whitney U tests showed that $^{87}Sr/^{86}Sr$ values at Paquimé are significantly higher than those at Ch-159 (U=3.414, p=0.001), El Ocote (U=5.955, p=<0.0001), and Cerro de Tepisuazco (U=3.965, p=<0.0001). As such, it is possible to differentiate between individuals who migrated to Paquimé from these regions and those who were born locally. Statistical comparisons between Paquimé and Ch-254 were not conducted because only one individual from Ch-254 had teeth available for analysis, however, this individual had similar $^{87}Sr/^{86}Sr$ values to the burials from Ch-159. This is expected given the relatively close geographic proximity of Ch-254 and Ch-159.

3.4.1.2 Faunal Samples

The results of the strontium isotope analysis of faunal specimens from Paquimé and four comparative sites are presented in Table 3.5. The mean value of Paquimé faunal remains is $^{87}Sr/^{86}Sr$ = 0.70715 ± 0.00011, with a range of 0.70699 to 0.70731 (N=10). The range of $^{87}Sr/^{86}Sr$ values from Site 315 is 0.70670 to 0.70709, with a mean of 0.70690 ± 0.00019 (N=3). The overlap in strontium isotope values at Paquimé and Site 315 is expected because the latter is located just 2 km east of Paquimé. If faunal data from

[8] T4-CC-B4 was an outlier ($^{87}Sr/^{86}Sr$ = 0.70822) and was therefore excluded from these calculations. This individual was likely an immigrant to the site.

Paquimé and Site 315 are combined, the range of $^{87}Sr/^{86}Sr$ values is 0.70699 to 0.70731 with a mean of 0.70709 ± 0.00017 (N=13). It is reasonable to combine the faunal data from these two sites because of their close proximity to one another. Furthermore, archaeological evidence suggests that the people of Paquimé may have acquired agricultural surpluses from sites up to 30 km away (Whalen and Minnis 2001b, 2009; Minnis et al. 2006). In addition, the three faunal specimens from Site 315 do not constitute a large enough sample size to construct a meaningful local range for that site. As such, the slightly broader range of $^{87}Sr/^{86}Sr$ values produced by this combined data set is likely a more accurate representation of bioavailable strontium sources at Paquimé.

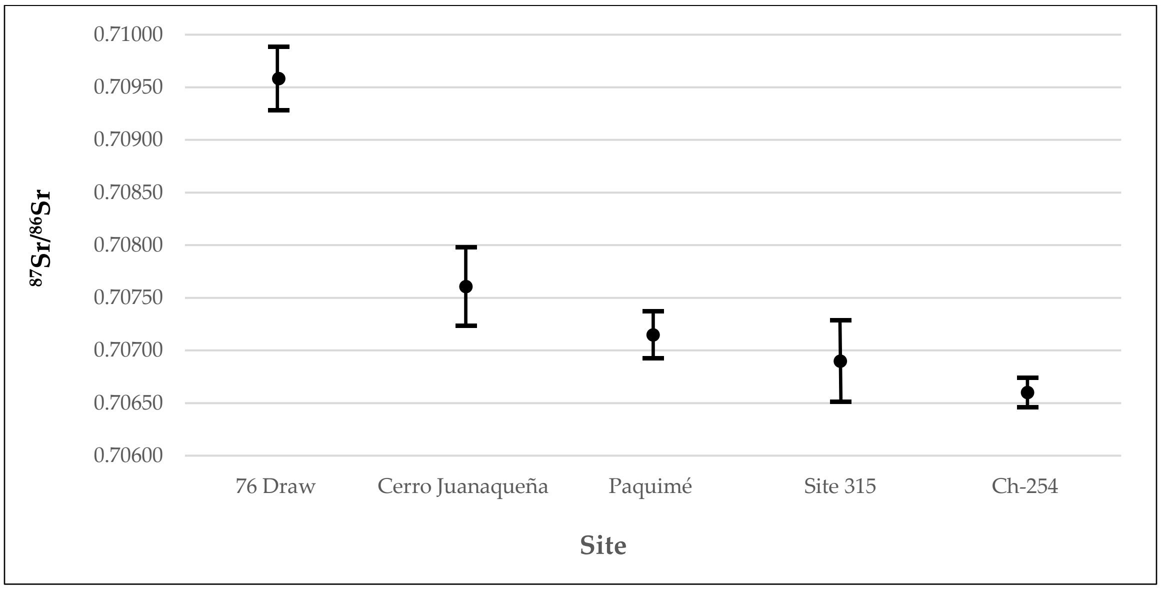
Higher strontium isotope ratios were found at sites to the north of Paquimé, with Cerro Juanaqueña having a $^{87}Sr/^{86}Sr$ range of 0.70738 to 0.70779 and a mean of 0.70761 ± 0.00019 (N=5) and the northern-most site, 76 Draw, having a range of 0.70925 to 0.70972 and a mean of 0.70958 ± 0.00015 (N=7). Conversely, Ch-254, which is located ~150 km south of Paquimé, had the lowest strontium isotope ratios of all the comparative faunal samples, with a range of 0.70650 to 0.70671 and a mean of 0.70660 ± 0.00007 (N=10). Following protocol established by Price and colleagues (2002), the local range at each site was calculated as the mean ± 2σ (Table 3.5; Figure 3.4). At Paquimé, the local $^{87}Sr/^{86}Sr$ range is 0.70693 – 0.70737. As demonstrated in Figure 3.4, $^{87}Sr/^{86}Sr$ values are significantly higher at 76 Draw (southern New Mexico) than $^{87}Sr/^{86}Sr$ values from any of the sites in the Casas Grandes region (Paquimé, Site 315, Cerro Juanaqueña, Ch-254). Meanwhile, there is some overlap in the local $^{87}Sr/^{86}Sr$ ranges at Paquimé and Cerro Juanaqueña and there is no overlap in the $^{87}Sr/^{86}Sr$ ranges calculated for Paquimé and Ch-254.

Table 3.5. Strontium isotope results of faunal specimens from Paquimé and comparative sites.

Sample ID	Genus/species	$^{87}Sr/^{86}Sr$
Paquimé		
CG-FS1	*Dipodomys* species	0.70725
CG-FS2	*Lepus californicus*	0.70710
CG-FS3	*Dipodomys* species	0.70731
CG-FS4	*Dipodomys* species	0.70725
CG-FS5	*Dipodomys* species	0.70705
CG-FS6	*Dipodomys* species	0.70702
CG-FS7	*Dipodomys* species	0.70724
CG-FS8	*Dipodomys* species	0.70699
CG-FS9	*Dipodomys* species	0.70710
CG-FS10	*Lepus californicus*	0.70714
Mean: 0.70715 ± 0.00011 (1σ) Range (mean ± 2σ): 0.70693 – 0.70737		
Site 315		
315-FS13	*Lepus* species	0.70709
315-FS15	*Lepus* species	0.70690
315-FS16	*Lepus* species	0.70670
Mean: 0.70690 ± 0.00019 (1σ) Range (mean ± 2σ): 0.70651 - 0.70748		
Cerro Juanaqueña		
CJ-FS1	*Lepus* species	0.70772
CJ-FS2	*Lepus* species	0.70779
CJ-FS3	*Lepus* species	0.70743
CJ-FS4	*Lepus* species	0.70771
CJ-FS5	*Lepus* species	0.70738
Mean: 0.70761 ± 0.00019 (1σ) Range (mean ± 2σ): 0.70723 - 0.70798		
CH-254		
254-F1	*Mephitus mephitus*	0.70651
254-F2	*Dipodomys* species	0.70657
254-F3	*Dipodomys* species	0.70665
254-F4	*Lepus* species	0.70650
254-F5	*Lepus* species	0.70660
254-F6	*Lepus* species	0.70653
254-F7	*Sylvilagus* species	0.70663
254-F8	*Canis lupus familiaris*	0.70671
254-F9	*Dipodomys species*	0.70660
254-F10	*Dipodomys species*	0.70668

Sample ID	Genus/species	$^{87}Sr/^{86}Sr$
Mean: 0.70660 ± 0.00007 (1σ) Range (mean ± 2σ): 0.70646 - 0.70674		
76 Draw		
PD-26	*Sylvilagus* species	0.70962
PD-48	*Sylvilagus* species	0.70963
PD-66	*Sylvilagus* species	0.70972
PD-93	*Sylvilagus* species	0.70925
PD-102	*Sylvilagus* species	0.70961
PD-130	*Sylvilagus* species	0.70962
PD-136	*Sylvilagus* species	0.70964
Mean: 0.70958 ± 0.00015 (1σ) Range (mean ± 2σ): 0.70925 - 0.70972		

Figure 3.4. Distribution (mean ± 2σ) of $^{87}Sr/^{86}Sr$ values in faunal remains from Paquimé and comparative sites. Cerro Juanaqueña, Site 315, and Ch-254 are located within the Casas Grandes region and 76 Draw is in the American Southwest. Note that the Casas Grandes sites have distinct $^{87}Sr/^{86}Sr$ values when compared to 76 Draw.



3.4.1.3 Local & Regional Strontium Isotope Range

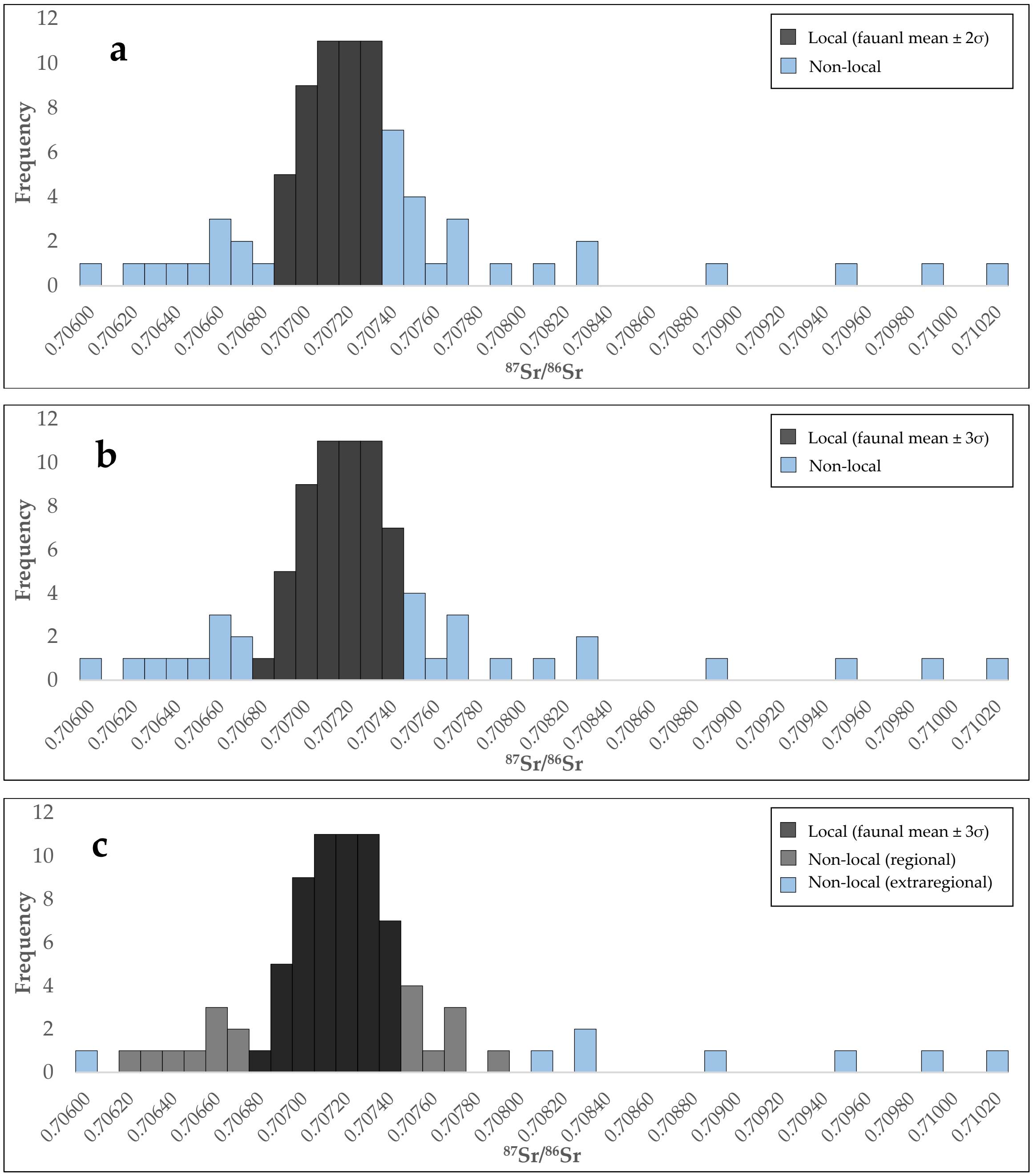
Determining the local $^{87}Sr/^{86}Sr$ range at Paquimé is a critical first step in classifying individuals as locals or immigrants. While $^{87}Sr/^{86}Sr$ values in faunal remains from the site provide a useful baseline for interpreting the human $^{87}Sr/^{86}Sr$ data, it is also important to consider how the distribution of human data compares to the faunal data. Figure 3.5a shows the distribution of human $^{87}Sr/^{86}Sr$ values at Paquimé, which is skewed to the right (Shapiro Wilk statistic: W=0.813, p=<0.001). This distribution is based on the early-forming tooth from each individual in the study sample or the late-forming tooth if an early-forming tooth was not available. Dark grey bars represent strontium isotope values that fall within the local range, as calculated by the faunal mean ± 2σ, while blue bars represent $^{87}Sr/^{86}Sr$ values that fall outside the local range. When the local range is calculated using the faunal mean ± 2σ, many of the human $^{87}Sr/^{86}Sr$ values in the central distribution fall just outside the local range, leading to the classification of a substantial number of non-local individuals. However, if the local range is expanded to the faunal mean ± 3σ ($^{87}Sr/^{86}Sr$ = 0.70682 – 0.70748), the resulting classifications of local/non-local are better aligned with the distribution of human $^{87}Sr/^{86}Sr$ values (Figure 3.5b).

The narrow range of $^{87}Sr/^{86}Sr$ values in faunal remains from Paquimé (when compared to the central distribution of human $^{87}Sr/^{86}Sr$ values) could be the result of a sampling bias, as the majority of faunal specimens analyzed from Paquimé were kangaroo rats (*Dipodomys* species). The home range of this species is quite narrow (< 200 m), so it is possible that the complete range of bioavailable strontium is not fully represented by the faunal samples analyzed for this study. If, however, the three faunal samples from Site 315 (all jackrabbits) are combined with the ten faunal samples from Paquimé (eight kangaroo rats and two jackrabbits), the bioavailable $^{87}Sr/^{86}Sr$ range at Paquimé becomes $^{87}Sr/^{86}Sr$ = 0.70676 – 0.70742. This range is very close to the one produced by the faunal mean ± 3σ ($^{87}Sr/^{86}Sr$ = 0.70682 – 0.70748). As mentioned above, this combined data set is likely a more accurate approximation of the local bioavailable strontium range at Paquimé

Even after expanding the local $^{87}Sr/^{86}Sr$ range to 0.70682 - 0.70748, there are still a number of individuals within the central distribution that are classified as non-local. When the $^{87}Sr/^{86}Sr$ results from comparative sites are considered, however, the remaining 'non-local' individuals within the central distribution have $^{87}Sr/^{86}Sr$ values that are consistent with other sites in the Casas Grandes region (Figure 3.5c). Classifying these individuals as regional non-locals (light grey bars) reflects a more normal distribution, such that the central distribution of human $^{87}Sr/^{86}Sr$ values consists of individuals who are local to the Casas Grandes region (Paquimé and surrounding sites), while the outliers (blue bars) are individuals with $^{87}Sr/^{86}Sr$ values that are not consistent with $^{87}Sr/^{86}Sr$ values found in this area. With the exception of the individual with the lowest $^{87}Sr/^{86}Sr$ value (0.70603), the other individuals with $^{87}Sr/^{86}Sr$ values below the local range at Paquimé are consistent with faunal and/or human values from the two sites in south-central Chihuahua (Ch-254 and Ch-159). Individuals with $^{87}Sr/^{86}Sr$ values above the local range but less than 0.70799 are consistent with the northern Casas Grandes region, as estimated by the faunal results from Cerro Juanaqueña.

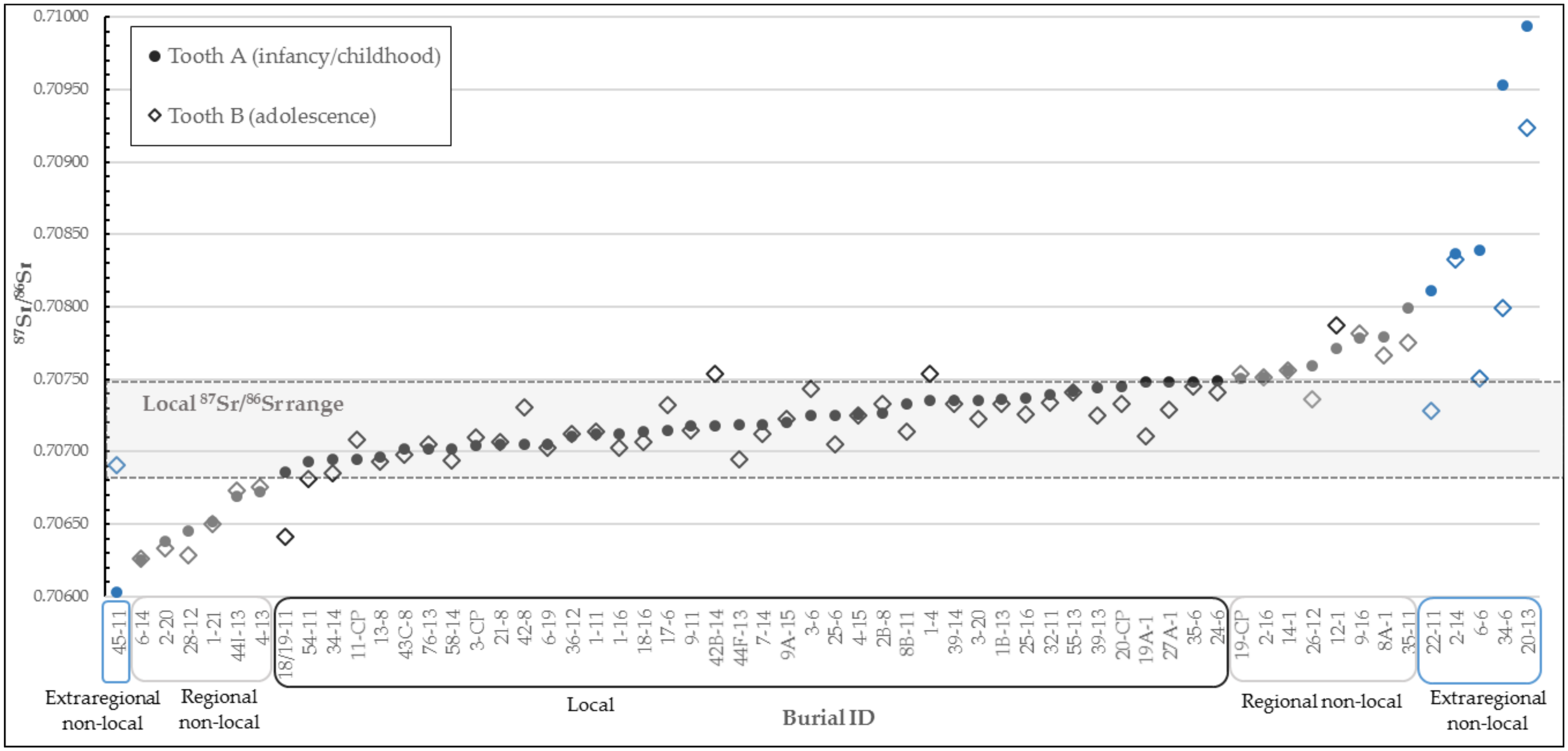
It should be noted, however, that the mean $\pm$ 2σ faunal range at Cerro Juanaqueña is 0.70723 - 0.70798, which overlaps with the local range calculated for Paquimé (0.70682 - 0.70748). This overlap is likely due to the fact that the sites are relatively close (~60 km) and have similar underlying geology. The wider local range at Cerro Juanaqueña is probably also a result of its small sample size (N=5). While individuals with $^{87}Sr/^{86}Sr$ values between 0.70723 and 0.70748 technically fall into the local range at either site, the most important point is that their strontium isotope ratios are consistent with sites in the Casas Grandes region and not with neighbouring regions.

Figure 3.5. Histogram showing the distribution of human $^{87}Sr/^{86}Sr$ values at Paquimé **(a)** Dark grey bars represent $^{87}Sr/^{86}Sr$ values that fall within the local range at Paquimé (faunal mean ± 2σ). This range does not correspond well with the distribution of human $^{87}Sr/^{86}Sr$ values **(b)** Same distribution as 3.5a, but with the local range (dark grey bars) expanded to the faunal mean ± 3σ (0.70682 – 0.70748). This range is more reflective of the distribution of human $^{87}Sr/^{86}Sr$ values **(c)** Same distribution as 3.5b, but with regional non-locals in light grey. These individuals have $^{87}Sr/^{86}Sr$ values that do not fall within the local isotope range at Paquimé but are consistent with other sites in the Casas Grandes region.



Based on the local and regional strontium isotope ranges discussed above, 26 individuals from Paquimé have non-local strontium isotope signatures, 18 of which are consistent with the Casas Grandes region (i.e., regional non-locals) and 8 with $^{87}Sr/^{86}Sr$ values that fell outside of this range (i.e., extraregional non-locals). While the extraregional non-locals and many of the regional non-locals have $^{87}Sr/^{86}Sr$ ratios that are distinct from the local range at Paquimé, there are several individuals that are on the border of the local range. These ambiguous cases are more difficult to classify as local or non-local, particularly those that fall just above the local range because they have $^{87}Sr/^{86}Sr$ values that could also be consistent with areas in the northern part of the Casas Grandes region. One way to approach this issue is to examine the results from both teeth together to look for evidence of mobility during childhood, as indicated by variation in $^{87}Sr/^{86}Sr$ values between teeth. As such, mobility profiles for all Paquimé individuals with two teeth available for analysis (N=60) are presented in Figure 3.6.

Figure 3.6. Strontium isotope mobility profiles for Paquimé individuals with two teeth available for analysis. Solid circles represent teeth that formed during infancy/childhood and open diamonds represent teeth that formed during adolescence. The upper and lower limits of the local $^{87}Sr/^{86}Sr$ range are marked with dashed lines. The colour of the data points corresponds to the individual's classification as local (black), regional non-local (grey), or extraregional non-local (blue). Migration to Paquimé during childhood occurred when Tooth A (solid circle) is outside of the local range and Tooth B (open diamond) is within the local range for the same individual (e.g., Burial 45-11 on far left). If both teeth are outside the local range, migration occurred post-adolescence.



Six of the extraregional non-locals had both teeth available for analysis; two had non-local $^{87}Sr/^{86}Sr$ ratios in their early-forming tooth (representing infancy or early childhood) and a local signature in their late-forming tooth (third molars; representing late childhood/adolescence), indicating that they migrated to Paquimé during childhood. The remaining four individuals had non-local signatures in both teeth, which means they migrated to the site after late childhood/adolescence. The remaining two extraregional non-locals had only one tooth available for analysis; Burial 26-14 likely migrated to the site post-adolescence given that their third molar had a non-local $^{87}Sr/^{86}Sr$ signature, whereas the timing of migration for Burial 1A-1 could not be determined because only an early-forming tooth was analyzed. With the exception of Burial 2-14, there was considerable variation in strontium isotope values between teeth from the same individual among the extraregional non-locals (blue) when compared to regional non-locals (grey) or locals (black). Whether they came to Paquimé as children or adults, this pattern indicates that extraregional immigrants were mobile during childhood and traveled between regions.

In contrast, regional non-locals exhibit a similar pattern to locally-born individuals whereby $^{87}Sr/^{86}Sr$ values are the same or very similar in both teeth, which indicates limited mobility between isotopically distinct areas. For example, Burials 19-CP and 2-16 have $^{87}Sr/^{86}Sr$ values that coincide with the upper boundary of the local range at Paquimé and have similar $^{87}Sr/^{86}Sr$ values in their I/EC and AD teeth. This pattern is likely a product of geographic distance since regional non-locals would not need to migrate as far as their extraregional immigrant counterparts. Depending on the specific place of origin, migration from within the Casas Grandes region (e.g., Cerro Juanaqueña area) may take only a few days. It is also possible that individuals classified as 'regional non-locals' may have actually been born at Paquimé and remained there throughout life, hence the near-local isotope values and lack of variability between teeth. These cases will be discussed further in the final part of the results section, which considers the strontium isotope results in conjunction with the oxygen isotope data.

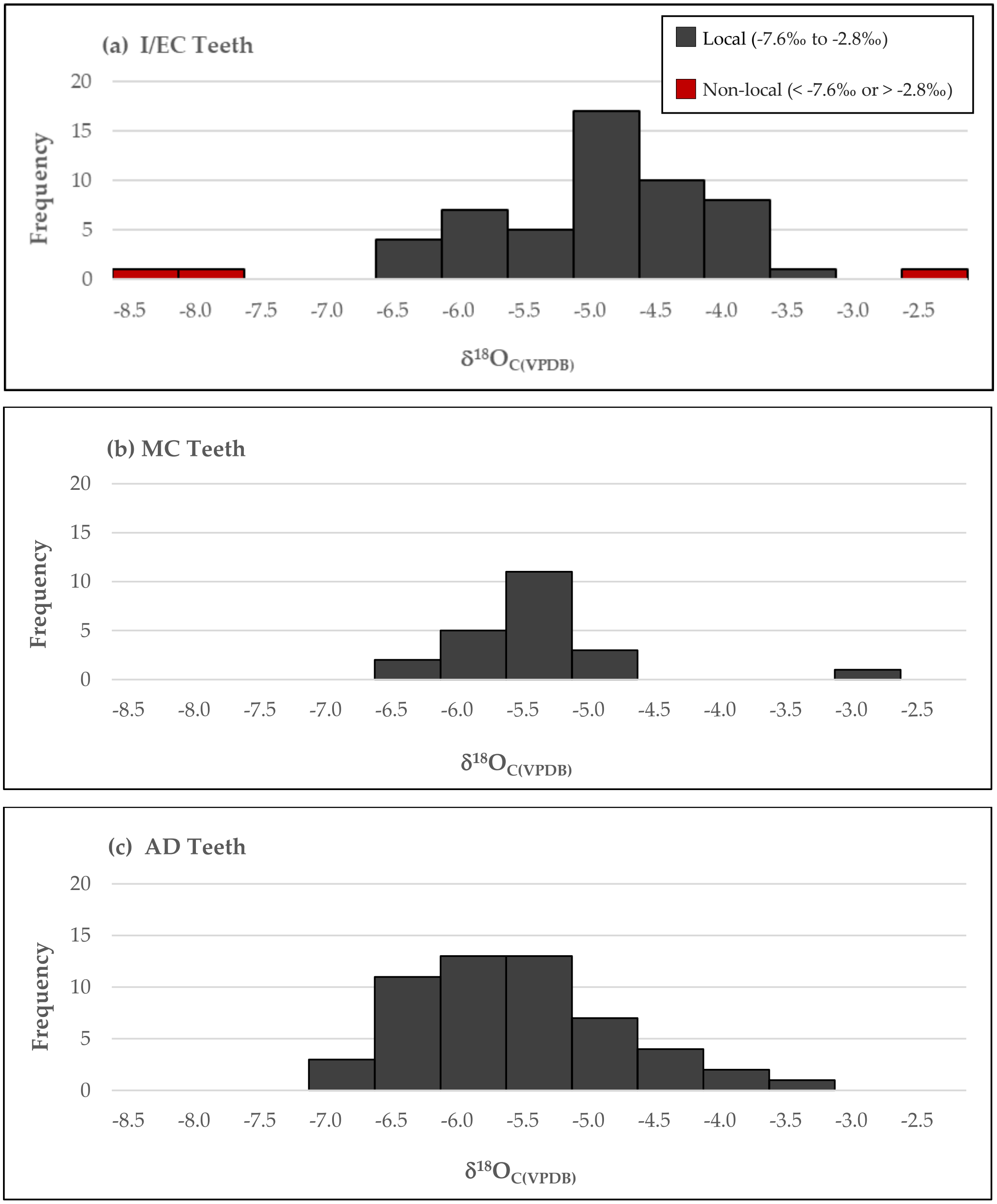
3.4.2 Stable Oxygen Isotope Results & Discussion

3.4.2.1 Paquimé

The results of the stable oxygen isotope analysis of tooth enamel carbonate ($\delta^{18}O_{C(VPDB)}$) from individuals at Paquimé are presented in Table 3.3 above. The range of stable oxygen isotope values at the site is $\delta^{18}O_{C(VPDB)}$ = -8.1‰ to -2.3‰, with a mean of -5.2‰ ± 0.9‰ (N=131). The $\delta^{18}O_{C(VPDB)}$ range for teeth that formed during infancy/early childhood (I/EC) is -8.1‰ to -2.3‰, with a mean of -4.9‰ ± 1.0‰ (N=55), while teeth that formed during middle childhood (MC) have a $\delta^{18}O$ range of -6.3‰ to -3.0‰, with a mean of -5.2‰ ± 0.7‰ (N=23). The $\delta^{18}O_{C(VPDB)}$ range for teeth that formed during adolescence (AD) is -6.9‰ to -3.5‰, with a mean of -5.4‰ ± 0.8‰ (N=54). Oxygen isotope values in I/EC teeth (first and second incisors) are enriched by an average of 0.5‰ when compared to $\delta^{18}O_{C(VPDB)}$ values in teeth that formed during adolescence (i.e., third molars). Teeth that formed during middle childhood (canines, premolars, second molars) have $\delta^{18}O_{C(VPDB)}$ values that are 0.2‰ higher than those of third molars. The average difference in $\delta^{18}O_{C(VPDB)}$ values between tooth categories is statistically significant (ANOVA: F=5.81, p=0.004) and indicates a nursing effect. Paired *t*-tests revealed that $\delta^{18}O_{C(VPDB)}$ values in I/EC teeth were on average 0.6‰ higher than AD teeth from the same individual (*t*=3.31, df=35, p=0.002). The difference between $\delta^{18}O_{C(VPDB)}$ values in MC and AD teeth from the same individual was not statistically significant (*t*=1.20, df=8, p=0.2629). Although mean $\delta^{18}O_{C(VPDB)}$ values vary by tooth category in the sample as a whole, the degree of change in $\delta^{18}O_{C(VPDB)}$ values between teeth will vary by individual based on the duration of nursing and whether the person was mobile during childhood. Thus, no adjustments were applied to $\delta^{18}O_{C(VPDB)}$ values in I/EC teeth, but the data are separated by tooth category when considering the local $\delta^{18}O$ range at Paquimé.

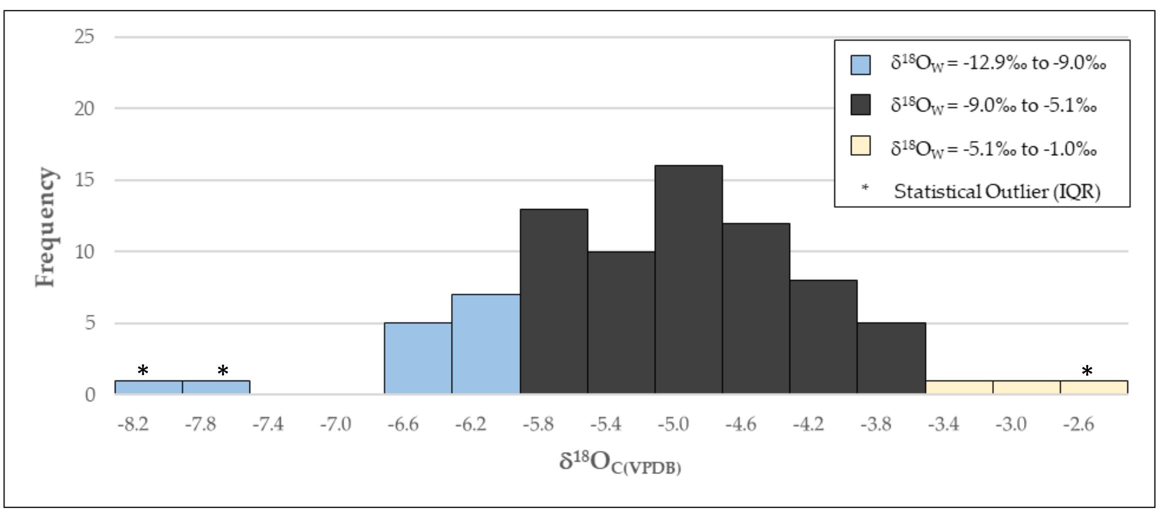
The distribution of stable oxygen isotope values from tooth enamel carbonate ($\delta^{18}O_{C(VPDB)}$) is shown in Figure 3.7. Teeth that formed during infancy/early childhood (Figure 3.7a) have an asymmetrical distribution that is skewed to the left because $\delta^{18}O$ values are higher in teeth that formed while an individual was nursing. In contrast, teeth that formed during middle childhood (Figure 3.7b) and adolescence (Figure 3.7c) have asymmetrical distributions that are skewed to the right because these teeth formed during the weaning process (MC teeth) or after weaning was complete (AD teeth and some MC teeth) and therefore have lower $\delta^{18}O$ values. The primary method used to determine the local $\delta^{18}O$ range at Paquimé is through the identification of statistical outliers using the interquartile range (IQR) method. When $\delta^{18}O_C$ data from all teeth (N=132) are used in the IQR calculation, the range is -7.6‰ to -2.8‰, which results in the identification of three outliers: 19A-1 (-8.1‰), 5-4 (-2.3‰), and 17-6 (-7.6‰). These outliers are represented by red bars in Figure 3.7a and are clearly distinct from the central distribution of the data (grey bars). None of the MC or AD teeth had $\delta^{18}O_C$ values that fell outside the local range, however, the $\delta^{18}O_C$ of Burial 1-4's MC tooth (-3.0‰) is higher than other MC teeth in the sample (Figure 3.7b) and is near the upper boundary of the local $\delta^{18}O$ range (-2.8‰). As such, it is possible that this individual was not born locally.

Figure 3.7. Histogram showing the distribution of $\delta^{18}O_{C(VPDB)}$ values at Paquimé by tooth category **(a)** Distribution of I/EC teeth (incisors) **(b)** Distribution of MC teeth (premolars, canines, second molars) **(c)** Distribution of AD teeth (third molars). Red bars represent statistical outliers (IQR).



In addition to identifying non-locals based on the IQR method, the human $\delta^{18}O_{C(VPDB)}$ results from Paquimé were also compared to the estimated range of oxygen isotope values in modern precipitation ($\delta^{18}O_{W(VSMOW)}$). Figure 3.8 shows the distribution of stable oxygen isotope values from tooth enamel carbonate $\delta^{18}O_{C(VPDB)}$ from all individuals at Paquimé. The data for Figure 3.8 consist of the $\delta^{18}O_{C(VPDB)}$ value of the I/EC tooth from each individual. If an I/EC tooth was not analyzed, the $\delta^{18}O_{C(VPDB)}$ value from an MC or AD tooth was used instead. The data are colour-coded by the corresponding $\delta^{18}O_{W(VSMOW)}$ value, which were converted to $\delta^{18}O_{C(VPDB)}$ using regression equations by Chenery et al. (2012) and Coplen et al. (1983). Based on these equations, the local $\delta^{18}O_{W(VSMOW)}$ range of -9.0‰ to -5.1‰ is roughly equivalent to $\delta^{18}O_{C(VPDB)}$ = -5.8‰ to -3.4‰. There are three individuals with higher $\delta^{18}O_{C(VPDB)}$ values than the local range (yellow bars), one of which was identified as an outlier using the IQR method (Burial 5-4) and two additional burials; Burial 14-1 whose $\delta^{18}O_{C(VPDB)}$ value is -3.3‰ and Burial 1-4 whose $\delta^{18}O_{C(VPDB)}$ value is -3.0‰. Meanwhile, fourteen individuals have $\delta^{18}O_{C(VPDB)}$ ratios that are below the local range (blue bars), including two outliers from the IQR analysis (Burials 19A-1 and 17-6). Thus, approximately 21% of the sample from Paquimé has non-local $\delta^{18}O_{C(VPDB)}$ values when compared to estimates from modern precipitation.

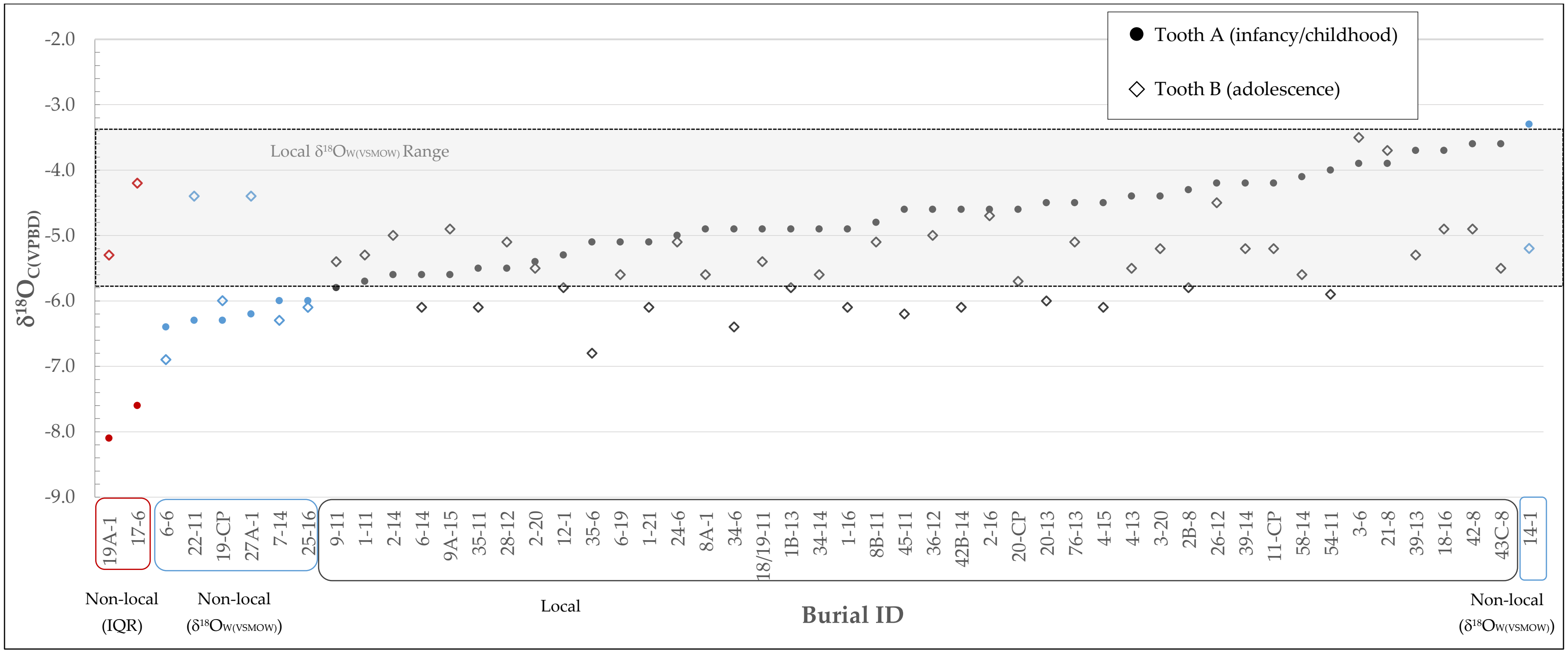
Figure 3.8. Distribution of human $\delta^{18}O_{C(VPDB)}$ values at Paquimé, colour-coded by $\delta^{18}O_{W(VSMOW)}$ values from modern precipitation. Grey bars represent expected $\delta^{18}O_{W(VSMOW)}$ values for the Casas Grandes region, while yellow and blue bars denote $\delta^{18}O_{W(VSMOW)}$ values above and below the local range, respectively. Outliers that were identified using the IQR method are marked with an asterisk (N=3).



The distribution of $\delta^{18}O_{C(VPDB)}$ values in Figure 3.8 does not align well with the estimated local $\delta^{18}O_{W(VSMOW)}$ range of modern water sources because a portion of individuals within the central distribution are classified as non-local (i.e., $\delta^{18}O_{C(VPDB)}$ values between -5.8‰ and -7.0‰). This discrepancy could be caused by variation in climate conditions over time or it may be the result of errors associated with the regression equations used to convert $\delta^{18}O_{W(VSMOW)}$ to $\delta^{18}O_{C(VPDB)}$. Either of these scenarios could result in a slightly different range of human $\delta^{18}O_{C(VPDB)}$ values when compared to the environmental baseline. Alternatively, the discrepancy between $\delta^{18}O_{W(VSMOW)}$ and $\delta^{18}O_{C(VPDB)}$ values could be similar to the distribution of $^{87}Sr/^{86}Sr$ values at Paquimé, whereby individuals with isotope values just outside the local range represent regional immigrants. These ambiguous cases will be discussed in further detail at the end of this section.

Mobility profiles for all individuals with two teeth available for oxygen isotope analysis are presented in Figure 3.9. For most individuals, the nursing effect is evident in the elevated $\delta^{18}O_{C(VPDB)}$ values in Tooth A (solid circles) when compared to Tooth B (open diamonds). The most obvious exception to this pattern are individuals with non-local $\delta^{18}O_{C(VPDB)}$ values below the local range. For example, two of the individuals identified as statistical outliers (19A-1 and 17-6) appear to have migrated to Paquimé during childhood, as evidenced by non-local $\delta^{18}O_{C(VPDB)}$ values in their I/EC teeth and local $\delta^{18}O_{C(VPDB)}$ values in their AD teeth (shown in red). Furthermore, the difference in $\delta^{18}O_{C(VPDB)}$ values between teeth is substantial (3.4‰ for 17-6 and 2.8‰ for 19A-1), which provides further evidence for extra-regional origins. Several of the individuals whose $\delta^{18}O_{C(VPDB)}$ ratios fall outside the local oxygen isotope range estimated from modern precipitation (shown in blue) also had large differences between their two teeth, particularly Burials 27A-1, 22-11, and 14-1. The latter two individuals also had non-local $^{87}Sr/^{86}Sr$ values, which further supports a classification of non-local.

Figure 3.9. Oxygen isotope mobility profiles for Paquimé individuals with two teeth available for analysis. Solid circles represent teeth that formed during infancy/childhood and open diamonds represent teeth that formed during adolescence. The local $\delta^{18}O_{W(VSMOW)}$ range (converted to $\delta^{18}O_{C(VPDB)}$) is denoted by the shaded grey area with dashed lines. Red markers indicate statistical outliers (i.e., non-locals) identified by the IQR analysis and blue markers represent individuals whose $\delta^{18}O_{C(VPDB)}$ values fall outside the local $\delta^{18}O_{W(VSMOW)}$ range of modern precipitation.

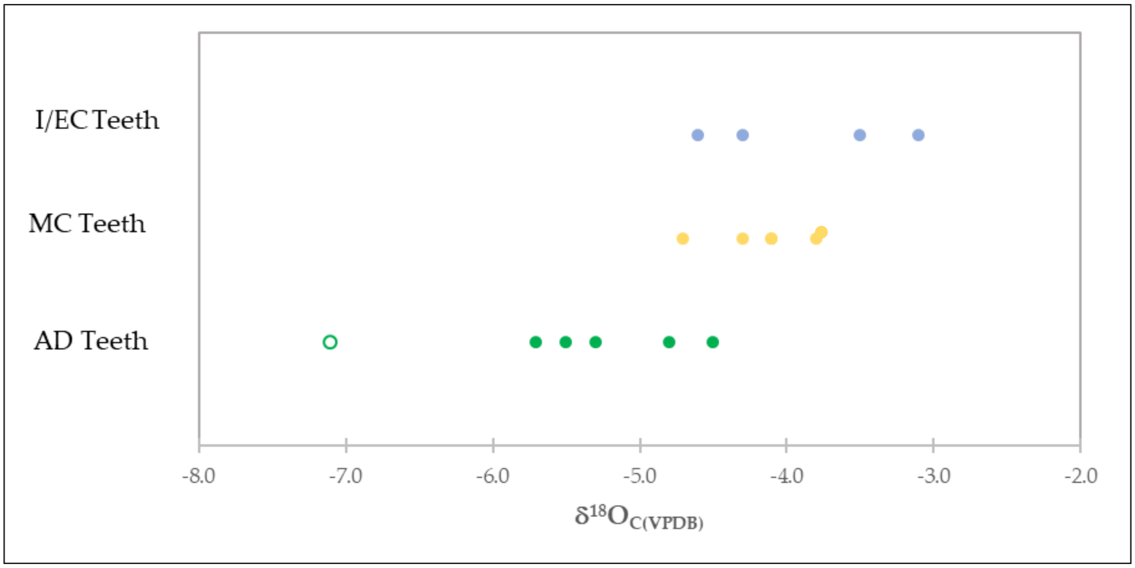


3.4.2.2 Convento

The range of $\delta^{18}O_{C(VPDB)}$ values at the Convento site is -7.1‰ to -3.1‰, with a mean of -4.5‰ ± 1.0‰ (N=16). The $\delta^{18}O_{C(VPDB)}$ range for teeth that formed during infancy/early childhood (I/EC) is -4.6‰ to -3.1‰, with a mean of -3.9‰ ± 0.6‰ (N=4). Teeth that formed during middle childhood (MC) have a $\delta^{18}O_{C(VPDB)}$ range of -4.7‰ to -3.8‰, with a mean of -4.2‰ ± 0.3‰ (N=5), while third molars that formed during adolescence have a $\delta^{18}O_{C(VPDB)}$ range of -7.1‰ to -4.5‰, with a mean of -5.5‰ ± 0.8‰ (N=6). Mean $\delta^{18}O_{C(VPDB)}$ values are significantly different by tooth category (ANOVA: F=7.55, p=0.008). Pairwise analyses could not be conducted because most individuals from Convento had only one tooth available for analysis. The mean $\delta^{18}O_{C(VPDB)}$ value at Convento (all teeth) is significantly higher (0.7‰) than the mean $\delta^{18}O_{C(VPDB)}$ at Paquimé (t=2.90, df=146, p=0.008).

The variation in $\delta^{18}O_{C(VPDB)}$ values between time periods requires the construction of an independent local baseline for the Convento site. Using the IQR method on all teeth analyzed from the Convento sample, the local $\delta^{18}O_{C(VPDB)}$ range is -6.3‰ to -2.7‰. The distribution of $\delta^{18}O_{C(VPDB)}$ values (by tooth category) is shown in Figure 3.10. Solid circles represent individuals whose $\delta^{18}O$ ratios fall within the local range, while the open circle denotes the only statistical outlier, Burial CO-38, whose third molar has a $\delta^{18}O$ value of -7.1‰. Burial CO-38 falls well outside the local $\delta^{18}O_{C(VPDB)}$ range estimated from modern precipitation (-5.8‰ to -3.4‰), which also supports a classification of non-local.

Figure 3.10. Distribution of $\delta^{18}O_{C(VPDB)}$ values at Convento. I/EC teeth (incisors) are in blue, MC teeth (premolars, canines, second molars) are in yellow, and AD teeth (third molars) are in green. Solid circles represent $\delta^{18}O$ values that fall within the local range (-6.3‰ to -2.7‰) and the open circle is a statistical outlier (i.e., non-local).



3.4.2.3 Comparative Sites

Oxygen isotope analysis was also conducted on individuals from four comparative sites (Ch-159, Ch-254, El Ocote, Cerro de Tepisuazco). The $\delta^{18}O_{C(VPDB)}$ range at Ch-159 is -6.3‰ to -4.2‰, with a mean of -5.3‰ ± 0.8‰ (N=5). The two individuals with early-forming have $\delta^{18}O_{C(VPDB)}$ values of -5.1‰ and -4.2‰, while the three late-forming teeth ranged from -6.3‰ to -5.1‰. The single individual from Ch-254 has an oxygen isotope signature of -3.8‰ in their early-forming tooth and -5.2‰ in their late-forming tooth. At El Ocote, the mean is $\delta^{18}O_{C(VPDB)}$ = -5.1‰ ± 1.3‰, with a range of -6.3‰ to -2.2‰ (N=13), while the mean $\delta^{18}O_{C(VPDB)}$ at Cerro de Tepisuazco is -4.2‰ ± 1.3‰, with a range of -6.0‰ to -2.5‰ (N=9). There is no difference in the mean $\delta^{18}O_{C(VPDB)}$ value at Paquimé when compared to Ch-159 (t=1.98, df=135, p=0.725) or to El Ocote (U=0.454, p=0.650)[9]. The mean $\delta^{18}O_{C(VPDB)}$ at Cerro de Tepisuazco is significantly higher than the mean $\delta^{18}O_{C(VPDB)}$ at Paquimé (t=1.98, df=139, p=0.0004). While the comparative value of these

[9] Oxygen isotope values at El Ocote were not normally distributed (Shapiro Wilk: W=0.822, p=0.013; Table 3.4), so the non-parametric Mann-Whitney U test was used instead of a *t*-test.

results is limited by small samples sizes, the data are consistent with the expectation that $\delta^{18}O$ values would be roughly similar between Paquimé and other sites in the Casas Grandes region (i.e., Ch-159 and Ch-254) and more differentiated from (some) sites in the southern area of West Mexico.

3.4.3 Combined Isotope Results & Discussion

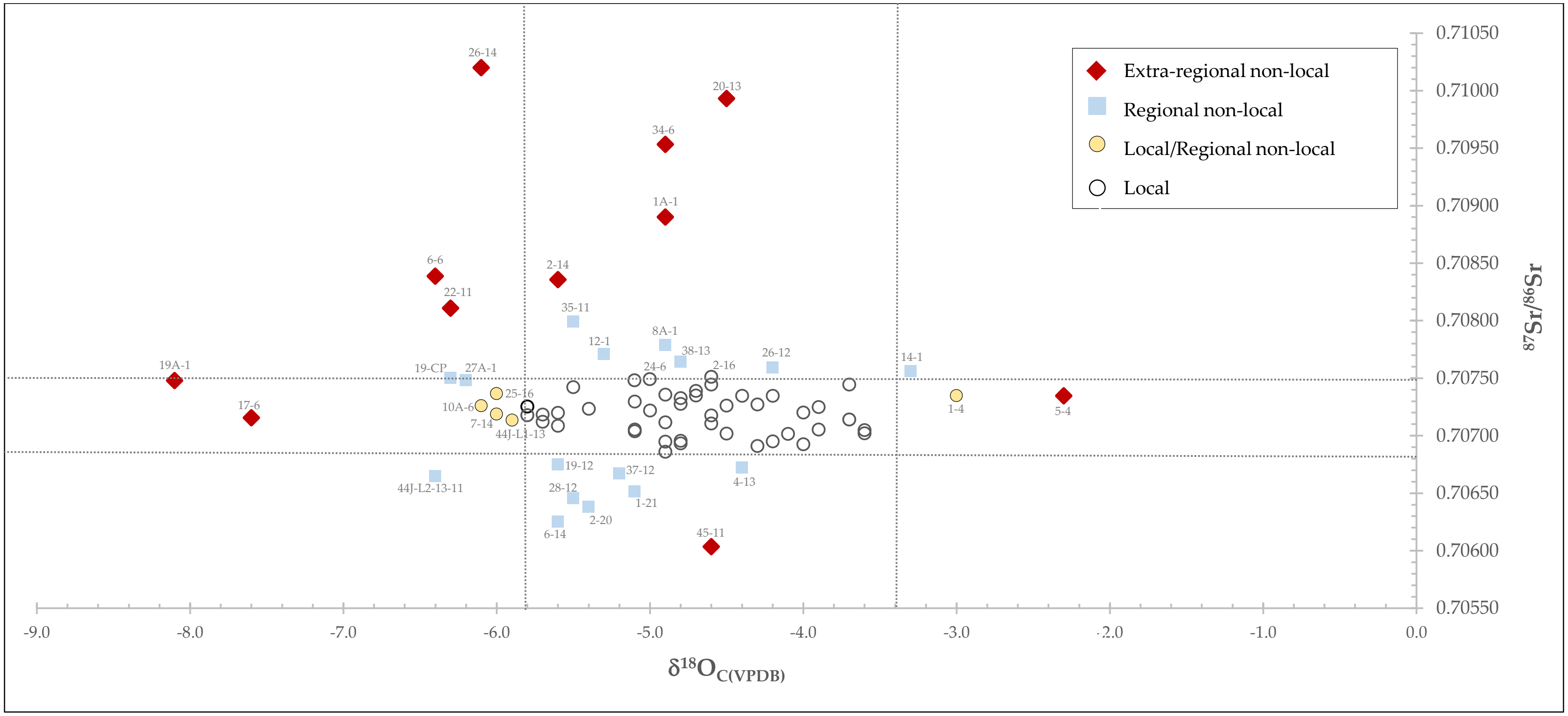
3.4.3.1 Paquimé

Thus far, individuals have been classified as local or non-local based on either their strontium or oxygen isotope values. In both cases, two types of non-locals were identified; those with significantly different isotope values from the local range ('extraregional non-locals' for strontium or 'IQR outliers' for oxygen) and those with isotope values that are outside the local range, but are not outliers ('regional non-locals' for strontium or individuals with $\delta^{18}O_{C(VPDB)}$ values outside the local $\delta^{18}O_{W(VSMOW)}$ range estimated from modern precipitation). Individuals with $^{87}Sr/^{86}Sr$ and/or $\delta^{18}O_{C(VPDB)}$ values that are highly distinct from the local range can be confidently classified as extra-regional non-locals, while those with isotope values within the local range for *both* $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{C(VPDB)}$ can be classified as locals. It is more difficult to determine the geographic origins for individuals with $\delta^{18}O_{C(VPDB)}$ values that are not statistical outliers but fall outside the expected local $\delta^{18}O_{W(VSMOW)}$ range of modern drinking water. Similarly, several individuals have $^{87}Sr/^{86}Sr$ values that are on the border of the local strontium isotope range at Paquimé and could therefore be classified as either locals or regional non-locals. In both instances, the combined isotope data may help to discriminate between local and non-local origins.

Figure 3.11 is a scatter plot of all individuals that were sampled for both strontium and oxygen isotope analyses (N=76). Oxygen isotope data was not available for the remaining six burials from Paquimé, so these individuals are not included in Figure 3.11. However, four of these individuals have unambiguously local $^{87}Sr/^{86}Sr$ values in all teeth and are therefore classified as locals (Burials 44F-13, 25-6, 32-11, and 22-8). The other two burials (9-16 and 44I-13) have $^{87}Sr/^{86}Sr$ values that fall outside the local strontium isotope range at Paquimé but are consistent with other sites in the Casas Grandes region and are therefore classified as regional non-locals. The local $^{87}Sr/^{86}Sr$ isotope range (0.70682 - 0.70748) and the local $\delta^{18}O_{C(VPDB)}$ range estimated from modern $\delta^{18}O_{W(VSMOW)}$ values ($\delta^{18}O_{C(VPDB)}$ = -5.8‰ to -3.4‰) are represented by dashed lines in Figure 3.11. Burial numbers are also included for all non-local individuals. Open black circles represent individuals that have isotope ratios that fall within the local ranges for both strontium and oxygen and are therefore classified as locals. Individuals that have $^{87}Sr/^{86}Sr$ values that fall outside the local and regional $^{87}Sr/^{86}Sr$ range (N=8) or $\delta^{18}O_{C(VPDB)}$ values that are statistical outliers (N=3) are represented by solid red diamonds and are classified as extraregional non-locals.

Solid blue squares represent individuals that have $^{87}Sr/^{86}Sr$ values that are outside the local strontium isotope range at Paquimé but are consistent with other sites in the Casas Grandes region. These individuals are classified as regional non-locals. One of these individuals (44J-L2-13) also has a non-local $\delta^{18}O_{C(VPDB)}$ value of -6.4‰ in their I/EC tooth, which further supports a non-local classification. The other eleven individuals have $\delta^{18}O_{C(VPDB)}$ values that fall within the local oxygen isotope range at Paquimé, which is expected because sites in the Casas Grandes region are located within the same physiographic province as Paquimé and should therefore have similar $\delta^{18}O_{C(VPDB)}$ values. Although the $^{87}Sr/^{86}Sr$ values of Burials 19-CP and 27A-1 are at the upper boundary of the local strontium isotope range, these individuals are classified as regional non-locals because they have non-local $\delta^{18}O_{C(VPDB)}$ values. Furthermore, there is a 1.8‰ shift in $\delta^{18}O_{C(VPDB)}$ values between the early- and late-forming teeth from Burial 27A-1, which is likely the result of childhood mobility. There was also a change in $^{87}Sr/^{86}Sr$ values from 0.70748 to 0.70729 between the two teeth from this individual. The remaining five individuals (Burials 25-16, 7-14, 44J-L1-13, 10A-6, 1-4) have non-local $\delta^{18}O_{C(VPDB)}$ values and local $^{87}Sr/^{86}Sr$ values and are represented by solid yellow circles. These individuals are classified as 'local/regional non-local' because of the difficulty in differentiating between real and introduced variation in oxygen isotope values (e.g., migration versus conversion equation errors). While a more conservative approach might be to classify them as local based on their local strontium isotope signatures, these individuals would likely have even lower $\delta^{18}O_{C(VPDB)}$ values if the nursing effect is adjusted for. Finally, two individuals that were designated as regional non-locals based on their $^{87}Sr/^{86}Sr$ signatures were re-classified as locals when data from both isotopes were considered together; Burials 2-16 and 24-6 have $^{87}Sr/^{86}Sr$ values that are at the upper boundary of the local strontium isotope range (0.70751 and 0.70749, respectively), but $\delta^{18}O_{C(VPDB)}$ values that are well within the local oxygen isotope range. As well, there is no evidence of childhood mobility in either of these individuals because there is no change in strontium or oxygen isotope values between I/EC and AD teeth.

Figure 3.11. Scatter plot of $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{C(VPDB)}$ values at Paquimé. The local $^{87}Sr/^{86}Sr$ range is marked by horizontal dashed lines, while the local $\delta^{18}O_{C(VPDB)}$ range (based on the estimated local range of $\delta^{18}O_{W(VSMOW)}$ in modern precipitation) is marked by vertical dashed lines. All individuals classified as non-local (extra-regional or regional) are labeled with a burial ID.



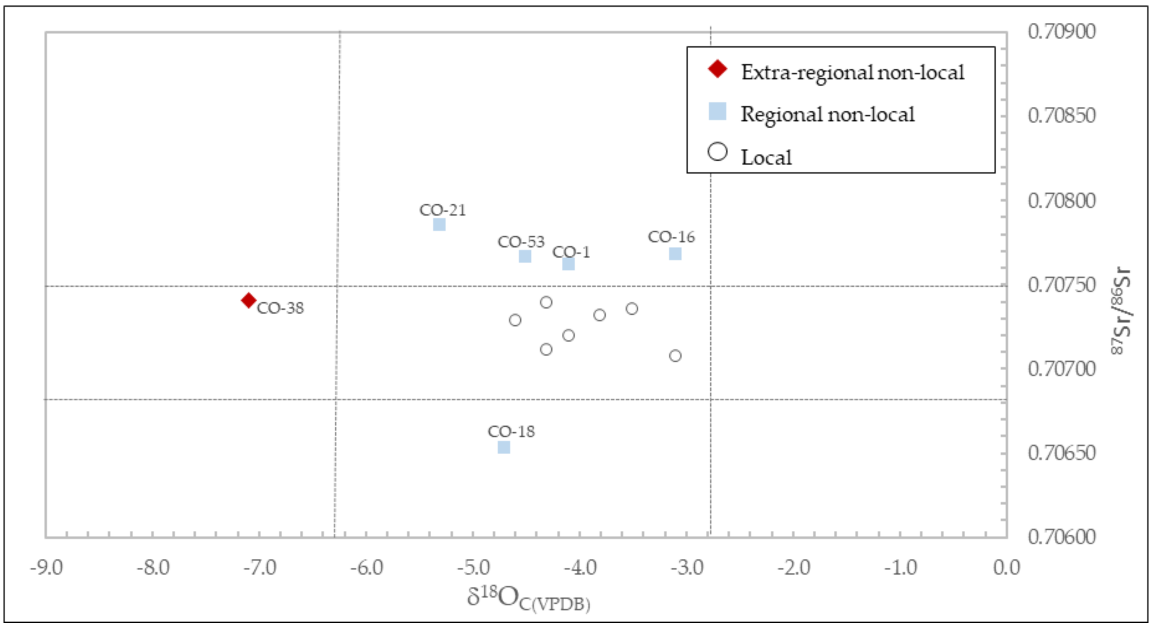
Based on the preceding discussion, 48 individuals were classified as local, 11 were extraregional non-locals, 18 were regional non-locals, and 5 were classified as local/regional non-local. Of the eleven extraregional non-locals, five were male, five were female, and sex could not be determined for the remaining adolescent. Most of these individuals were young adults (N=7), followed by middle adults (N=2), then old adults and adolescents (N=1 each). Based on the strontium and oxygen isotope mobility profiles (Figures 3.6 and 3.9), four of the extraregional non-locals migrated to Paquimé during childhood and five migrated after late childhood/early adolescence. The remaining two individuals had only one tooth available for analysis, so the timing of migration could not be determined.

The 18 regional non-locals consisted of 8 males, 5 females, and 5 individuals of indeterminate sex (N=4 adolescents). There was a slight majority of young adults (N=6), followed by old adults (N=4) and adolescents (N=4), then middle adults (N=3). The age-at-death of the remaining individual could not be determined. Five of these individuals migrated to Paquimé as children and eleven came to the site after late childhood/early adolescence. Timing of migration could not be determined for the other two regional non-locals. Finally, the five individuals classified as local/regional non-local were two young adult females, two young adult males, and one adolescent of indeterminate sex.

3.4.3.2 Convento

The combined isotope data for the Convento site (N=13) are shown in Figure 3.12. These results do not change the original classifications discussed previously; the five individuals with non-local $^{87}Sr/^{86}Sr$ values have local $\delta^{18}O_{C(VPDB)}$ values, while the one individual with a non-local $\delta^{18}O_{C(VPDB)}$ signature has a local $^{87}Sr/^{86}Sr$ ratio. There are four individuals with $^{87}Sr/^{86}Sr$ ratios above the local range, which are consistent with the northern Casas Grandes region and one individual with a $^{87}Sr/^{86}Sr$ signature below the local range and consistent with the southern zone. These five individuals are classified as regional non-locals. Two of the regional non-locals are adult females, one is a young adult female, one is an adolescent of indeterminate sex, and one is an adult of indeterminate sex. There is also one individual (CO-38) with a $\delta^{18}O_{C(VPDB)}$ ratio that was a statistical outlier based on the IQR analysis[10]. As such, this young adult female is classified as an extraregional non-local. None of the non-local individuals had two teeth available for analysis, so the timing of migration could not be determined.

Figure 3.12. Scatter plot of $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{C(VPDB)}$ values at Convento. The local $^{87}Sr/^{86}Sr$ range is marked by horizontal dashed lines and the local $\delta^{18}O_{C(VPDB)}$ range (based on the estimated local range of $\delta^{18}O_{W(VSMOW)}$ in modern precipitation) is marked by vertical dashed lines. All individuals classified as non-local (extra-regional or regional) are labeled with a burial ID.



3.5 Discussion

3.5.1 Overall Trends in Isotope Results

The results of this study indicate that both strontium and oxygen isotopes were successful, to varying degrees, at identifying non-local individuals in the Paquimé and Convento burial assemblages. As expected, strontium isotopes were better geographic tracers in this study, not only for differentiating between northwest Mexico and

[10] The sample size from the Convento site (N=13) is small for conducting statistical outlier tests. However, the outlier $\delta^{18}O_{C(VPDB)}$ value of -7.1‰ is well outside the expected local range for the Casas Grandes region estimated from $\delta^{18}O_{W(VSMOW)}$ in modern precipitation, so this individual likely came from a neighbouring region.

neighbouring regions, but also for detecting intraregional variability between sites in the Casas Grandes region. More specifically, $^{87}Sr/^{86}Sr$ values at Paquimé were statistically different from the 76 Draw site in southern New Mexico and from El Ocote and Cerro de Tepisuazco in central Mexico, which demonstrates that immigrants from the American Southwest and southern West Mexico/northwest Mesoamerica can be distinguished (isotopically) from individuals born at Paquimé or in the surrounding Casas Grandes region. As expected, $^{87}Sr/^{86}Sr$ values from Paquimé and Convento are also highly distinct from previously published human and faunal $^{87}Sr/^{86}Sr$ data from sites in the American Southwest, which have $^{87}Sr/^{86}Sr$ values of ~0.70830 or higher (Dudás et al. 2016; Ezzo et al. 1997; Ezzo and Price 2002; Price et al. 1994, 2017; Waller 2009). This is a critical finding in terms of the ability to use isotopic methods to determine whether extraregional immigrants were present at Paquimé and thereby evaluate the research questions posed in this study.

There were also statistically significant differences between the mean $^{87}Sr/^{86}Sr$ values at Paquimé and the mean $^{87}Sr/^{86}Sr$ values at three comparative Casas Grandes sites (i.e., Ch-254, Ch-159, Cerro Juanaqueña). This suggests that geographic origins *within* the Casas Grandes region are also discernable in some cases. For instance, sites in the southern Casas Grandes region are characterized by $^{87}Sr/^{86}Sr$ values below the local range at Paquimé, while sites in the northern region have $^{87}Sr/^{86}Sr$ values that are higher than Paquimé. It is therefore possible to use strontium isotope analysis to examine both inter- and intraregional population dynamics at Paquimé. The lower $^{87}Sr/^{86}Sr$ values at sites in the southern Casas Grandes region (Ch-159 and Ch-254) are likely the result of strontium inputs from younger volcanic rocks, which have lower $^{87}Sr/^{86}Sr$ values, given the sites' close proximity to the Sierra Madre Occidental when compared to Paquimé. The difference between Paquimé and Casas Grandes sites to the north, however, is less pronounced and there is some overlap in $^{87}Sr/^{86}Sr$ values within this area. Thus, it is challenging to determine if individuals with $^{87}Sr/^{86}Sr$ values between ~0.70740 to 0.70780 are locals or regional non-locals. It should also be noted that sites to the west of Paquimé in the Sierra Madre could have comparable $^{87}Sr/^{86}Sr$ values to sites in the southern zone of the Casas Grandes region due to similar underlying geology. Fortunately, these distinctions are irrelevant to the research questions posed in this study since population aggregation from the immediate surrounding areas is expected under local development models (e.g., Whalen and Minnis 2003, 2009). In other words, the designation of local or regional non-local means that the individual was born in the Casas Grandes region and did not migrate to Paquimé from a neighbouring region, as suggested by external development models.

Although limited comparative oxygen isotope data was analyzed for this study, the results indicate that oxygen is not as useful as strontium at discriminating between locals and non-locals in this region. The samples from the southern Casas Grandes region and even from El Ocote, which is hundreds of kilometers south of Paquimé, had statistically indistinguishable mean $\delta^{18}O_{C(VPDB)}$ values from Paquimé. The sample sizes from these sites are admittedly small, however, $\delta^{18}O$ estimates from modern precipitation maps also predict largely uniform oxygen isotope values throughout the Casas Grandes region in northwest Mexico. In addition, the range of $\delta^{18}O_{C(VPDB)}$ values at Paquimé (-8.1‰ to -2.3‰) overlaps almost entirely with the range of $\delta^{18}O_{C(VPDB)}$ values reported by Price and colleagues (2017) for Pueblo Bonito (-8.3‰ to -2.8‰), which is located over 700 km north of Paquimé in northern New Mexico. Furthermore, there is also no difference in the mean $\delta^{18}O_{C(VPDB)}$ values between I/EC teeth at Paquimé (-4.9‰ ± 1.0‰, N=55) and I/EC teeth at Pueblo Bonito (-4.8‰ ± 1.1‰, 61) (t=0.766, df=120, p=0.446). As such, oxygen isotopes are not good indicators of intraregional variation within the Casas Grandes interaction sphere and do not appear to be sensitive indicators between Casas Grandes and some neighbouring regions. The overlap between Paquimé and Pueblo Bonito is particularly surprising because modern precipitation maps predict lower $\delta^{18}O_{W(VSMOW)}$ values for northwest New Mexico when compared to northwest Chihuahua (Bowen 2017; Bowen and Ravenaugh 2003; IAEA/WMO 2015).

The oxygen isotope mobility profiles presented in Figure 3.9 also demonstrate significant intra-individual variability in $\delta^{18}O_{C(VPDB)}$ among Paquimé individuals. While slightly elevated $\delta^{18}O_{C(VPDB)}$ values are expected in early-forming teeth due to the nursing effect, the difference in $\delta^{18}O_{C(VPDB)}$ values between teeth from the same individual often exceeds the expected enrichment of ~0.5 to 0.7‰. This means that other factors, such as cooking practices, short-term climate fluctuations, and/or childhood mobility, may also be contributing to intra-individual variability (e.g., Bretell et al. 2012). Additionally, the mean

$\delta^{18}O_{C(VPDB)}$ value at Paquimé was significantly lower than the Convento site by 0.7‰ (t=2.90, df=146, p=0.008). This difference may be the result of climatic variation between the two time periods, the use of different water sources (e.g., groundwater versus surface waters), variation in food preparation techniques, or simply an effect of the small sample size from Convento. Whatever the case, both lines of evidence indicate $\delta^{18}O$ variability at Paquimé that is not fully understood at this time, especially given the lack of comparative human $\delta^{18}O$ data for this region.

3.5.2 Research Questions

The primary goals of this chapter were to determine the occurrence, structure, and scale of migration, and examine the geographic origins of the migratory individuals identified in the Paquimé and Convento burial assemblages. First, the results of the radiogenic strontium and stable oxygen isotope analyses demonstrate that there were indeed immigrants present at Paquimé. In terms of the scale of migration, the results of these analyses revealed that over half (58.5%) of the sample population exhibited $^{87}Sr/^{86}Sr$ and/or $\delta^{18}O$ values that fell within the local range established for the site, while 22% had isotope values consistent with other parts of the Casas Grandes region (i.e., regional non-locals). Five individuals (6.1%) had ambiguous isotope values and were therefore classified as local/regional non-local. Finally, 13.4% (N=11) of the individuals from Paquimé were classified as extraregional non-locals because they had $^{87}Sr/^{86}Sr$ and/or $\delta^{18}O$ values that fell outside the local range at Paquimé and that were also distinct from strontium isotope values from other sites in the Casas Grandes region.

Of the thirteen individuals from the Convento site, 53.8% (N=7) had local $^{87}Sr/^{86}Sr$ or $\delta^{18}O$ values, 38.5% (N=5) were classified as regional non-locals, and one individual was classified as an extraregional non-local based on their $\delta^{18}O$ signature. When the proportions of non-local individuals from Convento and Paquimé are compared using two-tailed Fisher's Exact tests, there are no statistically significant differences in the proportion of extraregional non-locals (p=1.000) or regional non-locals (p=0.580). These data suggest that the scale of migration at Casas Grandes (Paquimé and Convento) was relatively constant between the Viejo and Medio Periods and do not support scenarios that involve a large influx of foreigners during the Medio Period. This also accords well with Butler's

(1971) biodistance study, the findings of which indicate genetic continuity from the Viejo to Medio Period.

In terms of the form (i.e., structure) of migration at Paquimé, mobility profiles provided evidence for both long- and short-distance migration to the site. With the exception of one individual, all of the extraregional non-locals had large differences in the isotope values between their early- and late-forming teeth, which indicates migration between two geologically distinct regions. Furthermore, the pattern of higher $^{87}Sr/^{86}Sr$ values in early forming-teeth, which are characteristic of strontium isotope values in the American Southwest, and lower $^{87}Sr/^{86}Sr$ values in late-forming teeth, which are either consistent with or trending toward strontium isotope values in the Casas Grandes region, indicates long-distance migration. More specifically, this pattern is characteristic of serial migration, which is the term used to describe the shorter moves, or segments, that make up long-distance migration (Bernardini 2005). This pattern was highly distinct from the mobility profiles of locals and regional non-locals, both of whom exhibited minimal or no variation in isotope values between teeth. For regional immigrants, this pattern may indicate that these individuals migrated only once (to Paquimé) or that residential mobility was confined to geologically similar parts of the Casas Grandes region. In both scenarios the pattern is characteristic of short-distance migration.

This leads to the next research question, which is *where* the immigrants to Paquimé may have come from. Beginning with the eighteen individuals classified as regional non-locals, nine have $^{87}Sr/^{86}Sr$ values consistent with the northern zone (0.70756 to 0.70799) and nine have $^{87}Sr/^{86}Sr$ values that are consistent with the southern zone of the Casas Grandes region (0.70620 – 0.70678). Previous studies have demonstrated that Paquimé's closest ties were with Medio Period groups in the northern region of the Casas Grandes interaction sphere (e.g., Whalen and Minnis 2001a, 2009), so a sizeable proportion of regional non-locals from this area is consistent with other lines of archaeological evidence. The finding that four of the five regional non-locals at the Convento site also have $^{87}Sr/^{86}Sr$ values above the local range provides further evidence for this pattern and indicates long-term relationships with groups from this area. It is also interesting that there was a similar proportion of regional non-locals from the southern zone at Paquimé, which suggests that interaction with groups from this region may have developed or expanded during the Medio Period.

It is important to remember that strontium isotope values are not unique to specific geographic locations, thus, individuals that exhibit $^{87}Sr/^{86}Sr$ values consistent with the Casas Grandes region may also have migrated from areas with similar underlying geology. In addition to potential overlap in isotope values within the Casas Grandes region (discussed previously), geological data indicate that areas in northeast Sinaloa along the Chihuahua and Durango borders are characterized by $^{87}Sr/^{86}Sr$ values between 0.7047 to 0.7063, while parts of central and south-central Sonora have $^{87}Sr/^{86}Sr$ values between 0.7064 to 0.7066 (Damon et al. 1983). Thus, it is possible that non-local individuals with strontium isotope signatures consistent with the southern Casas Grandes sites (0.7063 – 0.7067) could have come from these regions in northwest Mexico. Such connections would, however, be speculative given the lack of comparative bioavailable strontium isotope data from Sonora and Sinaloa. When considering the possibility of West Mexican immigrants influencing the cultural trajectory of Paquimé via the Aztatlán system, whose northernmost extension was in Sinaloa/Durango, two points can be made. First, all but one of the geological $^{87}Sr/^{86}Sr$ values reported from northeast Sinaloa and northwest Durango are below 0.7050, which is significantly lower than $^{87}Sr/^{86}Sr$ values from the southern Casas Grandes region, and the one location with a $^{87}Sr/^{86}Sr$ value of 0.7063 barely overlaps with this area. Second, it is important to remember that these West Mexican individuals were believed to have been Aztatlán traders who introduced sophisticated technology (e.g., city planning) and exotic goods to the less advanced people of Casas Grandes (JC Kelley 2000). As such, they would have been important public figures and should therefore exhibit mortuary treatment that symbolizes this status. Only two of the nine individuals with $^{87}Sr/^{86}Sr$ values below the local range at Paquimé had burial accompaniments (Burials 1-21 and 19-12) and these consisted of only a single Ramos Polychrome jar each. Ramos Polychrome jars were the most common type of pottery recovered from Paquimé and were found in all units excavated, as well as all types of contexts (Di Peso et al. 1974: vol. 6). As such, the presence of a single Ramos Polychrome vessel is unlikely to symbolize elite status. Furthermore, neither of these individuals received any other type of elaborate burial treatment that would indicate high status, nor were they interred with exotic items (e.g., copper) that might symbolize foreign origins or connections (Ravesloot 1988). The remaining non-local individuals with values below the local range at Paquimé had no grave goods. It seems unlikely that West Mexican elites would be given such unceremonious mortuary treatment; therefore, if these individuals did originate from this region, they do not appear to be persons of high status.

While this alternative scenario is certainly possible, immigration from within the Casas Grandes region is a more plausible explanation for several reasons. First, most human migrations consist of short-distance movements within areas where regular social interaction occurs (Anthony 1990). In prehistoric mid-level societies like Paquimé and others in the NW/SW, these small-scale movements likely occurred at the household or individual level (Cameron 1995; Pailes 2017). Second, intensive survey and excavation throughout the Casas Grandes region have revealed a more sizeable regional population during the late Viejo and early Medio Periods than was previously recognized and there is evidence for population decline at sites in the Core Zone that coincides with population growth at Paquimé (JH Kelley et al. 2012; Whalen and Minnis 2001b, 2003, 2009). Based on these findings, Whalen and Minnis (2003, 2009) have argued that the absorption of neighbouring groups from within the Casas Grandes region likely contributed to Medio Period population growth at Paquimé. They also aptly note that it would be surprising if the Paquimé population did not include individuals from the surrounding area. As such, it seems probable that these immigrants are from other parts of the Casas Grandes region.

In addition to the individuals that were classified as regional immigrants, seven individuals have $^{87}Sr/^{86}Sr$ values that are not only higher than the local range at Paquimé, but also exceed $^{87}Sr/^{86}Sr$ values observed at other Casas Grandes sites. As such, they were classified as extraregional non-locals. It is clear that the isotope signatures of these immigrants are highly distinct from the comparative $^{87}Sr/^{86}Sr$ values from El Ocote or Cerro de Tepisuazco (0.70413 – 0.70580), which are located in the northernmost frontier area of Mesoamerica. Instead, many of these isotope values are consistent with areas in the American Southwest, where $^{87}Sr/^{86}Sr$ values of 0.7083 to 0.7114 have been reported from previous studies (Table 3.1). The 76 Draw faunal remains that were analyzed for this study also yielded $^{87}Sr/^{86}Sr$ values of 0.70925 - 0.70972. As such, it is likely that these seven individuals migrated to Paquimé from sites in the American Southwest.

Unfortunately, various areas within the American Southwest exhibit overlapping strontium (and oxygen) isotope ranges, so differentiating between sites within the broader region is difficult. For instance, burials from Pueblo Bonito in northwest New Mexico have $^{87}Sr/^{86}Sr$ values of 0.7091 – 0.7095 (Price et al. 2017), a range that has significant overlap with $^{87}Sr/^{86}Sr$ values from 76 Draw in southern New Mexico (0.7093 - 0.7097). The Salt River drainage and other parts of central and southern Arizona do, however, have some of the highest and most distinct strontium isotope ratios that have been reported for the American Southwest (ranging from 0.7096 to 0.7175) and are therefore distinguishable from areas in New Mexico (Ezzo and Price 2002; Ezzo et al. 1997).

When compared to the isotope data from the American Southwest (Table 3.1), Burials 1A-1, 34-6, 20-13, and 26-14 have $^{87}Sr/^{86}Sr$ ratios that are consistent with multiple regions including southern New Mexico, the San Juan region of northwest New Mexico, and the Salt River drainage in central Arizona. Burials 6-6 and 2-14 have $^{87}Sr/^{86}Sr$ values of 0.70839 and 0.70836, respectively, which are consistent with sites in the Mimbres Valley region of southern New Mexico. The $^{87}Sr/^{86}Sr$ values found in the early-forming tooth of Burial 22-11 (0.70811) is slightly lower than reported values from all comparative sites in the American Southwest, but also slightly higher than values from Cerro Juanaqueña in the northwest Chihuahua (<0.70799). Based on the comparative data that is currently available, this individual probably migrated to Paquimé from northern Mexico/southern New Mexico, near the modern international border.

Stable oxygen isotope analysis of tooth enamel carbonate has also been conducted on skeletal remains from Pueblo Bonito, Mine Canyon, and the Tommy site, all of which are located in the San Juan region of northwest New Mexico (Price et al. 2017; Waller 2009). The range of $\delta^{18}O$ values at Pueblo Bonito (-8.3‰ to -2.8‰) is nearly identical to the $\delta^{18}O$ range at Paquimé (-8.1‰ to -2.3‰). Tommy Site and Mine Canyon exhibit narrower $\delta^{18}O$ ranges of -9.3‰ to -5.3‰ and -8.3‰ to -5.4‰, respectively. The Tommy and Mine Canyon Sites are Chacoan outliers located near Aztec Ruins. As such, isotopic data from these sites can be used as a rough proxy for nearby Aztec Ruins, which is the intermediate stop between Chaco Canyon and Paquimé in Lekson's (1999, 2015) Chaco Meridian scenario. If Lekson's model is correct, we should expect to see non-locals in the Paquimé skeletal assemblage with isotope values consistent with the Middle San Juan region. We would also expect such individuals to have special mortuary treatment resulting from their elite status.

As mentioned above, there are four individuals that have $^{87}Sr/^{86}Sr$ signatures consistent with these sites: 1A-1, 34-6, 20-13, and 26-14. Burials 19A-1 and 17-6, which were classified as extraregional non-locals based on their oxygen isotope values, have $\delta^{18}O$ values that fall within the observed $\delta^{18}O$ range at Tommy and Mine Canyon, but their $^{87}Sr/^{86}Sr$ ratios (0.70748 and 0.70715) are significantly lower than $^{87}Sr/^{86}Sr$ values reported for this region (i.e., >0.70890). As such, it is highly unlikely that these individuals originated from this area. Of the four possible San Juan region immigrants, Burial 34-6, an old adult female, was interred with a variety of grave goods, including *Nassarius* shell beads (N=11), a Playas Red sherd disc, stone knives (N=2), a stone ornament blank, raw felsite, an obsidian chipped preform, and debitage (obsidian, felsite, chert) (Di Peso et al. 1974: vol. 8). The mortuary treatment of this woman suggests that she may have been a higher status individual. Although the combined isotope and mortuary data could indicate an elite foreigner from the Chaco/Aztec region, the $^{87}Sr/^{86}Sr$ signature in her early-forming tooth (0.70953), is consistent with *all* of the Southwest sub-regions presented in Table 3.1. Furthermore, the remaining three individuals that are potential San Juan region immigrants had no grave accompaniments. While these data are intriguing given their relevance to the Chaco Meridian hypothesis, the various alternative geographic origins of Burial 34-6 and the unceremonious mortuary treatment of the other individuals do not constitute compelling evidence for Lekson's (1999, 2015) proposed model.

A more likely scenario is that these extraregional immigrants came from southern New Mexico and/or south-central Arizona, as Paquimé had ties to Animas phase, Jornada Mogollon, Rio Grande valley, and Salado populations during the Medio Period (Douglas and MacWilliams 2015; Rakita et al. 2011; Schaafsma and Riley 1999; VanPool et al. 2017). Not only are there social and cultural connections to these regions, biodistance studies have demonstrated genetic affinity between Casas Grandes and Mimbres populations (Turner 1993, 1999; LeBlanc et al. 2008; Morales-Arce et al. 2017), which indicates biological affinity with this region as well. Although the Classic Mimbres period ended prior to the beginning of the Medio Period (ca. A.D. 1130), descendant populations that branched off into various adjacent cultures (e.g., Animas, Black Mountain, El Paso, and Salado) most certainly interacted with the people of Casas Grandes (Douglas and MacWilliams 2015; Rakita et al. 2011; Schaafsma and Riley 1999; VanPool et al. 2017).

Burial 45-11, a young adult male, was also classified as an extraregional non-local, based the $^{87}Sr/^{86}Sr$ value 0.70603 in his early-forming tooth, which is significantly below the local range and just slightly below comparative isotope values from the southern zone of the Casas Grandes region. The difference in $^{87}Sr/^{86}Sr$ values between his two teeth is also quite large, which indicates migration between geologically distinct areas and possibly long-distance migration. The strontium isotope signature from his early-forming tooth is consistent with reported geological $^{87}Sr/^{86}Sr$ values from northeast Sinaloa (Damon et al. 1983), but as previously mentioned, estimating geographic origins based on geological $^{87}Sr/^{86}Sr$ values provides less conclusive evidence than bioavailable $^{87}Sr/^{86}Sr$ values. Oxygen isotope ratios in this individual's lateral incisor and third molar were -4.6% and -6.2%, respectively. The oxygen isotope value in the incisor is local, while the third molar is just slightly outside of the local range at Paquimé. It is important to note that these $\delta^{18}O$ values are not consistent with a coastal environment, therefore geographic origins in the western coastal regions of Sinaloa are highly unlikely. Instead, it is probable that this individual is from northwest Mexico or non-coastal areas in West Mexico, but due to the lack of comparative bioavailable $^{87}Sr/^{86}Sr$ data, it is difficult to posit a more specific location.

The final three extraregional immigrants (19A-1, 17-6, and 5-4) were classified as such based on their oxygen isotope signatures. Burial 19A-1 is an adolescent with isotope ratios of $\delta^{18}O$ = -8.1% and $^{87}Sr/^{86}Sr$ = 0.70748 in their lateral incisor and $\delta^{18}O$ = -5.3% and $^{87}Sr/^{86}Sr$ = 0.70711 in their second molar. Both strontium and oxygen isotope values show a shift toward local values from the I/EC tooth to the MC tooth. Burial 17-6 is a young adult male with isotope ratios of $\delta^{18}O$ = -7.6% and $^{87}Sr/^{86}Sr$ = 0.70715 in their lateral incisor and $\delta^{18}O$ = -4.2% and $^{87}Sr/^{86}Sr$ = 0.70732 in their third molar. Thus, both individuals have $^{87}Sr/^{86}Sr$ values that fall within the local strontium isotope range at Paquimé, which suggests their place of origin is in Mexico and not the American Southwest. Their $\delta^{18}O$ values are significantly lower than the local $\delta^{18}O$ range at Paquimé and in northwest Mexico generally, which suggests they are from an area with a higher elevation than Paquimé and possibly wetter/cooler conditions. Origins in the Sierra Madre

Occidental, perhaps in the highlands of southern Chihuahua or northern Durango, are plausible.

In contrast to these individuals, Burial 5-4 has a $\delta^{18}O$ value of -2.3% and a $^{87}Sr/^{86}Sr$ value of 0.70735 in their lateral incisor (a late-forming tooth was not available for analysis). This oxygen isotope ratio is characteristic of a warmer/drier, lowland coastal environment, possibly along the west coast of Mexico. This individual's strontium isotope values are too high for coastal regions in West Mexico (i.e., Sinaloa and further south), but are consistent with reported geological $^{87}Sr/^{86}Sr$ ratios in Sonora (Damon et al. 1983). None of the three extraregional non-locals discussed above were interred with grave goods, nor did they receive elaborate burial treatment that might indicate high status.

In sum, seven of the extraregional immigrants had isotope values consistent with sites in the American Southwest, one likely migrated from the coast of northwest Mexico, and the other three may have originated in the Sierra Madre region of northwest (or possibly West) Mexico. These findings suggest that migrants to Paquimé came from several different geographic areas, which is consistent with the site's mix of non-local objects and influences from various surrounding regions (e.g., Bradley 1999; Di Peso 1974: vol. 2; Lekson 1999, 2015). Additionally, mobility profiles from most of the extraregional immigrants indicate multiple episodes of migration during life, which accords well with the inference that many of these individuals came to Paquimé from the American Southwest. The 13th to 15th centuries in the Southwest are characterized by widespread movement across the region, with an overall population shift from the Four Corners region to the central and southern regions of Arizona and New Mexico, and into northern Mexico (Cordell and Gumerman 1989; Lekson 2008; Plog 2008). Aggregation into multi-ethnic communities was pervasive during this period; mobility was the norm, not the exception (Arakawa 2012; Bernardini 2005; Clark 2011; Plog 2008). Finally, the data gleaned from the mobility profiles of extraregional immigrants from the Southwest provide support for Bernardini's (2005) suggestion that serial migration was a common form of mobility amongst prehistoric Southwesterners.

3.6 Conclusion

The results of the radiogenic strontium and stable oxygen isotope analyses indicate that approximately 13% of the Medio Period sample from Paquimé was comprised of extraregional non-locals from neighbouring regions. These findings serve as empirical evidence for the presence of immigrants at the site. However, the proportion of extraregional immigrants at Paquimé was not considerably higher than the proportion of extraregional immigrants present at the Viejo Period Convento site (~8%). These findings do not indicate a large influx of foreigners to Paquimé during the Medio Period. Instead, over 86% of the individuals at Paquimé have isotope values that indicate origins within the Casas Grandes region. The presence of at least 18 regional non-locals at Paquimé also provides direct evidence of population aggregation from the surrounding Casas Grandes region, which is consistent with other archaeological lines of evidence and is predicted under local development models (Whalen and Minnis 2001a, 2001b, 2003, 2009).

Although most individuals with non-local isotope signatures migrated to Paquimé from within the Casas Grandes interaction sphere, seven extraregional non-locals have isotope values that are consistent with regions in the American Southwest. These results are congruent with biodistance and aDNA studies that have demonstrated biological affinity to groups in the Southwest (LeBlanc et al. 2008; Morales-Arce et al. 2017; Turner 1993, 1999; Walker 2006). There were also four extraregional non-locals with isotope values that could be consistent with northwest (or West) Mexico, which aligns well with other biodistance studies that have indicated genetic affinity between Paquimeños and populations in Sinaloa (Turner 1993, 1999). Although most scholars have rejected Di Peso's (1974) *Pochteca* hypothesis, the isotope results from this study add to the growing body of evidence that Paquimé was not a trading outpost for Mesoamerican groups, as there is no evidence for direct and sustained contact with regions to the far south. Instead, the data presented thus far support local development models that attribute Medio Period development to largely internal processes, particularly through the absorption of surrounding populations from the Casas Grandes region (e.g., Whalen and Minnis 2003, 2009).

It is important to note that the presence of extraregional non-locals is not incongruent with local development models since they acknowledge that external influences helped to shape the cultural trajectory of Paquimé. While the data from this chapter demonstrate that immigrants were indeed present at the site, further analyses are needed to determine their specific role or place within Paquimé society. As such, the remaining chapters in this thesis will examine the identities of the non-local individuals, particularly in comparison to their locally born counterparts, to better understand who these individuals were and how their presence at Paquimé may have influenced social dynamics within the community.

Chapter 4
The Relationship between Social Status and Geographic Origins at Paquimé

4.1 Introduction

In the previous chapter, radiogenic strontium and stable oxygen isotope analyses were conducted on a large sample of individuals from the Casas Grandes skeletal assemblage to examine the occurrence, scale, and structure of migration at Paquimé. Comparative samples from sites within the Casas Grandes region, as well as from neighbouring regions, were also analyzed to identify possible geographic origins of the migratory individuals. In addition to examining population dynamics at Paquimé, a more specific goal of the analysis was to evaluate various culture development models that have been proposed for the site. More specifically, some researchers have suggested that Medio Period culture change at Paquimé was due to the arrival of foreigners from Mesoamerica (Di Peso 1974), West Mexico (e.g., Foster 1999; JC Kelley 2000), or the American Southwest (Lekson 1999, 2015), while others argue that local developments served as the primary catalyst (Whalen and Minnis 2001a, 2001b, 2003, 2009; JH Kelley et al. 1999, 2012).

Results of the isotope analyses indicate that 13.4% of individuals from the Paquimé sample were extraregional immigrants to the site, while another 22 - 28% were immigrants from the surrounding Casas Grandes region. Furthermore, the proportion of non-local individuals identified at Paquimé was statistically similar to that of the Convento site, which dates to the preceding Viejo Period. This suggests that similar levels of migration occurred during the Viejo and Medio Periods. However, despite having similar proportions of migratory individuals, most of the non-locals from Convento exhibited isotope values very close to the expected local range, indicating short-range migration from within the Casas Grandes region. In contrast, Medio Period population dynamics involved both regional and extraregional migration, which hints at the possibility of external stimuli playing a role in the cultural development of Paquimé.

A key component of the various external stimuli models, such as Lekson's (1999, 2015) Chaco Meridian model, is that Medio Period cultural change resulted from the arrival of foreign *elites.* If such models are correct, we should expect to find evidence of these high status individuals at the site. Previous studies have demonstrated that mortuary variability within the Paquimé skeletal assemblage indicates status differentiation within the population (Ravesloot 1988; Rakita 2001, 2009), thus, the presence of foreign elites should be evident in the form of distinct mortuary treatment among individuals with non-local isotope signatures. More specifically, extraregional non-locals should exhibit more elaborate burial treatment when compared to their local and regional non-local counterparts. As such, the primary goal of this chapter is to examine the identity and status of the individuals who migrated to Paquimé by analyzing various mortuary indicators of social status. This chapter also uses mobility profiles to determine the demographic structure of migratory units and spatial analysis of burial locations to explore social dynamics between immigrants and locals. When combined with the results from the previous chapter, these analyses will provide a more comprehensive data set with which to evaluate competing cultural development models.

4.2 Background

4.2.1 Mortuary Theory

Mortuary data from archaeological contexts can provide valuable insight into prehistoric social phenomena when interpreted within a firm conceptual framework. The validity of this method assumes that mortuary practices are indeed reflective of social identity, as opposed to other factors like religious beliefs or circumstances surrounding death (Carr 1995). The ability to differentiate between the types of social dimensions that may be symbolized through mortuary ritual is equally important. For instance, certain mortuary practices may be reflective of vertical social status while others represent horizontal social roles. Finally, it is essential to understand the archaeological manifestations of such practices, as well as how to classify and analyze these data.

The use of mortuary analysis as a means of examining prehistoric social organization largely stems from early processual studies by Saxe (1970) and Binford (1971), who applied concepts from role theory to link social phenomena to mortuary practices. Role theory defines the various roles that can be assumed by an individual during social interactions. Under this model, *social identity* refers to the rights and duties of the individual as they relate to others in a social interaction (Goodenough 1965). Social identities can manifest simultaneously, and others may not manifest at all in a given social interaction. Furthermore, social identities can simultaneously represent relative horizontal and vertical social status positions in a given social interaction. Vertical social status refers to differences in ranked grading, while horizontal social status refers to differences in social roles occupying the same hierarchical level (Tainter 1978). For instance, an individual may assume the identity of supervisor, friend, and doctor during an interaction with a colleague, which represents two horizontal positions (doctor and friend) and a vertical social position (supervisor). The combination of social identities that an individual assumes is defined as a *social persona* (Goodenough 1965). Social personae are selected by an individual based on the structure of their social system, such that more complex societies allow for a greater number and diversity of social identities than simple societies.

The application of these concepts to mortuary archaeology is based on the assumption that the rights and duties of an individual relative to others (i.e., their *social identities*) are the same in death as they were in life. Saxe (1970) used these principles as the basis for examining whether mortuary rituals reflect social organization, attempts to control resources, and/or maintain links to the ancestors in a series of three ethnographically documented populations. He found that mortuary practices did indeed reflect social organization and that corporate groups with lineal descent maintain formal disposal areas for their dead. Based on these findings, Saxe (1970) noted that it should be possible to differentiate between social systems based on ascribed social ranking and those based on achieved social ranking by examining the social identities available to individuals within that society. For example, in egalitarian societies, infants have relatively few social identities available to them when compared to adults and should therefore receive comparatively simpler mortuary treatment. In contrast, infants in societies with hereditary social ranking are born with more social identities and thus, may receive more elaborate mortuary treatment than some adults with fewer identities (i.e., less social status) within the same social system.

According to Binford (1971), two facets of the social system must be analyzed to infer the type of social phenomena symbolized by mortuary rituals: 1) the deceased's social persona (i.e., the composite of their social identities); and 2) the number and social personae of individuals with status responsibilities to the deceased. The higher the rank of the deceased person, the greater the responsibilities owed to them by others. In his cross-cultural ethnographic survey, Binford (1971) tested the hypothesis that a correlation exists between a society's level of social complexity and the complexity of its mortuary program. In other words, less complex societies, such as hunter gatherers, should have less mortuary differentiation among individuals than more complex societies (e.g., sedentary agriculturalists) because the latter have ranked social systems that allow for status, and thus, mortuary differentiation. In Binford's (1971) study, the level of social complexity was determined by the mode of subsistence, which was acknowledged by the author as less than ideal, but necessary given the nature of the data set.

Binford (1971) posited that age, sex, and personal attributes/achievement would be the primary determinants of social status in less complex societies, while inherited (i.e., ascribed) status distinctions would influence mortuary behaviour in more complex societies. In turn, culturally designated symbols related to different status levels would be used in more complex societies. The results of the survey indicate that the form and structure of mortuary rituals practiced by a society is correlated with the form and complexity of social organization that exists within that society (as measured by subsistence practices). More specifically, he found significant correlations between: 1) the types of social persona recognized by a society and the level of social complexity; 2) the number of dimensions of social persona recognized by a society and the level of social complexity; and 3) the forms of mortuary ritual and dimensions of the social persona that are symbolized.

The Saxe-Binford research program was a significant development in American mortuary archaeology because it created the theoretical link between social phenomena and mortuary practices. Subsequent mortuary studies have built upon these findings by testing, critiquing, and refining the theoretical concepts, as well as developing new approaches for analyzing the archaeological correlates of social status (e.g., Braun 1977; Carr 1995; Kamp 1998; Peebles and Kus 1977; Tainter 1975). Scholars searched for methods that could reliably differentiate between social dimensions, such as horizontal and vertical social roles, using archaeological correlates. The contributions that are most relevant to the present study are discussed below.

Tainter (1975, 1978) proposed the energy expenditure approach, which is based on the premise that the amount of energy (or labour) expended on a mortuary act is proportional to the vertical status position of the deceased. This assumption is based on the following concepts outlined by Binford (1971): first, mortuary rituals typically involve many of the individuals with whom the deceased had social interactions with during life. Thus, death brings forth a greater number of the deceased's social identities than probably any other social occasion during life. Second, the size and composition of the group of individuals who have status obligations and responsibilities to the deceased will influence the form of mortuary ritual. Thus, the higher the social status of the deceased, the more involvement from the social aggregate and the more energy expended on their mortuary treatment (Tainter 1975). Tainter (1975) tested his hypothesis through an ethnographic survey of mortuary data from 103 groups and found that energy expenditure was reflective of vertical social rank in all cases that were examined. He also emphasized that when considered on their own, the quantity and quality of burial goods rarely indicate social status, so it is essential to examine as many mortuary variables as possible when using energy expenditure as a predictor of social status.

Peebles and Kus (1977) expanded upon Tainter's (1975) energy expenditure approach by delineating two distinct dimensions of social rank: the superordinate and the subordinate. The superordinate dimension is based on ascriptive ranking and is not determined by age or sex, while the subordinate dimension is based on achievement and is ordered by age and sex. According to Peebles and Kus (1977), the highest ranked individuals in the subordinate category will rank lower than the lowest ranked individuals in the superordinate dimension in terms of overall mortuary expenditure. The authors also proposed a paramount social position, which is only occupied by the most elite individuals, most of whom are male. These elite individuals would have status-specific mortuary symbols that were not afforded to other social dimensions.

Braun (1977) proposed a similar approach to examine ascriptive social ranking, which is based on the assumption that dimensions of variation in mortuary practices reflect the different dimensions of social status within a given society (*sensu* Binford 1971). In this approach, social dimensions can include any criteria that a society uses to differentiate social positions, but such dimensions will consist of suites of covarying mortuary attributes, as opposed to single variables. These symbols of rank and authority are both costly in terms of energy expenditure (e.g., labour required to construct a burial facility, or the labour used to obtain an exotic artifact) and rare in terms of their overall distribution within a given archaeological context.

The primary focus of the processual studies discussed above was to identify broad cross-cultural patterns in mortuary behaviour (derived from ethnographic data) that could be used as a theoretical framework to infer social organization from archaeological mortuary assemblages. In contrast, post-processual researchers view mortuary practices as highly variable across populations and argue against cross-cultural generalizations (Arnold and Jeske 2014; Hodder 1982; Pader 1982; Parker Pearson 1982). Individual agency, as opposed to social roles, serves as the analytical focus. Furthermore, these scholars emphasize that rank and status are not static at the time of death, but are instead actively contested, transformed, and manipulated by mourners and funeral organizers. Thus, if status is indeed conveyed through mortuary behaviour, it reflects the status of the living participants as much as that of the deceased (Parker Pearson 1999:84). Based on this perspective, grave goods (and mortuary treatment in general) are symbolic of both the deceased’s identity and their relationship to funeral participants (Parker Pearson 1999).

This point highlights another key critique made by post-processualists; that processual approaches tend to focus solely on grave wealth while failing to consider the *meaning* of grave goods and other mortuary attributes. For example, mortuary behaviour and its material correlates can serve as ideological symbols with ritual, as opposed to economic or political, significance (Parker Pearson 1982, 1999). Thus, “high value” grave goods could be classified as such because they are imbued with specific qualities (e.g., supernatural powers), not because they required more energy to produce or procure. Additional reasons for variability in funerary ostentation that are not related to the deceased’s social status include mourning due to untimely death (especially children and young adults), gender or age-related identities, gifts from high status persons (as opposed to possessions of the dead), and cyclical trends in funerary elaboration resulting from political instability (Arnold and Jeske 2014; Hodder 1982; McCafferty and McCafferty 2006; Pader 1982; Parker Pearson 1982, 1999). As such, post-processual researchers tend to dismiss conclusions about social organization that are based on mortuary differentiation since meaning is culturally variable.

In response to the "post-processual critique," various studies have examined the relationship between mortuary behaviour and social organization by re-analyzing cases from the Human Relations Area Files (HRAF) (e.g., Carr 1995; Kamp 1998) or by refining methodology to better differentiate between alternative predictors of mortuary behaviour (e.g., Fisher-Caroll and Mainfort 2000; Porčic and Stefanović 2009; Rakita 2001, 2009). Although previous cross-cultural analyses using the HRAF (e.g., Binford 1971; Goldstein 1976, 1981; Tainter 1975) have found strong evidence that mortuary practices, in general, are reflective of social dimensions, they did not explicitly test for the relative contribution of social determinants versus other causes, such as philosophical and religious beliefs, physical attributes, and circumstances surrounding death. As such, Carr (1995) conducted a survey of the HRAF to determine if factors other than social dimensions influenced mortuary practices. The goal of his study was to test whether the methods most frequently used by archaeologists to infer social organization from mortuary practices were indeed appropriate. He examined 46 mortuary variables and 29 possible causes for the observed mortuary practices among 31 non-state societies. The causes were classified into four main categories: circumstances of death, physical requirements, social position of the deceased, and philosophical-religious beliefs.

Carr (1995) found that the following mortuary practices more frequently reflected social organization than belief systems: internal cemetery organization, overall energy expended on mortuary activities and disposition of the body, number of socially recognized burial types, number of persons per grave, and the quantity of burial accompaniments. Overall energy expenditure was found to be a particularly good indicator of *vertical* social position, thus lending support to the approaches used by Tainter (1975, 1978), Peebles and Kus (1977), and Braun (1977). The suite of energy expensive traits that Tainter (1975) found to be most consistently associated with social ranking were also supported by Carr's (1995) analysis. This suite of traits includes complexity of body treatment, construction and placement of the burial facility, extent and duration of mortuary ritual, material contributions to the ritual, and human sacrifice. Carr (1995) also examined the key issue of whether burial accompaniments are useful indicators of social status, as contradictory evidence had been found by different researchers (e.g., Binford 1971; Stickel 1968; Tainter 1975; Whittlesey 1978). Carr's (1995) analysis suggests that while the *number* of burial accompaniments within a grave was reflective of vertical social position in some societies (~18%), it was more often associated with other variables, such as age, and was therefore not a useful indicator of vertical social position. In contrast, the *kinds* of burial accompaniments were the third most common mortuary practice determined by vertical social position, which indicates that this variable has utility in mortuary studies. The analysis also revealed that the social position of the deceased was a common determinant of burial location within a cemetery (Goldstein 1976; Saxe 1970), though location was also frequently related to philosophical-religious beliefs. Meanwhile, mortuary practices that were found to be more reflective of philosophical-religious beliefs included body position, body orientation, and the spatial arrangement of burial accompaniments.

According to Carr (1995), the most important finding of this study was that most mortuary variables are determined by a complex mix of factors, primarily related to social position and philosophical-religious beliefs and to a much lesser extent, circumstances of death and physical constraints. Although many of the variables were determined by a variety of causes, several strong indicators of vertical social status were identified. Carr (1995) concludes that the following variables are useful for reconstructing social organization in past populations: overall energy expenditure, Tainter's (1975) five manifestations of energy expenditure, and the types of burial accompaniments placed with the deceased.

Kamp (1998) also conducted a cross-cultural analysis of 55 groups from the HRAF to investigate whether mortuary expenditure was a valid proxy for social status and if so, what degree of variability was necessary to infer social differentiation within a society. Seven social and situational variables, as well as the relative degree of mortuary expenditure for each variable were recorded. The variables included social status (social differences due to wealth, power, or leadership roles), age, sex, religious affiliation, whether the deceased was a religious practitioner, cause of death, and idiosyncratic reasons (catchall category). Only mortuary behaviour that would be observable to the archaeologist was scored. For instance, funerary practices that do not leave a physical trace, such as song or dance, were not considered. The relative degree of mortuary expenditure was rated on a five-point scale from "no cost difference" (0) to "major differences in expenditure with at least three levels" (5) (Kamp 1998:83).

The results of the analysis revealed that burial practices reflect at least some aspects of social identity in most societies. Kamp (1998) found that status differentiation was the most frequently symbolized dimension of mortuary behaviour among the societies that were analyzed, as 67% of groups express social status in burials. Importantly, all groups that conveyed status through mortuary treatment did so through some degree of increased mortuary expenditure (Kamp 1998:90). The relationship between mortuary practices and hierarchy was, however, nuanced in that mortuary expenditure was not as pronounced as expected in some hierarchical groups and was sometimes more pronounced than expected in non-hierarchical groups. Based on this finding, Kamp (1998) argues that minor to moderate differences in mortuary expenditure within a population are not likely to be reliable indicators of status hierarchies in archaeological populations. Instead, only more substantial differences in mortuary expenditure (i.e., two or more levels of differentiation) between burials in the same population represent differences in social status.

Kamp (1998) posited that the observed variability in mortuary expenditure may be related to social competition since funerals represent one possible venue where status can be displayed and manipulated by the living, which could result in the portrayal of some aspects of the deceased's identity and the masking of others. To examine this possibility, the author looked for an association between mortuary expenditure and cultural acceptance of competition within a society (as determined by ethnographic data on 'potential for increased power/wealth'). She found that societies that limit competition for wealth and power exhibit either minimal or no differences in mortuary expenditure. In short, these groups do not have ostentatious burials. Thus, Kamp (1998) concludes that variability in mortuary expenditure is often the product of intra-societal competition as opposed to social organization.

The problem that arises from these disparate interpretations is how to differentiate between the two. As Rakita (2001) aptly notes, the two scenarios are not mutually exclusive; it is certainly plausible that "rich" burials within a mortuary assemblage can be the result of both status negotiations amongst the living and those belonging to high status individuals. Depending on one's research question(s), however, it may be necessary to differentiate between these two scenarios. Rakita (2001) has suggested that such distinctions can be made by analyzing histograms of both the quantity and diversity of grave goods, which should produce different patterns for each scenario. More specifically, populations with distinct and undisputed social roles should exhibit skewed, discontinuous distributions of grave good measures, whereby outliers represent high status individuals who exhibit more elaborate mortuary treatment than the rest of the population. In contrast, status negotiations by the living would manifest as a more continuous (but still skewed) distribution resulting from the progressive matching and surpassing of competitor's funerary displays. According to Rakita (2001), competitors would outdo each other, but only slightly in order to minimize costs, thus resulting in a continuous distribution of grave good counts and diversity scores with few or no breaks.

The critical evaluation and subsequent reassessment of several foundational tenets of processual mortuary archaeology has led to more robust approaches for examining status and social organization in the past. There has been an overall shift toward using multi-faceted approaches to infer social phenomena in the past, which often include both mortuary and skeletal data (e.g., Cheung et al. 2017; Harrod 2012; Marcoux 2010; Pechenkina and Delgado 2006; Porčic and Stefanović 2009; Rakita 2001, 2009; Robb et al. 2001; Sullivan 2003; Woo and Sciulli 2011). Some of these studies have also employed novel methodological approaches involving both types of data. For instance, Pechenkina and Delgado (2006) examined the relationship between social structure, health, and ethnicity at the prehistoric site of Villa El Salvador, Peru by using heterogeneity in health, as opposed to mortuary attributes, as the starting point for inferring social differentiation. The advantage of this approach was to minimize the inherent subjectivity associated with delineating social groupings based on mortuary attributes whose intended meaning is unknown. Finally, although processual and post-processual approaches are often at odds with one another, archaeological mortuary studies can benefit from a more moderate and synergistic combination of the two approaches (Arnold and Jeske 2014).

4.2.2 Mortuary Evidence of Social Differentiation at Paquimé

There are several overarching themes in the mortuary studies that were presented in this chapter and in Chapter 2 that have important implications for the present study. First, energy expenditure has consistently proven to be a reliable indicator of social organization and the best indicator of vertical social status (Carr 1995; Kamp 1998; Peebles and Kus

1977; Tainter 1975, 1978). Furthermore, Carr (1995) has validated Tainter's (1975) five key determinants of energy expenditure, which include: 1) complexity of body treatment; 2) construction and placement of burial facilities; 3) extent and duration of mortuary ritual; 4) material contributions to ritual; and 5) human sacrifice. In addition to overall energy expenditure, Carr (1995) found that the *types* (but not quantities) of mortuary accompaniments were reflective of vertical social status. The types of artifacts most likely to be associated with high status individuals are those that are both energy expensive (labour dedicated to material acquisition or to production) and rare in terms of their overall distribution at the site (Braun 1977). Numerous mortuary studies have also demonstrated that grave location within a site is commonly associated with vertical social status (Binford 1971; Carr 1995; Goldstein 1976; Peebles and Kus 1977; Tainter 1978). However, there are several caveats to the energy expenditure approach that have come to light in the more recent post-processual environment; first, differentiating between energy expenditure reflecting the social status of the deceased or status negotiations amongst the living; second, the consideration of alternate meanings for funerary ostentation; and third, the relative degree of differentiation in mortuary expenditure necessary to infer social status (Kamp 1998; Parker Pearson 1982, 1999; Hodder 1982).

Although the mortuary analyses conducted by Ravesloot (1988) and Rakita (2001, 2009) varied in their approach, the results of both studies align well with expectations set forth by mortuary theory. In Ravesloot's (1988) study, most mortuary variables that comprised the covarying suite of symbols of rank and authority involve more energy expenditure than alternative states of the same variable. For example, subfloor burial tombs and burial vaults require more energy to construct than a simple pit. Similarly, multiple interments are more expensive than single interments and secondary burials require an additional mortuary act when compared to primary burials. The other variables (ceramic handdrums, frogged leg position, and rare artifacts) have limited distribution in mortuary contexts and would therefore be considered rare at the site. Furthermore, these traits represent three of the five key archaeological indicators of energy expenditure outlined by Tainter (1975): complexity of body treatment, construction and placement of burial facilities, and material contributions to ritual.

Rakita's (2001, 2009) analysis demonstrated that the remaining two indicators (extent and duration of mortuary ritual and human sacrifice) were both present in key ritual loci at the site, which in turn were associated with emerging elites. Rakita (2001, 2009) also found that artifact counts and richness significantly increased from the Viejo to Medio Period, which he interpreted as representing increasing status negotiations. While artifact counts have not proven to be a robust indicator of vertical status distinctions (Carr 1995; Tainter 1975, 1978), artifact richness (i.e., the different types of artifacts present in a burial) has been shown to reflect vertical social positions (Carr 1995). Finally, Ravesloot (1988) and Rakita (2001, 2009) both found that specific locations at the site were associated with high status individuals. Ravesloot's (1988) results suggest that high status individuals were associated with Units 4, 13, 14, and 16, while Rakita (2001, 2009) demonstrated that ongoing ritual activity, which was controlled by emerging elites, occurred primarily in the same four units, as well as within Unit 15. Apart from a few indicators (e.g., artifact count), the archaeological correlates of social status at Paquimé align well with those predicted by processual mortuary theory. As such, many of the variables identified by Ravesloot (1988) and Rakita (2009) will be utilized in the present study to examine the relationship between geographic origins and social status at Paquimé.

In terms of the post-processual caveats discussed above, Kamp (1998) found that energy expenditure approaches were only reflective of social status when there were major differences in mortuary expenditure within a burial assemblage. Ravesloot's (1988) multivariate principle components analysis identified at least three primary dimensions of mortuary variability, whereby only three percent of the Paquimé burials fell into each of the top two dimensions identified. Even without using multivariate statistical approaches, it is readily apparent that mortuary expenditure was highly variable at Paquimé; some individuals received extremely ostentatious burials (e.g., thousands of items, dozens of different artifact classes, elaborate burial facilities, etc.), others were interred with a handful of grave goods or with one or two rare or significant objects, and the majority were not interred with gave goods or in any seemingly special manner (Di Peso et al. 1974: vol. 8; Rakita 2001, 2009). Additionally, the symbols of rank and authority identified through Ravesloot's (1988) multivariate approach cross-cut sex and age-at-death categories, so it is unlikely that they reflect demographic facets of identity or mourning due to untimely death. And perhaps most importantly, many of the symbols of rank and authority have socio-religious or ritual significance (e.g., hand drums, socio-religious accompaniments, burial position), which aligns well with Rakita's (2001, 2009) finding that elite social status at Paquimé was likely derived from or associated with religious authority. Thus, Ravesloot's (1988) mortuary indicators seem to be capable of identifying important status positions at Paquimé, whether they represent political, economic, or religious authority, or (likely) some combination of the three. As Rakita (2001, 2009) concluded, aspiring leaders at Paquimé likely utilized ritual as a source of social power and as a means for encouraging community cohesion and conflict resolution.

4.3 Materials and Methods

4.3.1 Materials

The sample used for this analysis consists of 82 individuals from Paquimé and 13 individuals from the Convento site. Although the temporal focus of this research is on the Medio Period at Paquimé, a small sample of individuals from the Convento site is included to examine diachronic patterns in mortuary practices. The sampling strategy for Paquimé involved several selection criteria. First, the proportion of individuals sampled from each architectural unit was determined by the overall proportion of burials per unit at the site as a whole. For example, if 10% of burials were excavated from a particular unit, 10% of the study sample came from that unit as well. Second, similar proportions of males and females were selected and individuals from all age categories were included, though the majority were adults. Third, individuals from several of the high status (i.e., most elaborate) burials that were repeatedly characterized as such by multiple researchers, including Di Peso et al. (1974: vol. 8), Ravesloot (1988) and Rakita (2001, 2009), were intentionally included in the study sample. It was important to sample the most elaborate burials at the site to evaluate whether locals or immigrants occupied these elite social positions. Finally, both interred and non-interred individuals (i.e., Type 2 burials) were included in the study sample to satisfy specific objectives of the larger research project to which this study belongs. This criterion was somewhat limiting in terms of conducting mortuary analyses since burial data (e.g., presence or absence of grave goods, burial position, etc.) could not be determined for most of the Type 2 burials. As such, these individuals were omitted from certain analyses, as discussed below.

The sampling strategy for the Convento site differed from the protocol employed at Paquimé in several ways. First, burial location considerations by architectural unit were unnecessary because all Convento burials were placed in communal plaza areas. Second, given that the presence or absence of burial accompaniments was the primary source of variation among Viejo Period burials, an effort was made to include individuals that were interred with and without grave goods. Three of the thirteen individuals (23%) sampled had burial accompaniments, which was similar to the overall proportion of Convento individuals with grave goods (33%). Unfortunately, poor preservation limited the number of individuals for which sex and age-at-death estimates could be confidently assigned, therefore, meaningful demographic patterns were difficult to discern with a sample size of thirteen.

4.3.2 Methods

4.3.2.1 Demographic Data

Sex estimation of adult individuals was based on morphological characteristics of the pelvis and cranium, as outlined in Buikstra and Ubelaker (1994). Age-at-death estimates for the Paquimé sample are primarily derived from Waller (2017), but data from Di Peso et al. (1974: vol. 8) and personal observations of the skeletal material were also considered. Waller's (2017) estimates were calculated using transition analysis, a Bayesian approach that elicits more precise age-at-death estimates, particularly for older individuals, by minimizing the effects of reference sample mimicry (Boldsen et al. 2002; Milner and Boldsen 2012). These data were preferentially derived from morphological characteristics of the pubic symphysis and auricular surface when available and secondarily, from cranial suture closure, morphological characteristics of the first rib (DiGangi et al. 2009), and degree of sacral closure (Ríos et al. 2008) when os coxae were not available for analysis or when preservation was poor. The transition analysis program statistically weights the data based on reliability of each indicator and generates a maximum likelihood estimate of age-at-death, along with a 95% confidence interval. Meanwhile, juvenile age-at-death estimates were based on dental development and epiphyseal fusion (Buikstra and Ubelaker 1994). Age-at-death estimates for the Convento sample are derived from Di Peso et al. (1974: vol. 8). In this chapter, the age-at-death estimates produced by the aforementioned methods were used to assign individuals to the following categories: child (3-12 yrs), adolescent (12-20 yrs), young adult (20-35 yrs), middle adult (35-50 yrs), and old adult (50+ yrs). 'Adult' and 'indeterminate' classifications were used when more precise estimates could not be made due to poor preservation.

It is important to emphasize that the age-at-death estimates presented here represent *biological age*, which is derived from the physical ageing of the body (Gowland 2006). It is acknowledged that socially-constructed age categories in Paquiméan society likely differed from the biological age categories presented here, however, the estimation of *social age* was beyond the scope of this study. Additionally, sex estimates represent anatomical sex as opposed to gender, which is an aspect of socially constructed identity (Walker and Cook 1998).

4.3.2.2 Isotope Analyses

Radiogenic strontium and stable oxygen isotope analyses were conducted on all individuals in the study sample (Chapter 3). Strontium isotope results were then compared to the local $^{87}Sr/^{86}Sr$ range at Paquimé, which was constructed using isotope data from archaeological faunal specimens. Individuals with strontium isotope ratios that fell within the local range were classified as local and those outside of it were considered to be non-local (Price et al. 2002). Additional human and faunal samples from several sites in the Casas Grandes region, the American Southwest, and central Mexico were also analyzed to establish; 1) the regional $^{87}Sr/^{86}Sr$ range within the Casas Grandes area; and 2) comparative $^{87}Sr/^{86}Sr$ values for surrounding regions. The expected oxygen isotope range at the site (and region) was estimated from published $\delta^{18}O$ values derived from rainfall, groundwater, and surface waters in the region (IAEA 2017; Somerville et al. 2010; Wassenaar et al. 2009). Statistical methods (interquartile range or IQR) were also used to identify outliers (Lightfoot and O'Connell 2016). Finally, non-local individuals were classified as regional immigrants if their isotope values were consistent with other Casas Grandes sites and extraregional immigrants if their isotope values fell outside the regional isotope range.

4.3.2.3 Mobility Profiles

Isotope analysis was conducted on two teeth per individual to establish mobility profiles for each member of the study sample. Sampling multiple tissues per individual has also been referred to as a life history approach to paleomobility because it elicits a record of mobility for each individual, whereby the timing of migration during an individual's life can be assessed (e.g., Marsteller et al. 2017; Sealy et al. 1995). In the previous chapter, mobility profiles were primarily used to differentiate between short- and long-distance migration (i.e., the form or structure of migration). In this chapter, these data are used to explore migration at multiple scales of analysis.

At the population level, mobility profiles can provide information on the demographic structure of migration in terms of *who* was moving (i.e., adults, children, both). In contrast, the age-at-death distribution of a sample (based on individual age-at-death estimates) does not indicate *when* people migrated to Paquimé, it simply tells us when they died. For example, if a middle-aged adult was determined to be an immigrant based on a non-local signature in their early-forming tooth only, it does not mean that a middle-aged adult migrated to Paquimé. Instead, all we know is that the individual *died* as a middle-aged adult but may have migrated to the site as a child or as an adult. Such distinctions are possible, however, when a multi-tooth sampling strategy is employed.

Determining the demographic structure of migration can also aid in reconstructing the motivations or causes of migration. For instance, a predominance of individuals who migrated to the site post-adolescence may indicate migration due to exogamy (i.e., post-marital residence), especially if there was a bias toward one sex over the other (Bentley et al. 2005, 2007; Cox et al. 2011; Stojanowski and Schillaci 2006). Conversely, if the study sample consists of some individuals who came to the site during childhood and others who came as adults, the migratory units were likely social or kin groups migrating for reasons other than exogamy (e.g., Anthony 1990; Cameron 1995).

Mobility profiles are also useful for examining migration at the level of the individual because the timing of migration during an individual's life can have potential implications for understanding identity (social, ethnic, etc.) and reconstructing life histories (Marsteller et al. 2017). For example, an individual who migrated to Paquimé as a child and lived there for multiple decades before dying as an old adult would have more time to become integrated into the community than an individual who moved to Paquimé as a young adult and died shortly thereafter. Although both individuals in this example would be classified as non-locals based on the isotopic signature in their early-forming teeth, their life history at Paquimé and their identity as immigrants may have been very different. In this regard, mobility profiles also provide a more nuanced way to examine mortuary variability at the level of the individual. For instance, an individual's status as an immigrant or the age at which they migrated may have influenced how they were treated in death by their kin and community.

4.3.2.4 Mortuary Analysis

The broad goal of examining mortuary variability between locals and non-locals is to examine the identity and social status of non-local individuals within the Paquimé community. Did immigrants occupy high or low status positions within the Paquimé social hierarchy? Did they adopt Paquiméan mortuary practices or maintain their own ethnic identity? Were they (spatially) integrated within the local community? The more specific goal of this analysis is to evaluate opposing cultural development models, which largely hinge on whether the Paquimé elites were locals or immigrants. More specifically, an integral component of several external development models, such as the Chaco Meridian scenario proposed by Lekson (1999, 2015), is that foreign *elites* migrated to Paquimé during the Medio Period and sparked a cultural revolution. Mortuary analysis is an ideal method for examining this topic because cross-cultural studies have demonstrated that mortuary treatment is reflective of an individual's social identity and status within their community, as perceived by their peers (e.g., Binford 1971; Braun 1977, 1981; Carr 1995; Saxe 1970; Tainter 1978).

Various mortuary studies have demonstrated that ranked social positions (ascribed and achieved) can be identified through both qualitative and quantitative differences in mortuary treatment (Binford 1971; Carr 1995; Tainter 1978). Furthermore, qualitative attributes (e.g., type and location of burial facility) are often used to convey rank and authority, whereas quantitative attributes, such as the total number of burial goods interred with an individual, are more often associated with access to wealth and prestige (Binford 1971; Braun 1981; Saxe 1970). This study considers both qualitative and quantitative attributes because hypotheses about the cultural trajectory of Paquimé have invoked status differentiation (i.e., the presence of foreign elites), as well as access to and control of prestige goods. This study also includes mortuary attributes that are typically more reflective of philosophical-religious beliefs than of social status (e.g., body position and orientation) since they could indicate community integration as it relates to the adoption of local belief systems by immigrants.

The raw mortuary data used in this analysis are derived from Di Peso et al. (1974: vol. 8), while supplemental information for burial accompaniments (e.g., raw material, form) comes from Di Peso et al. (1974: vols. 6-7). All mortuary attributes reported by Di Peso and colleagues (1974) were included in this study and are listed in Table 4.1. These attributes fall into three main categories of mortuary treatment: treatment of the body, characteristics of the burial facility, and burial accompaniments. Frequencies were calculated by geographic origin category (i.e., local, regional non-local, extraregional non-local) as the number of individuals exhibiting a given attribute divided by the total number of observable individuals for that attribute. When calculating mortuary variable frequencies, non-interred individuals (Type 2 burials) were excluded from the following categories because the variable state was unknown: Form of Disposal, Body Position, Deposition, Body Orientation, Number of Individuals, and all Burial Accompaniment tabulations. Exceptions include non-interred individuals whose burial attributes were discernable because they were found articulated in room fill or on floor surfaces. Two-tailed Fisher's Exact tests ($\alpha = 0.05$) were used to determine if there were statistically significant relationships between mortuary variables and geographic origin. The Fisher's Exact test is ideal for small sample sizes (< 1000) and is recommended over alternative statistical tests of independence (e.g., chi-square) when expected values in any cell of a contingency table are less than five (McDonald 2014), which is the case in the present study.

Table 4.1. List of mortuary attributes and variable states used in this study.

Mortuary Attributes	Variable States
I. Body Treatment	
Interment Type	Interred, Non-interred
Form of Disposal	Primary, Secondary
Degree of Articulation	Articulated, Disarticulated
Position	Extended, Flexed, Semi-flexed
Deposition	Supine, Sitting, Side (left), Side (right)
Orientation (head)	North (315-44°), East (45-134°), South (135-224°), West (225-314°)
II. Burial Facility	
Form	Sealed Pit, Unsealed Pit, Tomb[a], On Floor Surface[a], In Room Fill, On Abandoned Structures, Stone Filled Shaft[b]
Location	Room, Plaza, Ballcourt[a]
Number of Individuals	Single Interment, Multiple Interment
III. Burial Accompaniments	
Total	Presence, Absence
Category	Polychrome Pottery, Non-Polychrome Pottery, Ceramic Handdrums, Utilitarian Accompaniments, Jewelry (local material), Jewelry (non-local material), Socio-Religious Accompaniments, Rare Accompaniments, Vegetal Accompaniments, Effigy Vessels, Ramos Black Vessels

[a] Paquimé burials only
[b] Convento burials only

Burial accompaniments were assessed by their presence/absence within a grave, as well as by the artifact category to which they belong. Grave goods were classified into categories, which stem from Ravesloot's (1988) categorization scheme. The establishment of these categories was firmly rooted in mortuary theory (e.g., Braun 1977, 1979; Peebles 1974; Peebles and Kus 1977; Tainter 1975) and designed to identify symbols of rank and authority within the Paquimé mortuary assemblage. The nine categories include: Polychrome Pottery, Non-Polychrome Pottery, Ceramic Handdrums, Jewelry made from Non-Local Material, Jewelry made from Local Material, Utilitarian Accompaniments, Socioreligious Accompaniments, Rare Accompaniments, and Vegetal Accompaniments. Under this scheme, Polychrome Ceramics and Jewelry made from Non-Local Material required more energy expenditure in terms of labour or procurement costs than Non-Polychrome Ceramics and Jewelry made from Local Material, respectively. Rare Accompaniments and Ceramic Handdrums were both rare at the site and likely associated with ritual/religious activities, as were items classified as Socioreligious Accompaniments. Utilitarian Accompaniments were common artifacts found in architectural contexts throughout the site, while Vegetal Accompaniments consisted of any type of plant/food remains.

In this study, two additional types of artifacts, Effigy Vessels and Ramos Black Vessels, were also recorded. Ravesloot's (1988) rationale for dividing ceramics into polychrome and non-polychrome categories was that the former required more energy expenditure than the latter. The same argument can be made for effigy vessels, which Ravesloot (1988) did not differentiate from other ceramics. Not only are effigy vessels labour intensive to make, they are also rare in mortuary contexts at Paquimé (N=11) and may therefore serve as status indicators (Carr 1995). The presence of Ramos Black Vessels is also noted in this study because the results of Rakita's (2001, 2009) mortuary analysis indicate that this type of vessel may be associated with the political/ancestor cult at Paquimé. Rakita (2001, 2009) posited that the focus of this cult was on power negotiations and maintaining elite authority, thus the presence of Ramos Black ceramics in mortuary contexts could symbolize sociopolitical rank and/or religious authority.

The primary reason for examining mortuary accompaniments by category is to determine if there is variability in the *types* of artifacts included in local versus non-local burials. Previous studies have used the variety (or diversity) of burial accompaniments as a proxy for the number of social roles that an individual held in life (Fisher-Carroll and Mainfort 2000; Howell and Kintigh 1996; Rakita 2001, 2009). Given that high status individuals generally possess a greater number of social roles than ordinary members of the community (Binford 1971; Peebles and Kus 1977; Saxe 1970), the expectation is that these individuals should also have the greatest variety of burial accompaniments (Fisher-Carroll and Mainfort 2000). In mortuary analyses, the relationship between status and grave good variety has been examined through diversity scores, which are calculated as the number of different types of artifacts included in a burial (Fisher-Carroll and Mainfort 2000; Howell and Kintigh 1996; Rakita 2001, 2009).

In the present study, artifact diversity is measured by calculating a *richness* score, which is defined as the number of different artifact classes included in a burial (Rakita 2001). Artifact classes vary by the type, composition, and form of an artifact. For example, if a burial included 25 flat disk stone beads (24 ricolite, 1 turquoise), two hammerstones (1 dacite, 1 tuff), and 20 pieces of stone debitage (10 obsidian, 5 felsite, 5 basalt), the richness score would be 9. The 24 ricolite beads, 10 obsidian debitage pieces, 5 felsite debitage pieces, and 5 basalt debitage pieces are counted as 4 (not 44) because only four artifact classes are represented (ricolite beads, obsidian debitage, felsite debitage, and basalt debitage). The two hammerstones are each counted individually because they are composed of different materials (dacite, tuff). If the hammerstones had both been composed of dacite, the count would have been one instead of two. The richness measure is useful for mitigating the effects of redundancy in raw artifact counts, particularly for composite artifacts (Rakita 2001), such as the stone beads in the example above, which were likely components of a single piece of jewelry.

While the richness measure reduces redundancies in raw artifact count data, it can also create redundancies by artifact category, which has potential implications for interpreting the symbolic meaning of artifact classes. In the example above, the raw artifact count is 49, the richness score is 9, but only 2 artifact categories are represented: Jewelry of Non-Local Material and Utilitarian Accompaniments. If the utilitarian objects in this burial convey the same meaning, perhaps that this individual was a lapidary, then all of the stone utilitarian artifacts (and possibly even the exotic stone beads) would symbolize only one social role, not many, as a richness score of 9 might suggest. To minimize this confounding factor, richness values are contextualized by an additional measure, which I refer to here as *categorical diversity*. Categorical diversity is simply a count of how many different categories are represented by the mortuary artifacts within a single burial.

It should also be emphasized that richness and categorical diversity measures may reflect both vertical and horizontal (e.g., clan membership, occupation), social positions as well as access to wealth and prestige (Carr 1995; Ravesloot 1988). As such, a third diversity measure, based on the results of Ravesloot's (1988) mortuary analysis, is used in this study.

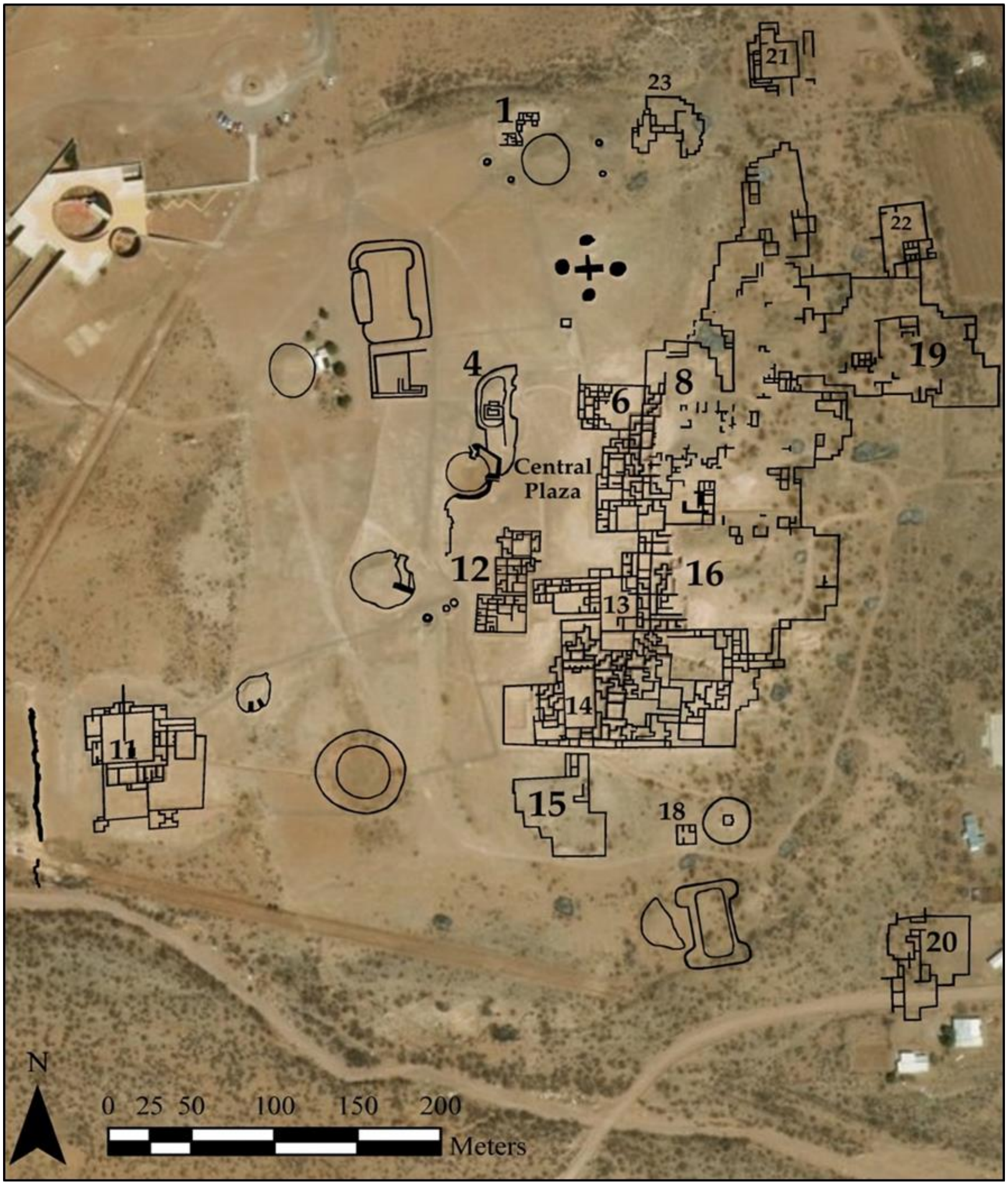
Ravesloot (1988) identified a suite of burial attributes that together represent symbols of rank and authority within a social hierarchy based on ascribed (inherited) status. This suite of traits includes the following mortuary attributes: Burial Vault, Multiple Burial, Room Subfloor Tomb, Legs Frogged position, Secondary Burial, Polychrome Ceramics, Ceramic Handdrums (associated with grave facility), and Rare Accompaniments. Importantly, these variables represent all facets of mortuary treatment, including Body Treatment, Burial Facility, and Burial Accompaniments, and are associated with either more energy expenditure when compared to alternate variable states or are rare in the Paquimé mortuary program. Many of these variables also have ritual significance and may therefore be tied to religious authority (Di Peso et al. 1974: vol. 8; Rakita 2001, 2009).

Additionally, Ravesloot (1988) demonstrated that these symbols crosscut demographic categories, which supports the conclusion that they are symbols of ascribed, as opposed to achieved, status. In the present study, individuals were scored for the presence/absence of each of the symbols of rank and authority, hereafter referred to as SRA. The *SRA Diversity* score is the sum of these scores. Although there are eight SRA, the maximum SRA Diversity score is seven because two of the variables, Burial Vault and Room Subfloor Tomb, are mutually exclusive. The Convento sample was not assessed for SRA Diversity, as Ravesloot's (1988) results stem from his analysis of the Paquimé burials and are therefore not applicable to other mortuary assemblages.

The final component of the mortuary analysis is to examine variability in burial location across the site. Mortuary studies have demonstrated that ranked societies based on inherited status tend to maintain formal and exclusive burial areas, which can result in the spatial segregation of high and low status burials (Saxe 1970; Goldstein 1981). Both Ravesloot (1988) and Rakita (2001, 2009) found evidence for restricted access to certain architectural locations at Paquimé, particularly in Units 4, 13, 14, and 16. As such, this study will examine the spatial distribution of local and non-local individuals by architectural unit to determine if exclusive access was afforded to either group. The analysis of spatial patterning can also contribute to our understanding of community integration at Paquimé. According to Clark (2011:87), one of the most interesting facets of migration from an anthropological perspective is to examine its impacts in terms of how immigrants and locals are "getting along". Thus, spatial patterning of burials by geographic origin can provide information on access to important locations at the site, as well as social dynamics between locals and non-locals (Batiuk 2013). For instance, a predominance of non-local burials in one residential location could indicate spatial segregation, such as the formation of immigrant enclaves, which has been documented in other prehistoric cultures by means of isotopic analyses (e.g., Price et al. 2000; CD White et al. 2004).

Paquimé is an ideal setting to study this phenomenon because individuals were interred beneath room and plaza floors within adobe room blocks, which were likely occupied by social/kin groups (Di Peso 1974: vols. 2, 5; Wilcox 1999). The individuals analyzed in this study are derived from 13 residential units and the Central Plaza (Figure 4.1). The four units that were not sampled for the present study (Units 18, 22, 23, and the East Plaza) yielded only a few burials, which were mostly derived from test trenches. As such, individuals from these units were not prioritized for analysis because they did not constitute meaningful mortuary samples. The sampling strategy for the remainder of the units, as discussed above, should elicit a representative burial sample of the mortuary program at Paquimé.

Figure 4.1. Modern aerial map of Paquimé with architectural units superimposed. Map drawn by Adam K. Benfer (Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USCS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community).



4.3.3 Limitations

Prior to discussing the results of this analysis, it is important to highlight one of the more significant methodological and interpretive challenges in this study; that isotopic methods can only identify first generation immigrants. Thus, descendants of immigrants who were born at Paquimé will exhibit local isotope signatures. Ravesloot (1988) has demonstrated ascriptive-based social organization at Paquimé, therefore immigrant children would have inherited status from their parents, which could result in the following scenario: An elite (first generation) immigrant to Paquimé would have a non-local isotope signature and display high status mortuary treatment. In turn, their descendants would inherit their elite status and should therefore also be given elaborate mortuary treatment, yet would exhibit a local isotope signature. In this scenario, second generation immigrants (and subsequent generations) would appear to be *local* elites. Clearly, this can impact the interpretation of whether there are foreign elites at the site, which a key facet of this study.

I have attempted to mitigate this methodological constraint in various aspects of the sampling strategy. First, a total of 95 individuals from Paquimé and Convento were analyzed for this study. This is a fairly large sample size for isotopic studies, which are both costly and labour intensive. Second, the number of individuals sampled from each architectural unit was proportional to the total number of individuals excavated from each unit, therefore the sample analyzed for this study is representative of the (excavated) burial population. Finally, many of the most elaborate burials recovered from the site were intentionally sampled to determine the geographic origins of the highest ranking individuals at Paquimé. This aspect of the sampling strategy was guided by the findings of previous studies that examined the Casas Grandes skeletal assemblage (Casserino 2009; Di Peso 1974: vol. 8; Rakita 2001, 2009; Ravesloot 1988).

4.4 Results

4.4.1 Stable Isotope Analysis

The main objective of this chapter is to determine if there is variability in the mortuary treatment of local versus non-local individuals. More specifically, the goal is to determine if *extraregional* non-locals exhibit mortuary treatment that indicates high status. This section summarizes the results of the isotopic analyses in terms of individuals' classification as locals or non-locals, with an emphasis on extraregional non-locals. Detailed results of the radiogenic strontium and stable oxygen isotope analyses can be found in Chapter 3 of this thesis (Table 3.3). A summary is provided below.

Of the 82 individuals analyzed from Paquimé, 29 had $^{87}Sr/^{86}Sr$ and/or $\delta^{18}O$ values that fell outside the established local isotope range at the site (Table 4.2). Eighteen of these individuals had isotope values that were consistent with other sites in the Casas Grandes region and were therefore classified as regional non-locals (RNL). The remaining eleven individuals had $^{87}Sr/^{86}Sr$ and/or $\delta^{18}O$ values that were not consistent with Paquimé or other Casas Grandes sites, and were therefore classified as extraregional non-locals (ERNL). An additional five individuals were classified as local/regional non-local (L/RNL) because their isotope values were ambiguous in that they could be consistent with Paquimé or other parts of the Casas Grandes region. Although this designation is not ideal for examining mortuary variability between locals and non-locals, the distinction between locals and *regional* non-locals is far less important than the distinction between individuals who were born within the Casas Grandes region (i.e., locals and regional non-locals) and those who migrated to the site from neighbouring regions (i.e., extraregional non-locals).

Table 4.2. Paquimé and Convento individuals with non-local isotope values.

Burial ID	Sex	Age	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_C$ (VPDB, ‰)	Timing of Migration
Paquimé							
Extraregional Non-locals							
1A-1	F	MA	LI^2	I/EC	0.70890	-4.9	Post-I/EC
19A-1	I	AD	LI^2	I/EC	0.70748	-8.1	CH
			LM^2	MC	0.70711	-5.3	
5-4	F?	YA	LI_2	I/EC	0.70735	-2.3	Post-I/EC
6-6	M	YA	LI^1	I/EC	0.70839	-6.4	Post-AD
			LM^3	AD	0.70750	-6.9	
17-6	M?	YA	RI_2	I/EC	0.70715	-7.6	CH
			RM_3	AD	0.70732	-4.2	
34-6	F	OA	RI^2	I/EC	0.70953	-4.9	Post-AD
			RM_3	AD	0.70799	-6.4	
22-11	M	YA	RC^1	MC	0.70811	-6.3	CH

Burial ID	Sex	Age	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_C$ (VPDB, ‰)	Timing of Migration
			RM^3	AD	0.70728	-4.4	
45-11	F?	YA	LI_2	I/EC	0.70603	-4.6	CH
			RM_3	AD	0.70690	-6.2	
20-13	F?	YA	RI_1	I/EC	0.70993	-4.5	Post-AD
			LM^3	AD	0.70923	-6.0	
2-14	M	YA	LI_2	I/EC	0.70836	-5.6	Post-AD
			RM_3	AD	0.70832	-5.0	
26-14	M	MA	LM_3	AD	0.71020	-6.1	Post-AD
<u>Regional Non-locals</u>							
8A-1	F	YA	RI^2	I/EC	0.70779	-4.9	Post-AD
			LM^3	AD	0.70766	-5.6	
12-1	M	YA	LC^1	MC	0.70771	-5.3	Post-AD
			RM_3	AD	0.70787	-5.8	
14-1	I	AD	LI_2	I/EC	0.70756	-3.3	CH
			LM^3	AD	0.70756	-5.2	
27A-1	M	OA	LI^2	I/EC	0.70748	-6.2	CH
			LM^3	AD	0.70729	-4.4	
35-11	F?	YA	RC^1	MC	0.70799	-5.5	Post-AD
			RM_3	AD	0.70775	-6.1	
19-12	F	OA	LM_3	AD	0.70675	-5.6	Post-AD
26-12	M	MA	LI_2	I/EC	0.70759	-4.2	CH
			RM^3	AD	0.70736	-4.5	
28-12	I	I	RI^1	I/EC	0.70645	-5.5	Post-AD
			RM_3	AD	0.70628	-5.1	
37-12	M	YA	RI_2	I/EC	0.70667	-5.2	Post-I/EC
4-13	M	MA	RI^1	I/EC	0.70672	-4.4	Post-AD
			LM_3	AD	0.70675	-5.5	
38-13	M	OA	RI^1	I/EC	0.70764	-4.8	Post-I/EC
44J-L2-13	I	AD	RI^2	I/EC	0.70665	-6.4	CH
44I-13	I	AD	LI_1	I/EC	0.70669	-	CH
			LM_3	AD	0.70673	-5.7	
6-14	F	OA	RP_3	MC	0.70625	-5.6	Post-AD
			LM^3	AD	0.70626	-6.1	
9-16	F	YA	RI_2	I/EC	0.70778	-	Post-AD
			RM_3	AD	0.70781	-6.6	
2-20	M	MA	RC^1	MC	0.70638	-5.4	Post-AD
			LM_3	AD	0.70633	-5.5	

Burial ID	Sex	Age	Tooth	Tooth Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_C$ (VPDB, ‰)	Timing of Migration
1-21	M?	YA	LC^1	MC	0.70651	-5.1	Post-AD
			RM^3	AD	0.70650	-6.1	
19-CP	I	I	LI_2	I/EC	0.70750	-6.3	Post-AD
			RM^3	AD	0.70753	-6.0	
Local/Regional Non-locals							
1-4	M?	YA	RP^3	MC	0.70735	-3.0	
			LM^3	AD	0.70754	-	
10A-6	F	YA	LC^1	MC	0.70726	-6.1	
44J-L1-13	I	AD	RI^1	I/EC	0.70713	-5.9	
7-14	F	YA	RI_1	I/EC	0.70719	-6.0	
			RM^3	AD	0.70712	-6.3	
25-16	M?	YA	RI_1	I/EC	0.70737	-6.0	
			RM^3	AD	0.70726	-6.1	
Convento							
Extraregional Non-local							
CO-38	F	YA	RM^3	AD	0.70741	-7.1	Post-AD
Regional Non-locals							
CO-1	F	A	RP^4	MC	0.70762	-4.1	Post-CH
CO-16	F?	A	LI^2	I/EC	0.70768	-3.1	Post-I/EC
CO-18	F	YA	RC_1	MC	0.70653	-4.7	Post-CH
CO-21	I	A	RM_3	AD	0.70785	-5.3	Post-AD
CO-53	?	AD	RM^3	AD	0.70766	-4.5	Post-AD

[a] F=Female; F?=Probable Female; M=Male; M?=Probable Male; I=Indeterminate

[b] CH=Child (3-12); AD=Adolescent (12-20); YA=Young Adult (20-35); MA=Middle Adult (35-50); OA=Old Adult (50+); A=Adult (20+); I=Indeterminate

[c] I/EC=Infancy/Early Childhood; MC=Middle Childhood; AD=Adolescence

[d] ERNL=Extraregional Non-local; RNL=Regional Non-local; L/RNL=Local/Regional Non-Local

[e] Post-AD=Post-adolescence; CH=Childhood; Post-I/EC=Post-Infancy/Early Childhood

Five of the thirteen individuals analyzed from the Convento site had $^{87}Sr/^{86}Sr$ values that were outside the local range, but consistent with $^{87}Sr/^{86}Sr$ values observed elsewhere in the Casas Grandes region (Table 4.2). These individuals were classified as regional non-locals (RNL). One individual was classified as an extraregional non-local (ERNL) because the $\delta^{18}O$ value of -7.1‰ in their early-forming tooth was much lower than expected for the region (IAEA 2017; Wassenaar et al. 2009).

4.4.2 Demographic and Mobility Profiles

The proportion of males and females in the Paquimé and Convento samples is shown in Table 4.3. Individuals of indeterminate sex are excluded from all statistical comparisons presented below. In addition, individuals classified as probable male (M?) and probable female (F?) are combined into the male and female categories, respectively, to increase sample sizes for statistical analyses. At Paquimé, sex could be determined for 23 of the 29 non-locals (RNL and ERNL) and of these individuals, 13 were male and 10 were female. A two-tailed Fisher's Exact test revealed that this difference was not statistically significant (p=0.556). When separated into non-local subcategories, the ERNL group was evenly split between the sexes, while 61.5% (N=8) of RNLs were male and 38.5% (N=5) were female (p=0.434). Meanwhile, among individuals classified as L/RNL, two were male, two were female, and sex could not be determined for the other. At the Convento site, 71.4% (N=5) of local individuals were male, whereas the three non-local individuals for which sex could be determined were female. The remaining individual, classified as L/RNL, was also female. The higher proportion of female immigrants was not statistically significant (Fisher's Exact, p=0.167), likely due to the small sample size.

Table 4.3. Sample composition showing the geographic origin and sex of individuals from Paquimé and Convento.

Geographic Origin	M	M?	**Total Male**	F	F?	**Total Female**	I
Paquimé							
Local	10	3	**13**	17	4	**21**	14
Regional Non-Local	7	1	**8**	4	1	**5**	5
Extraregional Non-Local	4	1	**5**	2	3	**5**	1
Local/Regional Non-Local	0	2	**2**	2	0	**2**	1
Convento							
Local	4	1	**5**	1	1	**2**	0
Regional Non-Local	0	0	**0**	2	1	**3**	1
Extraregional Non-Local	0	0	**0**	0	0	**0**	1
Local/Regional Non-Local	0	0	**0**	1	0	**1**	0

M=Male; M?=Probable Male; F=Female; F?=Probable Female; I=Indeterminate

Age-at-death data are presented in Table 4.4. Some individuals could not be classified into specific age-at-death categories due to poor preservation and were therefore classified as Adults or Indeterminate, depending on the skeletal elements available for analysis. Individuals with indeterminate age were excluded from statistical analyses. At Paquimé, the majority of both locals and non-locals (RNL and ERNL) were young adults.[11] While there was slight variation in age-at-death composition among the different geographic origin categories, none of these differences were statistically significant (Fisher's Exact, p=0.643). Nearly all non-local individuals were adults, whereas 64.4% of the local individuals were adults and 35.6% were non-adults (i.e., children or adolescents). Six of the thirteen individuals analyzed from Convento were assigned to the Adult category because of poor preservation, leaving only seven to be assigned to more specific categories. Due to the resulting small sample sizes, comparisons of age-at-death variability by geographic origin category were not statistically meaningful.

Table 4.4. Age-at-death distribution by geographic origin for Paquimé and Convento.

Geographic Origin	CH	AD	**Total Non-Adult**	YA	MA	OA	A	**Total Adult**	I
Paquimé									
Local	6	10	**16**	20	7	2	0	**29**	3
Regional Non-Local	0	3	**3**	6	3	4	0	**13**	2
Extraregional Non-Local	0	1	**1**	7	2	1	0	**10**	0
Local/Regional Non-Local	0	1	**1**	4	0	0	0	**4**	0
Convento									
Local	0	0	**0**	2	2	0	3	**7**	0
Regional Non-Local	0	1	**1**	1	0	0	2	**3**	0
Extraregional Non-Local	0	0	**0**	1	0	0	0	**1**	0
Local/Regional Non-Local	0	0	**0**	0	0	0	1	**1**	0

CH=Child (3-12 years); AD=Adolescent (12-20 years); YA=Young Adult (20-35 years); MA=Middle Adult (35-50 years); OA=Old Adult (50+ years); A=Adult (20+ years); I=Indeterminate

[11] The age-at-death distribution of the sample used in this study may be somewhat biased toward younger individuals since older adults are more likely to have antemortem tooth loss and/or extensive tooth wear and may therefore have been excluded from sampling due to their absence of teeth or insufficient amount of tooth enamel.

Age-at-death alone is not ideal for examining the structure of migratory units because it only indicates when an individual died, not when they migrated to Paquimé. Mobility profiles, on the other hand, reveal the timing of migration within an individual's life, which is useful for examining both individual identity and the structure of broader migration processes. Mobility profiles were created for all non-local individuals (RNL and ERNL) and are presented in Table 4.2 as the 'Timing of Migration'[12].

Of the eleven individuals classified as ERNL, five migrated to Paquimé as adults (3 males, 2 females), four migrated during childhood (2 males, 1 female, 1 indeterminate sex), and the remaining two individuals (Burials 1A-1 and 5-4), both of whom were female, migrated sometime after infancy/early childhood (Table 4.2). Precise timing of migration could not be determined for the latter two individuals because only one tooth was available for analysis. The majority (N=10) of individuals classified as RNL migrated to Paquimé post-adolescence (4 males, 5 females, 1 indeterminate), six migrated as children or young adolescents (2 males, 4 indeterminate), and two migrated sometime after birth. When the two subcategories of non-locals (ERNL and RNL) are combined, 60.0% (N=15) of non-local individuals migrated to Paquimé as adults (7 males, 7 females, 1 indeterminate) and 40.0% (N=10) moved to the site as children or young adolescents (4 males, 1 female, 5 indeterminate). Graphic representations of Paquimé mobility profiles can be found in Chapter 3 (Figures 3.6 and 3.9). Mobility profiles for Convento site individuals are listed in Table 4.2, however, the designations are not particularly useful because all non-local individuals had only one tooth available for analysis.

4.4.3 Mortuary Analysis

4.4.3.1 Mortuary Treatment

Mortuary variable frequencies for the Paquimé individuals analyzed in this study are presented in Table 4.5. Raw mortuary data can be found in Appendix A. There were six variables related to Body Treatment, including interment type, form of disposal, degree of articulation, position, deposition, and orientation. There were no statistically significant

[12] Mobility profiles were not estimated for individuals classified as L/RNL given the ambiguity of their geographic origin.

differences by geographic origin for any of these variables. The majority of individuals from all groups were interred, primary, articulated burials that were placed in a flexed position. There was only one secondary burial, which was a local individual. There was some variability in body deposition among groups: most locals were deposited on their backs in the supine position (37.5%) or on their left side (29.1%). The remaining local individuals were found in a seated position (16.7%) or on their right side (16.7%). Regional non-locals were predominantly found in a seated position (41.7%), followed by the supine position (33.3%). Extraregional non-locals were most often placed on their left sides (62.5%) but were also deposited on their backs (25.0%) and right side (12.5%). In terms of burial orientation, most individuals from all groups were interred with their heads to the west.

Table 4.5. Frequencies of mortuary variables by geographic origin at Paquimé.

Mortuary Variable	Local	Regional Non-local	Extraregional Non-local	Local/Regional Non-Local[a]	p-val
I. Body Treatment					
Interment Type					
Interred	60.4% (29)	77.8% (14)	54.5% (6)	60.0% (3)	0.302
Non-Interred	39.6% (19)	22.2% (4)	45.5% (5)	40.0% (2)	
Form of Disposal					
Primary Burial	96.6% (28)	100.0% (12)	100.0% (7)	100.0% (2)	1.000
Secondary Burial	3.4% (1)	0.0% (0)	0.0% (0)	0.0% (0)	
Degree of Articulation					
Articulated	64.6% (31)	66.7% (12)	72.7% (8)	40.0% (2)	0.940
Disarticulated	35.4% (17)	33.3% (6)	27.3% (3)	60.0% (3)	
Position					
Extended	7.7% (2)	25.0% (3)	12.5% (1)	0.0% (0)	0.333
Flexed	84.6% (22)	75.0% (9)	62.5% (5)	100.0% (2)	
Semi-flexed	7.7% (2)	0.0% (0)	25.0% (2)	0.0% (0)	
Deposition					
Supine	37.5% (9)	33.3% (4)	25.0% (2)	0.0% (0)	0.179
Sitting	16.7% (4)	41.7% (5)	0.0% (0)	50.0% (1)	
Side (left)	29.1% (7)	8.3% (1)	62.5% (5)	50.0% (1)	
Side (right)	16.7% (4)	16.7% (2)	12.5% (1)	0.0% (0)	
Orientation					
North	20.8% (5)	18.2% (2)	33.3% (2)	0.0% (0)	0.305
East	25.0% (6)	18.2% (2)	16.7% (1)	0.0% (0)	
South	4.2% (1)	36.3% (4)	16.7% (1)	0.0% (0)	
West	50.0% (12)	27.3% (3)	33.3% (2)	100.0% (2)	
II. Burial Facility					
Form					
Sealed Pit	45.8% (22)	44.4% (8)	36.3% (4)	20.0% (1)	0.789
Unsealed Pit	2.1% (1)	11.1% (2)	9.1% (1)	20.0% (1)	
Tomb	6.2% (3)	11.1% (2)	0.0% (0)	20.0% (1)	

Mortuary Variable	Local	Regional Non-local	Extraregional Non-local	Local/Regional Non-Local[a]	p-val
On Floor Surface	27.1% (13)	16.7% (3)	27.3% (3)	40.0% (2)	
In Fill	14.6% (7)	11.1% (2)	18.2% (2)	0.0% (0)	
Abandoned Structures	4.2% (2)	5.6% (1)	9.1% (1)	0.0% (0)	
Location					
Room	66.7% (32)	77.8% (14)	54.5% (6)	80.0% (4)	
Plaza	33.3% (16)	16.7% (3)	36.4% (4)	0.0% (0)	0.152
Ballcourt	0.0% (0)	5.5% (1)	9.1% (1)	20.0% (1)	
Number of Individuals					
Single	43.7% (21)	66.7% (12)	45.5% (5)	40.0% (2)	0.279
Multiple	56.3% (27)	33.3% (6)	54.5% (6)	60.0% (3)	
III. Burial Accompaniments					
Present	29.2% (14)	38.9% (7)	9.1% (1)	20.0% (1)	0.237
Absent	70.8% (34)	61.1% (11)	90.0% (10)	80.0% (4)	

[a] L/RNL not included in statistical comparisons

The three categories related to Burial Facility included form, location, and number of individuals. There were no statistically significant differences among groups for any of these variables. Most individuals from all groups were placed in sealed pits and were also interred beneath room floors. The third variable state for the burial location category is interment beneath a private ceremonial ballcourt in Unit 14. The seven individuals interred beneath this ball court were classified as human sacrifices (Di Peso (1974: vol. 8) and will be discussed in further detail in Chapter 5 of this thesis. Three of these burials were included in the study sample; one was classified as a RNL, one was an ERNL, and the other was a L/RNL. Three local individuals and two regional non-locals were interred within a tomb, while no extraregional non-locals were afforded this rare mortuary treatment[13]. There was some variation in the number of individuals placed within a grave; the majority of local and extraregional burials were multiple interments (56.3% and 54.5%, respectively), while regional non-locals were more frequently single interments (66.7%). This difference was not statistically significant (p=0.279). The final category of mortuary treatment was the presence or absence of grave goods. Although the variation between groups was not statistically significant (0.237), a higher proportion of locals (29.2%) and regional non-locals (38.9%) were interred with one or more mortuary accompaniments

[13] It should be noted, however, that the two RNLs are suspected human sacrifices (Di Peso et al. 1974: vol. 8; Kohn 2011), therefore it is unlikely that the placement of these individuals in the elaborate 44-13 burial tomb means that they had elevated social status.

than were extraregional non-locals (9.1%).

Mortuary variable frequencies by geographic origin for the Convento skeletal assemblage are presented in Table 4.6. It is important to note that although Fisher's Exact tests were conducted on all mortuary variable categories, the small sample size (N=13) was not conducive for statistical analysis. Of the thirteen individuals, seven were local, five were classified as RNL, and one was classified as ERNL. Thus, many of the contingency table calculations involved a cell count of one. No statistically significant differences in mortuary treatment between groups were found. Despite the statistical limitations, these data are useful for examining individual-level variation in mortuary treatment between locals and non-locals. As with the skeletal assemblage from Paquimé, the majority of burials among all groups were primary, articulated interments. In contrast to Paquimé, there were no Type 2 (non-interred) burials at the Convento site. Most local individuals (60.0%) were placed in flexed position, with the remaining local individuals interred in each of the other two burial positions (extended and semi-flexed). The four RNLs were evenly split between the flexed and semi-flexed burial positions, while the one ERNL was flexed. Four local individuals were placed on their right sides and one was placed on their back in the supine position. Most RNLs were interred on their sides (40% each) and one was placed in the supine position (20.0%). The ERNL was placed in a seated position, the only burial in the Convento sample to exhibit that variable state. The only two orientations represented in this sample were south and east; all non-local (ERNL and RNL) individuals had their heads placed to the east, while 40.0% of local individuals also exhibited this burial orientation. The remaining 60.0% of local individuals were placed with their heads to the south.

Table 4.6. Frequencies of mortuary variables by geographic origin at Convento.

Mortuary Variable	Local	Regional Non-Local	Extraregional Non-Local	p-val
I. Body Treatment				
Interment Type				
Interred	100.0% (7)	100.0% (5)	100.0% (1)	1.000
Non-Interred	0.0% (0)	0.0% (0)	0.0% (0)	
Form of Disposal				
Primary Burial	85.7% (6)	100.0% (5)	100.0% (1)	1.000
Secondary Burial	14.3% (1)	0.0% (0)	0.0% (0)	
Degree of Articulation				
Articulated	71.4% (5)	80.0% (4)	100.0% (1)	1.000
Disarticulated	28.6% (2)	20.0% (1)	0.0% (0)	
Position				
Extended	20.0% (1)	0.0% (0)	0.0% (0)	1.000
Flexed	60.0% (3)	50.0% (2)	100.0% (1)	
Semi-flexed	20.0% (1)	50.0% (2)	0.0% (0)	
Deposition				
Supine	20.0% (1)	20.0% (1)	0.0% (0)	0.192
Sitting	0.0% (0)	0.0% (0)	100.0% (1)	
Side (left)	0.0% (0)	40.0% (2)	0.0% (0)	
Side (right)	80.0% (4)	40.0% (2)	0.0% (0)	
Orientation				
North	0.0% (0)	0.0% (0)	0.0% (0)	0.250
East	40.0% (2)	100.0% (4)	100.0% (1)	
South	60.0% (3)	0.0% (0)	0.0% (0)	
West	0.0% (0)	0.0% (0)	0.0% (0)	
II. Burial Facility				
Form				
Sealed Pit	0.0% (0)	20.0% (1)	0.0% (0)	1.000
Unsealed Pit	42.9% (3)	40.0% (2)	100.0% (1)	
On Abandoned Structures	28.6% (2)	20.0% (1)	0.0% (0)	
Stone Filled Shaft	28.6% (2)	20.0% (1)	0.0% (0)	
Location				
Room	0.0% (0)	0.0% (0)	0.0% (0)	1.000
Plaza	100.0% (7)	100.0% (5)	100.0% (1)	
Number of Individuals				
Single	100.0% (7)	100.0% (5)	100.0% (1)	1.000
Multiple	0.0% (0)	0.0% (0)	0.0% (0)	
III. Burial Accompaniments				
Present	42.9% (3)	0.0% (0)	0.0% (0)	0.388
Absent	57.1% (4)	100.0% (5)	100.0% (1)	

Mortuary variables related to the Burial Facility were also consistent across groups. All individuals, regardless of geographic origin, were single interments that were placed in public plaza areas. The four burial forms observed in the Convento sample were sealed pit, unsealed pit, placement on abandoned structures, or in stone filled shafts. Three of the local individuals were placed in unsealed pits, two on abandoned structures, and two in stone filled shafts. All four burial forms were represented by the four RNLs, while the ERNL was placed in an unsealed pit. Finally, three of the seven local burials contained grave goods, while none of the non-local burials (RNL or ERNL) had burial accompaniments.

4.4.3.2 Burial Accompaniments

Raw artifact counts, richness, and categorical diversity scores were tabulated for all individuals in the Paquimé study sample who were interred with at least one burial accompaniment (Table 4.7). Burials are listed in order of their categorical diversity scores from highest to lowest. A breakdown of grave goods by artifact category is also provided in Table 4.7; an "X" indicates that an individual was interred with one or more artifacts belonging to a given category. The presence of Ramos Black ceramic vessels and Effigy vessels was also recorded for reasons discussed in the previous section. A total of twenty-three individuals were interred with burial accompaniments; fourteen local individuals, seven regional non-locals, one extraregional non-local, and one individual classified as local/regional non-local. Fourteen of the individuals with burial accompaniments were male, seven were female, and two were of indeterminate sex. The sample included five old adults, five middle adults, ten young adults, two adolescents, and one child.

Table 4.7. Burial accompaniment data for Paquimé. Only individuals with burial goods are included. The presence of artifacts from each category is indicated by an X. Bold, italicized burial IDs indicate multiple burials where grave goods were associated with more than one individual.

				Artifact Categories[a]											
Burial[b,c]	**Geographic Origin**	**Sex**	**Age-at-Death**	**VG**	**UT**	**NP**	**JL**	**JN**	**PC**	**HD**	**SR**	**RA**	**Count**	**Richness**	**Categorical Diversity**
44A-13[b,c]	L	M	OA	X	X	X	X	X	X	X	X	X	35	26	9
27A-1[b]	RNL	M	OA		X	X	X	X	X		X		37	25	6
55-13	L	M	YA	X	X		X	X	X		X		49	18	6
2-16[b,c]	L	M	YA	X		X	X	X	X			X	199	11	6
44F-13	L	F	MA		X	X	X	X	X	X			100	15	6
25-16	L/RNL	M?	YA	X			X	X	X		X		39	18	5
38-13	RNL	M	OA		X			X		X	X		52	7	4
54-11	L	M	MA	X	X							X	4	4	3
34-14	L	F	YA	X	X			X					3	3	3
34-6	ERNL	F	OA		X			X					30	10	2
43C-8[b,c]	L	I	CH			X			X				3	3	2
37-13	L	M	AD		X					X			2	2	2
76-13	L	F	MA			X			X				2	2	2
26-12	RNL	M	MA		X			X					3	3	2
19-12[c]	RNL	F	OA	X					X				3	3	2
12-1	RNL	M	YA					X	X				2	2	2
1-21	RNL	M?	YA	X					X				2	2	2
25-6	L	M	MA						X				2	1	1
22-8	L	I	CH								X		2	1	1
35-6	L	F	YA					X					1	1	1
36-12	L	M	YA						X				1	1	1
3-CP	L	M	YA					X					1	1	1
8A-1	RNL	F	YA									X	1	1	1

[a] Abbreviations: VG=Vegetal Items; UT=Utilitarian Accompaniments; NP=Non-Polychrome Pottery; JL= Jewelry of Local Material; JN=Jewelry of Non-Local Material; PC=Polychrome Pottery; HD=Ceramic Handdrums; SR=Socio-Religious Accompaniments; RA=Rare Accompaniments

[b] Individual interred with Ramos Black vessel

[c] Individual interred with Effigy vessel

Raw artifact count ranged from 1 to 199. Most individuals (N=15) were interred with four items or less, though eight individuals had more than thirty artifacts each. Four of these individuals were locals, two were regional non-locals, one was a local/regional non-local, and one was an extraregional non-local. The highest grave good count (N=199) was primarily due to the presence of composite jewelry, as this individual (Burial 2-16) was interred with 192 stone and shell beads/pendants. Richness scores, which measure artifact diversity, ranged from 1 to 26 and largely mirrored raw artifact counts, though on a smaller magnitude; seven individuals had scores of 10 or higher, while the remaining sixteen individuals had scores of 4 or lower (Table 4.7). Of these seven individuals, four were locals, one was a regional non-local, one was a local/regional non-local, and one was an extraregional non-local. These individuals also had raw artifact counts of 30 or more, though redundancy produced by count data was (predictably) reduced in several of the richness scores. For example, the individuals with the two highest raw artifact counts (199 and 100) had the fourth and fifth highest richness scores (15 and 11), respectively. While these individuals are highly ranked for each measure, the inflated counts produced by burial goods made of composite materials is attenuated in the richness score.

The complimentary diversity measure employed in this study was categorical diversity, which had a maximum score of 9. The individuals at Paquimé exhibited the full range of categorical diversity (1 to 9), with most individuals (N=17) having a score of 4 or lower and six individuals having a score of 5 or higher (Table 4.7). Of the six highest ranking individuals, four were locals, one was a regional non-local, and one was a local/regional non-local. Only one individual, 44A-13, had the maximum score 9. Burial 44A-13 also scored the highest for artifact richness. The six individuals with categorical diversity scores of 5+ were the only burials associated with jewelry made from local materials. Given that they were also associated with jewelry of *non-local* origin, these individuals were the only burials in this study sample with composite jewelry made of both local and non-local materials. Ramos Black ceramic vessels and effigy vessels were found with four individuals each and co-occurred in three of these burials (44A-13, 2-16, 43C-8). The fourth Ramos Black vessel was interred with 27A-1, while the remaining effigy vessel was found with burial 19-12. The individuals with both vessels (44A-13, 2-16, and 43C-8) were locals, while Burial 27A-1 was a regional non-local and Burial 19-12 was a local/regional non-local.

Burial 34-6, an old adult female, was the only extraregional non-local that was interred with grave goods (N=30). These items consisted of utilitarian accompaniments (an obsidian knife, a chert knife, an obsidian chipped preform, an unidentified stone ornament blank, a Playas Red sherd disk, a piece of felsite raw material, 13 pieces of debitage consisting of chert, obsidian, and felsite) and jewelry made of non-local material (11 *Nassarius* shell beads). She had a richness score of 10, which was the seventh highest in the sample, but a categorical diversity score of only 2 and was therefore not highly ranked in this measure. The main reason for the disparity in scores is because most of her burial goods were utilitarian objects (made from various types of stone), the counts of which were slightly elevated due to the 13 pieces of debitage, as well as the presence of 11 shell beads. All other individuals with high artifact counts and/or diversity scores were locals, regional non-locals, or local/regional non-locals.

When grave good counts and diversity measures are examined by sex and age-at-death, the richest burials are predominantly adult males. Of the seven individuals with categorical diversity scores greater than 4, six are male and only one is female. There is also a possible male bias for two of the artifact categories, Socioreligious Accompaniments and Ceramic Handdrums. Of the six individuals interred with artifacts classified as socioreligious, five were male and one was a child. It should be noted, however, that the child was from a multiple burial that included two adult males and another juvenile, so it is possible that these objects were placed in the grave for the adult males and not the child. The three individuals found in association with ceramic handdrums, which likely served ritual purposes (Di Peso 1974: vol. 6; Rakita 2001, 2009), were also all male. Age-at-death distribution among the richest burials appears to be somewhat less biased, with young adults and old adults having high scores in each of these measures.

At the Convento site, three of the thirteen individuals were interred with burial accompaniments; a single shell bead was found with Burial 5 (young adult female), a pyrite stone plaque (mirror back) with Burial 50 (adult male), and a bone awl with Burial 54 (young adult male(?)). All three individuals had local isotope signatures. Burial 50 was also the only secondary burial at the Convento site (Di Peso et al. 1974: vol. 8).

4.4.3.3 Symbols of Rank and Authority

All individuals included in the Paquimé study sample (N=82) were evaluated for the eight symbols of rank and authority identified by Ravesloot (1988). The SRA Diversity score was calculated as the total number of symbols of rank and authority present in a single burial[14]. Although there are eight SRA, the maximum score is seven because two attributes are mutually exclusive (Burial Vault and Burial Tomb). It is important to emphasize that the symbols of rank and authority were identified as a *suite* of traits via multivariate statistical analysis (Ravesloot 1988), therefore, the presence of only one SRA is unlikely to represent elevated social status. In fact, the results of the SRA analysis indicate that eleven of the thirteen Paquimé burials with an SRA diversity score of 1 were scored as such because they were multiple interments. While multiple burial is one of the eight SRA, this attribute is less meaningful on its own, especially given that approximately half of all burials analyzed in this study were multiple interments (Table 4.5). As such, only burials with SRA diversity scores of 2 or higher (N=15) are listed in Table 4.8.

[14] SRA Diversity scores are based on the mortuary data presented in Appendix A.

Table 4.8. Symbols of Rank and Authority (SRA Diversity scores) among the Paquimé burials. The presence of an SRA is indicated by an X. Bold, italicized burial IDs indicate multiple burials where grave goods were associated with more than one individual.

				Symbols of Rank & Authority[a]								
Burial	**Geo. Origin**	**Sex**	**Age**	**SB**	**MB**	**FP**	**BV**	**BT**	**HD**	**RA**	**PC**	**SRA Diversity**
44A-13[b,c]	L	M	OA		X			X	X	X	X	5
44F-13	L	F	MA		X			X	X		X	4
2-16[b,c]	L	M	YA		X			X		X	X	4
37-13	L	M	AD	X	X				X			3
8A-1	RNL	F	YA		X					X		2
27A-1[b]	RNL	M	OA		X						X	2
25-6	L	M	MA		X						X	2
43C-8[b,c]	L	I	CH		X						X	2
54-11	L	M	MA		X					X		2
19-12[c]	RNL	F	OA		X						X	2
36-12	L	M	YA		X						X	2
38-13	RNL	M	OA		X				X			2
55-13	L	M	YA		X						X	2
76-13	L	F	MA		X						X	2
25-16	L/RNL	M	YA		X						X	2

[a] Abbreviations: SB=Secondary Burial; MB=Multiple Burial; FP=Frogged (leg) Position; BV=Burial Vault; BT=Burial Tomb; HD=Ceramic Handdrums; RA=Rare Accompaniments; PC=Polychrome Ceramics

[b] Individual interred with Ramos Black vessel

[c] Individual interred with Effigy vessel

The proportion of individuals by geographic origin exhibiting two or more SRA is as follows: 66.7% (N=10) local, 26.7% (N=4) regional non-local, and 6.6% (N=1) local/regional non-local. The majority (73%) had an SRA diversity score of 2, while the remaining four had scores of 3 or higher. The individuals with the four highest scores were local, while the regional non-locals and the individual classified as L/RNL had scores of 2. Importantly, none of the extraregional non-locals had a score of 2 or higher. The four individuals with the highest ranking SRA diversity scores consisted of an old adult male (44A-13), a young adult male (2-16), an older adolescent male (37-13), and a middle adult female (44F-13). Although there was a bias toward males (75%), four different age-at-death categories were represented among the high ranking individuals, which lends support to this measure being indicative of vertical social status (Saxe 1970). Additionally, this was the only instance of a non-adult being one of the highest ranked individuals within a diversity measurement category. Of the eleven individuals with an SRA score of 2, seven were male, three were female, and one was a child of indeterminate sex. The breakdown by age-at-death was evenly split among adult age categories, with four young adults, three middle adults, and three old adults.

In terms of the distribution of SRA among the study sample, all individuals with scores of two or higher were multiple interments (N=15) and the majority were interred with polychrome pottery (N=11). Rare accompaniments were found with only four burials (three locals, one regional non-local), while ceramic handdrums and interment within a burial tomb were associated with three individuals each. Only local individuals were interred in burial tombs (see footnote 13, p. 139) and ceramic handdrums were found with three locals and one regional non-local. Only one locally-born individual was afforded a secondary burial. None of the individuals analyzed for this study were interred with their legs in the frogged position, however, Burials 44A-13 and 44F-13 were found in the same burial tomb as two individuals who exhibited the frogged leg position. Similarly, none of the individuals examined in this study were interred within a burial vault. Only one burial vault was discovered at Paquimé. This vault was located in Unit 4 (The Mound of the Offerings) and contained three individuals (Burials 2,3,4-4), whose disarticulated post-cranial skeletons were placed in oversized Ramos Polychrome vessels (urns). Various researchers have suggested that the characteristics of this unique burial context indicates that these interments represent the highest ranking individuals at the site (Di Peso 1974; Rakita 2001, 2009; Ravesloot 1988). Regrettably, these burials consisted of only post-cranial remains, so no teeth were available for isotopic analyses.

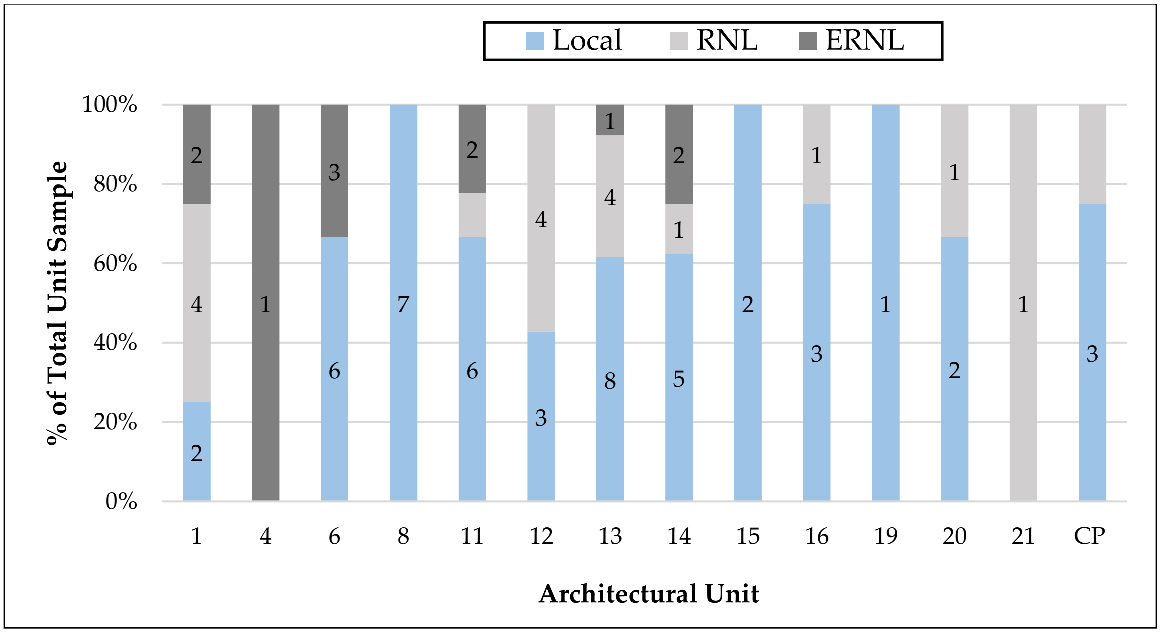
4.4.3.4 Spatial Distribution of Burials by Geographic Origin

Spatial distribution of the Paquimé burials by geographic origin is presented in Figure 4.2[15]. Of the 14 architectural units represented by the study sample, the majority contain a mix of both local and non-local individuals. Although Units 4, 15, 19, and 21

[15] Individuals classified as L/RNL (N=5) were not included in Figure 4.2 due to the ambiguity of their geographic origin. One L/RNL was found in each of the following five Units: 4, 6, 13, 14, and 16.

contain either locals or non-locals only, the sample sizes from these units are too small (N=≤2) to identify meaningful spatial patterning by geographic origin. If these units are excluded, Unit 8 (The House of the Well) is the only area occupied exclusively by one group, as all seven of the individuals analyzed were local. The samples from Units 6, 11, 13, 16, and the Central Plaza are also predominantly local, while the majority of individuals sampled from Unit 1 are of non-local geographic origin. When assessed by geographic origin sub-category, all the non-local individuals in Unit 6 are extra-regional immigrants.

Figure 4.2. Distribution of local and non-local (RNL & ERNL) individuals by architectural unit (Individuals classified as L/RNL not included). Note that Units 4, 15, 19, and 21 have samples sizes of ≤ 2, therefore meaningful spatial patterning by geographic origin cannot be determined.



4.5 Discussion

4.5.1 Demographic Structure of Migration

Mobility profiles were assessed in conjunction with sex and age-at-death data to better understand the demographic identity of the non-local individuals identified via isotopic analyses. The results indicate that individuals migrated to Paquimé post-adolescence (60%) and during childhood/early adolescence (40%) and that these immigrants consisted of both males (N=13) and females (N=10). This demographic pattern suggests that migration likely occurred within social- or kin-based units, particularly because there are children among the migratory individuals (Grupe et al. 1997). This was especially true for extraregional immigrants who came from west/northwest Mexico, as all three individuals from this area came to the site as children (Chapter 3). Thus, these immigrants not only lacked elaborate mortuary treatment indicating elite social status, they also do not fit the demographic profile expected of Aztatlán traders (i.e., adults) (JC Kelley 2000).

Meanwhile, five of the individuals with isotope signatures characteristic of the American Southwest migrated post-adolescence (3 males, 2 females) and one did so as a child (male). An isotopic study of individuals from Grasshopper Pueblo revealed a similar pattern of adult male and female immigrants, which the authors suggest was due to movement within social, kin-based groups (Ezzo and Price 2002). While the presence of both adult male and female non-locals lends support to a kin-based migration structure, it is not overtly reflective of migration resulting from exogamy. Namely, postmarital residence practices typically result in sex-specific migration, leading to a predominance of one sex over the other (Stojanowski and Schillaci 2006), which does not appear to be the case for these Southwestern immigrants.

In contrast to the observed demographic patterns at Paquimé, all immigrants at the Convento site (for which sex could be determined) were female (N=3). Conversely, five of the seven local individuals were male. The three females were classified as regional non-locals, meaning they likely migrated to Convento from within the surrounding Casas Grandes region. This sex-specific pattern of female mobility hints at the possibility of patrilocal postmarital residence patterns during the Viejo Period, however, the sample size is far too small to draw firm conclusions.

4.5.2 Evidence of Foreign Elites?

A foundational aspect of mortuary theory is the higher the rank of the deceased, the greater the number of social roles held during life (Binford 1971; Peebles and Kus 1977). This also means that these individuals will have greater responsibilities owed to them by others. These relationships should manifest themselves in mortuary treatment, such that high ranking individuals exhibit mortuary attributes that indicate a greater number of social roles than lower ranking individuals. Thus, if elite Southwesterners or Aztatlán/ Mesoamerican traders migrated to Paquimé and sparked a cultural revolution, these individuals would have been owed substantial social obligations by other Paquimeños. In the mortuary record, we should see evidence of these social obligations in the form of high diversity scores or mortuary treatment that reflects increased energy expenditure among extraregional non-locals. Based on the evidence presented in this study, this is not the case.

Social status was assessed in several ways, including comparisons of mortuary variables by group, and individual-level analyses of raw artifact counts and diversity scores (richness, categorical diversity, SRA). First, ten burial attributes were analyzed to examine mortuary variability by geographic origins. Many of these burial attributes were included because they represent mortuary treatment that reflects either high or low status. More specifically, secondary burial, interment in a tomb, the inclusion of grave goods, and the presence of multiple individuals within a single grave would require increased energy expenditure. Meanwhile, other burial attributes represent typical mortuary treatment (i.e., treatment that is neither rare nor energy intensive). These include single, primary interments, burial within a pit or on abandoned structures, plaza burials, and/or a lack of grave goods. Mortuary treatment that could indicate low status and disrespect of the corpse includes sacrificial contexts (ballcourt burial), non-interment (Type 2), disarticulation, and disposal on the surface of a floor or in room fill. No statistically significant differences in mortuary attributes among the groups were found, which suggests that, at least at the population-level, extraregional immigrants received similar mortuary treatment to locally born individuals. However, variability within specific high status and sacrificial contexts will be explored through two bioarchaeological case studies presented in Chapter 5. There were also no statistically significant differences among groups for attributes that are typically associated with philosophical-religious beliefs (i.e., body position, deposition, and orientation). While this pattern could suggest that immigrants adopted the local belief system at Paquimé (or perhaps shared the same beliefs when they arrived), such interpretations are tenuous because this aspect of the Casas Grandes mortuary program has not yet been examined.

The results of the various individual-level analyses demonstrated that the majority of extraregional immigrants identified in this study did not receive mortuary treatment that would have required increased energy expenditure (e.g., tomb burial, secondary burial), nor did they exhibit any rare mortuary attributes (secondary burial, interment with rare artifacts). First, none of the extraregional immigrants had an SRA diversity score of 2 or higher, whereas every other group (L, RNL, L/RNL) had at least one individual with an SRA of 2+. Second, only one of the eleven extraregional non-locals was interred with burial goods. This individual was an old adult female who migrated to Paquimé as an adult. She was interred with 30 items, had a richness score of 10, a categorical diversity score of 2, and an SRA diversity score of zero. As mentioned previously, the primary reason for the disparity in count and richness scores is that the bulk of her artifact count came from 13 pieces of stone debitage and 11 shell beads (*Nassarius* species). Her low categorical diversity score is because only two artifact categories, utilitarian items and jewelry made from non-local materials (shell), are represented by the burial goods. Importantly, this burial did not have any of the eight symbols of rank and authority identified by Ravesloot (1988), resulting in an SRA diversity score of 0. She was also interred beneath a plaza, which Ravesloot (1988) found to be indicative of low social status in his mortuary analysis. Based on the lack of SRA, the low categorical diversity score, and her interment beneath a communal plaza, it is unlikely that Burial 34-6 was a high status individual.

This extraregional immigrant did, however, have a fairly high artifact count and moderately high richness score, which could represent a horizontal social position, personal achievement, wealth, or prestige (Carr 1995). Many of the items in this burial are of low value (stone debitage, *Nassarius* shell beads, stone ornament blank, sherd disk) and there are no rare artifacts, so personal or family wealth does not appear to be a good explanation. It seems more likely that the artifact assemblage in this burial symbolizes a horizontal social role such as guild membership or occupation given the predominance of utilitarian stone items (two knives, a chipped preform, raw material, an ornament blank, and 13 pieces of debitage). The quantity and variety of grave goods could also be reflective of social status as a respected elder since she lived past the age of 50. Both teeth that were analyzed from this individual had non-local $^{87}Sr/^{86}Sr$ signatures (0.70953 and 0.70799), so it is not possible to determine when during her lifetime she came to Paquimé. The $^{87}Sr/^{86}Sr$ value in her third molar (0.70799), however, is consistent with the Middle or Outer zone of the northern Casas Grandes region (Chapter 3), so it is likely that she was living in (or moving through) the Casas Grandes interaction sphere during adolescence. As such, it is possible that she spent most of her life in the Casas Grandes culture area and therefore had ample time to become an assimilated and respected, member of the Paquimé community.

In contrast to the unexceptional mortuary treatment of extraregional immigrants, various lines of evidence suggest that the highest ranked social positions within the Paquimé community were occupied by individuals from Paquimé or those from sites in the immediate environs. In terms of mortuary attributes that served as symbols of rank and authority, ~67% of the individuals with an SRA score of 2 or higher were locals, while the remaining ~33% were native to the Casas Grandes area (i.e., RNL or L/RNL). There were only four individuals with scores of 3 or higher and they were all locals. In addition to SRA diversity scores, the following local individuals also consistently scored among the highest in each artifact measure (count, richness, and diversity): 44A-13, 44F-13, 2-16, and 55-13. Two regional non-locals (27A-1 and 38-13) and one individual classified as L/RNL (25-16) also scored high for each measure.

Burials 44A-13, 44F-13, and 2-16 were either *the* highest scoring individual(s) or among the highest scoring individuals for all diversity measurements (richness, categorical, and SRA). There are several common characteristics about these burials that warrant further discussion. First, Burial 44A-13, an old adult male, and Burial 44F-13, a middle adult female, were interred within the same tomb, which was the most complex burial recovered from the site (Di Peso 1974: vol. 8). Although this tomb will be discussed as part of an in-depth case study in the next chapter, the most relevant aspects of the burial, as they pertain to the current discussion, are summarized below. This summary is derived from Di Peso (1974: vols. 2,8) and from my own analysis of the skeletal remains. The tomb, and the burials within it, exhibit a multitude of characteristics that mortuary studies have associated with high social status, and importantly, *all* of Tainter's five manifestations of increased energy expenditure: (1) complexity of body treatment; (2) construction and placement of the burial facility; (3) extent and duration of mortuary ritual; (4) material contributions to the ritual; and (5) human sacrifice.

Burial Tomb 44-13 contains twelve individuals, which were interred during at least four different burial events/episodes. There are seven primary, articulated burials and an upper layer consisting of at least five fragmentary and disarticulated individuals. The uppermost layer of skeletal remains exhibits extensive post-mortem processing and consists of probable human sacrifices (Casserino 2009; Kohn 2011). As mentioned previously, two of the individuals within this tomb exhibited the rare frog legged burial position, of which only one other case was observed at the entire site. In terms of artifact accompaniments, this burial was one of the richest recovered from the site, with many of the items being both rare and ritually significant (e.g., ceramic handdrums, a turkey sacrifice, an effigy vessel, and Ramos Black ceramics). Finally, a shelf that likely held a removable wood plank was built into the side of the tomb, which suggests that this mortuary context was a site of ongoing ritual activity (Di Peso et al. 1974: vol. 8; Rakita 2009). All of these mortuary attributes indicate high status according to the mortuary theory presented in this paper. I would also suggest that the mortuary treatment of Burial 44A-13 (and also 44E-13) may represent what Peebles and Kus (1977) have called a paramount social position within hierarchical societies, which ranks above both subordinate (achieved status) and supraordinate (ascribed status) positions and is reserved for only the most elite individuals, who are usually male.

Burials 44A-13 and 44E-13 are two robust adult males who are believed to be the most important individuals in this tomb (Di Peso et al. 1974: vol. 8; Lekson 2008) and the highest ranking individuals at the site aside from the urn burials in Unit 4 (Ravesloot 1988). Importantly, Lekson (1999, 2015) has argued that these two burials, and the burial tomb as a whole, have similarities to elite interments found at Pueblo Bonito in Chaco Canyon, thus serving as another line of evidence for his Chaco Meridian model. He argues that both sets of males, at Paquimé and Chaco, are elites that were buried in important places with copious amounts of grave goods, including "odd" vessels. At Chaco, the odd vessels were cylindrical jars with traces of cacao (Crown and Hurst 2009), while at Paquimé they were ceramic hand drums. Although Lekson (1999, 2015) does not explicitly state where he thinks these important males at Paquimé originated, foreign origins, or at the very least, foreign connections, are implied. Burial 44E-13 was not analyzed for this study, however, Burial 44A-13 has isotope values that are consistent with the local range at Paquimé and strontium isotope values that are far lower than those reported for sites in the American Southwest (Dudás et al. 2016; Grimstead et al. 2015; Price et al. 1994, 2002, 2017; Waller 2009). Furthermore, Burial 44F-13, the first individual placed in this elite burial tomb, also had local strontium and oxygen isotope values. Thus, local isotope values in the first and last primary interments placed within this tomb provides strong evidence that this is a local elite lineage.

The other high ranking individual identified in this study was Burial 2-16, a young adult male who was also interred in a sub-floor burial tomb along with a middle adult male. In addition to 193 pieces of jewelry that consisted of limestone, turquoise, and shell, several different kinds of ceramic vessels were placed in this tomb, including a Ramos Polychrome effigy jar, a Ramos Black miniature bowl, a Ramos Polychrome Jar, an Escondida Polychrome Bowl, and unidentified plant remains. A wand fashioned from the bone of an artiodactyl was found in direct association with Burial 2-16. This artifact is extremely rare, as only two bone wands were recovered from burial contexts at Paquimé (Di Peso et al. 1974: vol. 8). According to Di Peso and colleagues (1974: vol. 8), bone wands are characterized by their long and curved shafts with blunt tips. Based on their unusual shape, as well as their association with human trophy skulls in Unit 16, they were classified as wands and not tools. Bone wands are also significant at Paquimé because they were recovered from several ritually-charged locations, including ceremonial caches and bone troves (Rakita 2001, 2009; VanPool and VanPool 2007). There were also two shelves on either end of the tomb in which Burial 2-16 was interred, which served as the base for wood planks (Di Peso et al. 1974: vol. 8). As with Burial Tomb 44-13, the presence of a removable covering indicates that this grave was a site for ongoing mortuary ritual. Furthermore, both tombs contained ritual paraphernalia and Ramos Black ceramic vessels, the latter of which Rakita (2001, 2009) has linked to an ancestor/political cult at the site. As such, the ritually-charged characteristics of Burial Tombs 2-16 and 44-13, paired with the finding that all of the high ranking individuals in these tombs exhibit local isotopic signatures, suggests that local lineages likely derived their elite status from ritual authority (Rakita 2001, 2009).

Although diversity scores were not calculated for the Convento burials because none were interred with more than one artifact, there were a few notable findings from this data. The main source of Viejo Period mortuary variation was the presence or absence of burial accompaniments. Of the thirteen individuals examined in this study, only three had grave goods and all had local isotope signatures. While the items found with Burial CO-5 (a single shell bead) and Burial CO-54 (a bone awl) were not exceptional, the pyrite mosaic plaque (mirror back) found with Burial CO-50 was the only one of its kind at either Convento or Paquimé. According to Di Peso et al. (1974: vol. 7:30), more work was involved in the manufacturing of this plaque than in the majority of other stone objects recovered from the Convento site. This object was not only rare at the site but would have required substantial energy expenditure. Although Convento did not have the same level of social differentiation as Paquimé, it was certainly not egalitarian, especially during later Viejo (JH Kelley and Searcy 2015; Rakita 2009). For example, JH Kelley and Searcy (2015) have suggested that Viejo Period social differentiation was likely tied to the status of lineages, which would have been slightly higher among founding kin groups with property rights. The association of this rare artifact with a locally-born individual supports such a scenario and indicates that Burial CO-50 may have been part of a founding lineage and/or held some type of leadership role within the community. Furthermore, although Ravesloot's (1988) mortuary analysis results from Paquimé cannot be extrapolated directly to Convento, it is noteworthy that Secondary Burial was one of the eight symbols of rank and authority at Paquimé and Burial CO-50 was the only secondary burial found at the Convento site. While this data set is small, it suggests that the pattern of locally-born individuals occupying leadership positions was present during the Viejo Period as well.

Finally, the results of this study align well with recent findings by Price and colleagues (2017) who also utilized a multi-isotope approach to examine the geographic origins of a large sample of individuals from Pueblo Bonito in northwestern New Mexico. More specifically, they analyzed individuals from two burial clusters at the site, one of which was Room 33, an elaborate mortuary context that housed the remains of two Chacoan elites - the same individuals cited by Lekson (1999, 2000) as having similarities to Paquimé's 44-13 elites. The Chaco elites were interred with large quantities of burial goods, including over 15,000 pieces of turquoise jewelry and their grave was covered by wood planks with more human burials placed on top. Adjoining rooms housed additional burials. Price and colleagues (2017) conducted strontium, oxygen, and lead isotope analyses on a sample of 61 individuals, including burials from Rooms 33, 56, and other rooms in a West cluster and found that nearly all individuals were local to Chaco Canyon or the nearby San Juan Basin. Importantly, the elite burials also had local isotope signatures, which led Price and colleagues (2017) to conclude that the cultural trajectory of Chaco Canyon was largely guided by internal sociocultural dynamics, rather than external influences. As such, it appears that Paquimé and Chaco Canyon may have shared similar, but unconnected, local developmental trajectories.

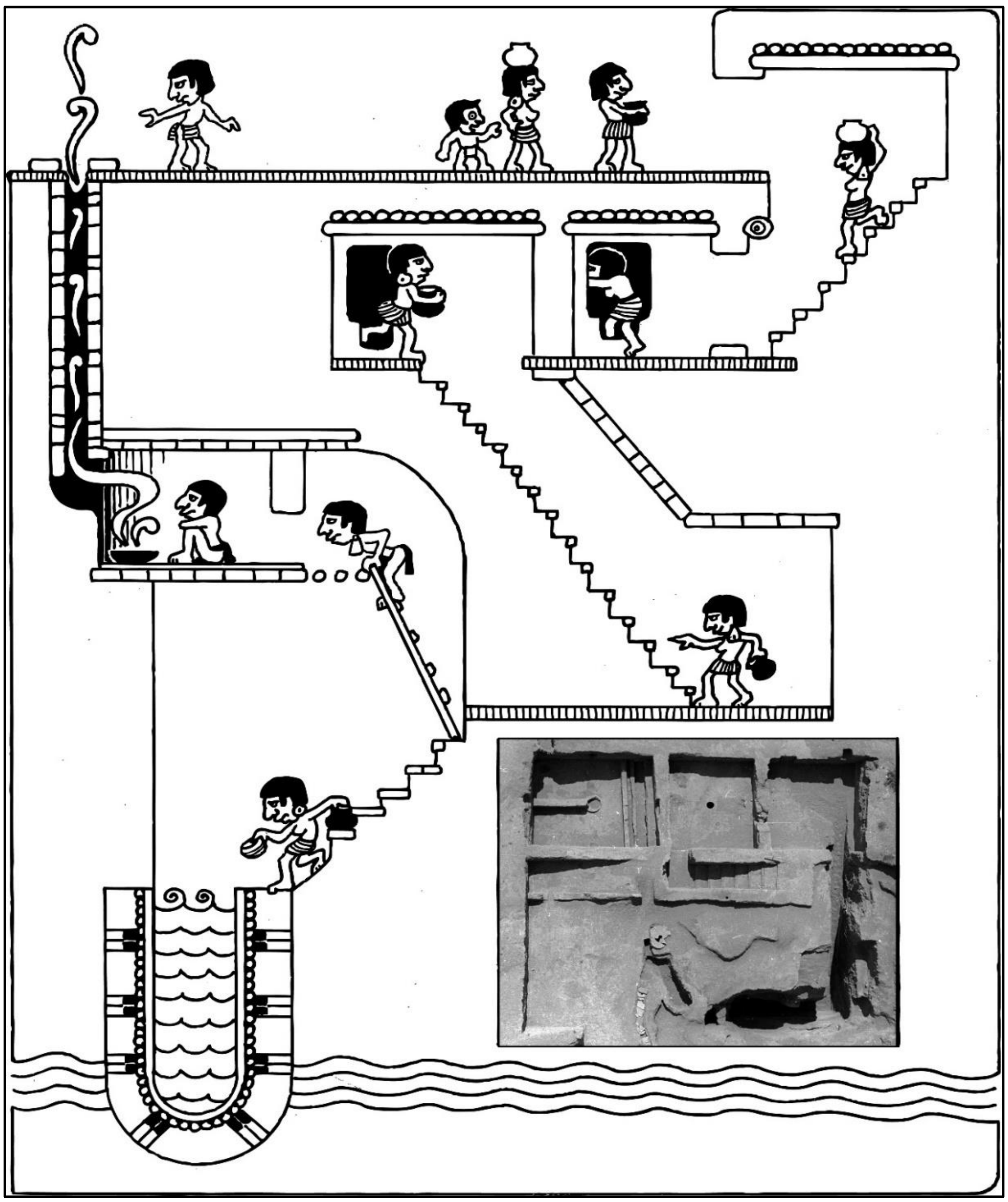
4.5.3 Community Integration

Along with the mortuary attribute data discussed above, the spatial distribution of the burials at Paquimé was also used to assess social dynamics between locals and immigrants. The results of the spatial analysis by architectural unit indicate that non-local burials were present in most units at the site, except for Unit 8. This pattern suggests that immigrants were integrated into the Paquimé community, as opposed to being segregated into separate habitation areas. This type of spatial segregation has been observed at the site of Teotihuacan in the Basin of Mexico, where at least two ethnic enclaves, the Oaxaca Barrio and the Barrio de los Comerciantes, have been identified via isotopic methods (Price et al. 2000).

The exclusion of non-locals from Unit 8, also called The House of the Well, is particularly intriguing because of its ritual significance at the site. This unit was not one of the four units that Ravesloot (1988) identified as housing elite burials, which is likely because the 57 interments recovered from this unit were not characterized by particularly elaborate mortuary assemblages. In fact, the number of burials recovered from Unit 8 was surprisingly low given its size and the number of people it could have accommodated (Di Peso et al. 1974: vol. 8). I would argue that the significance of Unit 8 was largely missed in Ravesloot's (1988) mortuary study precisely because it does not contain elaborate burials. This unit, however, was an incredibly important ritual location at Paquimé (VanPool and VanPool 2007). The unit is named for its elaborate subterranean well, which was only accessible through a hidden entrance located beneath one of its plazas (Figure 4.3). A human calvarium was intentionally embedded in the floor of the entryway and ritual paraphernalia was found strewn down the steps of the stairs when the site was excavated

(Di Peso 1974: vol. 2). Another ritually-charged aspect of this unit is its association with sacrifice; first, a child sacrifice was placed around a roof support beam when one of its rooms was constructed and second, it is also the location of the majority of macaw sacrifices (N=34) recovered from the site.

Figure 4.3. Drawing and aerial photograph (inset) of the Unit 8 subterranean well. Courtesy of The Amerind Foundation, Inc., Dragoon, Arizona. Alice Wesche, Illustrator.



Unit 8 also contained hoards of exotic items, including copper artifacts from West Mexico, turquoise from the American Southwest, and over 2.5 million pieces of shell from the Gulf of California. A cache of ritually significant Gila polychrome pottery was also recovered from one of the rooms in Unit 8. Although many of these items were originally interpreted as being stockpiled for trade (Di Peso 1974: vol. 2), recent studies have suggested that these objects had ritual, rather than economic, significance (Fish and Fish 1999; VanPool and VanPool 2007; Vargas 1999; Whalen 2013). For instance, Whalen (2013) has convincingly argued that most of the shell recovered from this unit was likely brought to the site on wampum-like strings, perhaps during religious pilgrimages. Furthermore, the shell hoards consist primarily of low-value *Nassarius* species that were not traded with other groups in the Casas Grandes region, which in turn indicates that this abundant item did not serve an economic function.

It is clear that Unit 8 had important ritual significance to the people of Paquimé. Furthermore, the results of this study accord well with the results of Rakita's (2001, 2009) mortuary analysis and suggest that the highest ranking individuals at the site likely derived their elite status from ritual authority. This is particularly evident for the high ranking, ritually-charged Burial Tombs 44-13 and 2-16, which contain locally born individuals. It is also clear that individuals exhibiting non-local isotope values are conspicuously absent from Unit 8. Taken together, these data indicate that local elites may have controlled ritual and religious activities at Paquimé, which lends further support to the finding that immigrants did not hold high ranking positions in the community.

4.6 Conclusion

The analyses conducted in this chapter have demonstrated that there were distinct status differences between locals and immigrants at Paquimé, with the former occupying the highest social ranks within the community. Although eleven of the burials analyzed in this study were extraregional immigrants, none of these individuals received elaborate mortuary treatment that indicates elite social status. One extraregional immigrant from the Southwest was interred with a fairly large number of burial goods, however, these items likely reflect horizontal social roles related to personal attributes, such as occupation or age, as opposed to vertical social status. Furthermore, two of the highest ranking individuals at Paquimé, Burials 44A-13 and 44F-13, who have been suggested as having connections to elites elsewhere in the Southwest (i.e., Pueblo Bonito), were born locally. As such, the results of this mortuary analysis do not support the Chaco Meridian model proposed by Lekson (1999, 2015).

Similarly, the few individuals that may have emigrated from other parts of northwest or West Mexico also lacked high status mortuary treatment. Most of these individuals were also children, which does not fit the expected demographic profile of merchants or traders, as suggested by the Aztatlán model (JC Kelley 2000). Rather, the demographic data suggest that migratory units from this region consisted of kin or social groups. This is not to say that foreign influences from the Southwest or West Mexico did not play a part in Medio Period cultural development, but there is currently no evidence that indicates a direct and sustained presence of important foreign individuals at Paquimé. Instead, the results of this study suggest that high ranking social, and probably religious, positions were held by individuals who were native to the Casas Grandes region. This is further supported by the results from the Convento site, where only locally-born individuals were interred with burial goods. While the data are limited by small sample size, the findings appear to suggest that like their Medio Period counterparts, Viejo Period immigrants did not occupy important social positions within the community.

<u>Chapter 5</u>

An Examination of Social Dynamics at Paquimé through the Bioarchaeological Analysis of Elites & Suspected Human Sacrifices

5.1 Introduction

Thus far, this thesis has focused on examining whether Medio Period culture change was due to external or local stimuli. Although the primary research goal of this study has been addressed, the aggregation of locals, regional non-locals, and extraregional immigrants at Paquimé undoubtedly led to a new and complex Medio Period social environment. This chapter will explore the impacts of migration in terms of sociopolitical dynamics between locals and immigrants.

The isotopic and mortuary results presented in Chapters 3 and 4 indicate that while extraregional immigrants were present in the Paquimé burial assemblage, none of these individuals were afforded mortuary treatment that suggests elite social status. Instead, the most elaborate burials belonged to locally-born individuals, several of whom were interred with socio-religious burial goods. Furthermore, a spatial analysis of burial location revealed that one of the most ritually significant units at the site (The House of the Well) contains only locally-born individuals. These results align well with previous studies that suggest social status and political leadership at Paquimé were connected to religious authority (Rakita 2001, 2009; VanPool 2003, 2009; VanPool and VanPool 2007). Rakita (2001, 2009) posited that during Medio Period population aggregation, kin groups originating in the Casas Grandes area would have access to the best agricultural lands and resources stemming from their primacy in the region, thus leading to real (or perceived) ritual success and social superiority over in-migrating clans. This scenario likely enabled local individuals to obtain important priestly positions within the newly developed religious system. Thus, the finding that only locally-born individuals held high status positions in the Paquimé social hierarchy and had exclusive access to one of the most ritually significant units at the site fits well with Rakita’s (2001, 2009) model of local religious leadership.

Importantly, these results suggest that there may be an association between geographic origins and inequality. In aggregated communities, asymmetrical power dynamics between locals and immigrants can result in conflict and violence (Clark 2011) and at Paquimé, there is evidence for ritually-charged competition, conflict, and violence in the form of graveside status negotiations (Rakita 2001, 2009; Ravesloot 1988) and ball game rituals (Harmon 2005, 2006; Rakita 2009; Whalen and Minnis 1996). One of the most conspicuous and intriguing elements of Paquimé religion was ritual sacrifice. In addition to the ritual killing of hundreds of macaws and turkeys, the people of Paquimé may also have engaged in the sacrifice of human beings, as Di Peso and colleagues (1974: vol. 8) classified nine individuals as human sacrifices and implied that five others may have served as "offerings" in an elite burial tomb. In reference to the practice of human sacrifice, JH Kelley (2017:188) noted that "some individuals in Paquimé apparently had a charter to kill other human beings in ritual – and perhaps other contexts. This to me seems rather hierarchical, with a fair amount of authority concentrated in someone." Kelley's succinct observation highlights the power differentials inherent in the act of human sacrifice, which in turn makes it an ideal context for examining sociopolitical dynamics at Paquimé. If asymmetrical power relationships between local and in-migrating groups did exist, they may have played out in these ritual contexts. Based on the results of Chapter 4, high status positions associated with ritual authority were probably held by locally-born individuals, therefore, individuals belonging to rival non-local groups may have been the targets of ritual violence, including human sacrifice.

In this chapter, I explore Medio Period social dynamics at Paquimé through a comprehensive bioarchaeological analysis of individuals from two ritually-charged mortuary contexts; a ceremonial ball court and an elite burial tomb. As mentioned above, both contexts contain burials that were either classified as human sacrifices ("Type 8" burials) or ritual offerings (Di Peso et al. 1974: vol. 8). Burial tomb 44-13 is an ideal context to explore social dynamics because it includes the two extremes of mortuary treatment at Paquimé, elite burials and suspected human sacrifices. In addition, it is believed to have been a locus for ongoing ritual activity related to ancestor veneration (Rakita 2009). Meanwhile, the ball courts at Paquimé likely served as important venues for elite competition over power and prestige, which may have occurred between rival factions within Paquimé society and/or between Paquimé elites and outside groups (Harmon 2005, 2006; Whalen and Minnis 1996).

The purpose of these case studies is to reconstruct various facets of the lives and deaths of the individuals interred in ritually significant burial contexts. This is accomplished through a multifaceted approach that utilizes osteological, isotopic, and archaeological data. More specifically, sex and age-at-death estimates are used to create demographic profiles, while the assessment of healed trauma, pathological lesions, and congenital anomalies provide information on an individual's life history of disease and interactions with their natural and social environs. Radiogenic strontium and stable oxygen isotope data are used to determine geographic origins and residential mobility during life. Finally, the assessment of perimortem trauma and mortuary context aid in reconstructing the manner of death, while evidence of anthropogenic processing and taphonomic modifications shed light on post-mortem treatment of the remains. This multifaceted approach will not only provide valuable insight into the identity of the individuals interred in two of the most ritually-charged mortuary contexts at Paquimé, but also enhance our understanding of Medio Period social dynamics within the broader Casas Grandes region through the analysis of geographic origins.

5.2 Background

5.2.1 Prehistoric Human Sacrifice: An Overview

Although human sacrifice has been documented in contexts across the world, this review is based primarily on evidence from the Americas, as this region is most relevant to the current study in terms of both spatial and temporal proximity. The goal of this section is to provide a broad overview of the topic among cultures where human sacrifice has been documented through multiple lines of evidence, such as ethnohistorical accounts, iconography, glyphs, and archaeological data. The combination of osteological data with these other lines of evidence is ideal because the osteological correlates of human sacrifice can be determined from known cases (Tiesler 2007). It is also important for surveying the range of variation in the motives, form, and victims of human sacrifice.

In ancient Mesoamerica, human sacrifice was a form of highly redundant ritual, often controlled by elites in power, which was performed to communicate with or provide an offering to supernatural forces (Schwartz 2017; Tiesler 2007). Sacrifice has been linked to various Mesoamerican deities including God A, God Q, and Xipe Totec, and is sometimes associated with defleshing, flaying, and ritual consumption (Di Peso 1974: vol. 2; Hurtado et al. 2007). Various forms of human sacrifice have been identified throughout the Americas, but two of the most common forms are communion sacrifice and companion sacrifice. *Communion sacrifice* refers to offerings that are intended to establish communication with deities, powerful beings or forces, with the goal of securing common well-being (Tiesler 2007). Calendrical ceremonies, commemorative/dedicatory ritual offerings, and captive killings are examples of communion sacrifice. Sacrifice may also take the form of *companion sacrifice (i.e., attendant or retainer sacrifice)* whereby ritual killing is done to fulfil specific demands or requirements related to the mourning or commemoration related to the death of elite individuals (Cucina and Tiesler 2006). The archaeological manifestation of companion sacrifice involves concurrent interment of an individual of elite status who is accompanied by burials with few or no grave goods that might also be placed in atypical or disrespectful positions (Schwartz 2017).

Human sacrifice is often intimately linked to social dynamics within a population, particularly in terms of group identity (ethnic or kin) and social hierarchies (Schwartz 2017; Swenson 2014). More specifically, this form of ritual violence can be associated with power asymmetries between the officiant and victim, the legitimization/reinforcement of authority structures, and/or social control (Swenson 2014). Victim selection may entail powerless victims, such as women, children, war captives, and otherwise marginalized individuals (Schwartz 2017). For example, bioarchaeological studies at both Aztec and Maya sites have documented poor health among child sacrifices (e.g., Cucina and Tiesler 2007; Hurtado et al. 2007; Román 1991). Cucina and Tiesler (2007) argue that unhealthy adolescents at Champotón and Becán in Campeche may have been chosen for sacrifice precisely because they were less useful to society. Meanwhile, it has also been suggested that the sacrifice of unhealthy children at Aztec sites, including Tenochtitlan and Tlatelolco, was due to the belief that deities associated with disease (i.e., Tlaloc) had marked these individuals for sacrifice (De la Cruz et al. 2008). Finally, sacrifice may have been intentionally violent, torturous, humiliating, and/or irreverent toward the victim, as has been depicted in many iconographic sources (e.g., Mensforth 2007; Miller 2007; Tiesler and Cucina 2006).

It should be noted, however, that the opposite pattern has also been documented, whereby victims were chosen based on desirable attributes. Such was the case in the sacrificial killing of the most beautiful children for the Inca *capacocha* ritual (Wilson et al. 2007). Children were sometimes even volunteered for sacrifice in *capacocha* rituals by their kin to increase the prestige or status of surviving family members (Gaither et al. 2008; Wilson et al. 2007). According to Swenson (2014), these seemingly disparate practices are, in fact, part of a broader cross-cultural pattern of choosing sacrificial victims that occupy either end of the social spectrum. Meanwhile, the act of sacrifice by elite individuals may represent an attempt to reinforce their association with supernatural entities and legitimize their status within society (e.g., Bourget 2016).

In addition to examining the choice and treatment of sacrificial victims, a more fundamental component in the bioarchaeological study of human sacrifice is identifying whether sacrifice occurred. This involves differentiating between human sacrifice and other funerary practices, such as ancestor veneration, which may leave similar traces on the skeleton (McAnany 1995; Schwartz 2017; Tiesler 2007). Non-osteological approaches to identifying human sacrifice are generally based on abnormal mortuary treatment or contextual evidence, such as irregular placement of the corpse (e.g., ventral position), burials with multiple interments placed around one central individual, and/or atypical absence of mortuary accompaniments. While these burial attributes hint at unusual mortuary practices that may represent human sacrifice, the combination of multiple lines of evidence, including archaeological/mortuary context *and* osteological data, provides a more robust dataset for identifying human sacrifice.

Tiesler (2007: Table 2.1) has outlined a set of archaeological correlates for differentiating between funerary and sacrificial deposits that is based on the following suite of attributes: biographic profile (age-at-death, sex), form of death, predepositional body treatment, primary deposition, postdepositional manipulation, and secondary deposition. Each set of attributes is also accompanied by one or more osteological or taphonomic correlates. For instance, predepositional body treatment (referred to as post-mortem processing in this study) associated with sacrificial deposits can be characterized by butchering, dismemberment, skinning, defleshing, consumption, and/or burning. While some of Tiesler's (2007) examples are not directly applicable to Paquimé because they were developed for the evaluation of sacrifice in state-level societies, her model serves as more of a broad conceptual framework for conducting comprehensive osteological and contextual analyses. In addition, Tiesler (2007: Figure 2.2) provides a useful summary of the anatomical distribution of the osteological marks associated with each type indicator. For example, flaying is characterized by slicing cut marks on the cranium, clavicles, and scapulae, while slicing and scratch marks on long bone shafts near muscle attachment points indicate defleshing.

5.2.2 Ritual Practices and Human Sacrifice at Paquimé

The ceremonial nature of Paquimé has been recognized by archaeologists since the site was first excavated in the late 1950s (Di Peso 1974: vols. 1-3). Ritual and religious elements at the site include iconography on ceramic vessels (e.g., plumed serpents), ritual paraphernalia, platform and effigy mounds, the sacrifice of macaws and turkeys, ritual caches found throughout the city, water symbolism, public feasting, and the ball game (Di Peso 1974; Rakita 2001, 2009; VanPool 2003, 2009; VanPool and VanPool 2007; Whalen 2013). The manipulation of human remains is also a prominent theme in Paquimé ritual, as various items made from human bone were recovered from the site and provide evidence for this practice. Examples include a necklace of hand and foot bones, six “trophy skulls”, musical rasps, a skull cap that was intentionally placed in the entrance of the walk-in well, and the presence of human long bones in a ceremonial bone trove (Di Peso 1974: vol. 2; Di Peso et al. 1974: vol. 8). Finally, suspected human sacrifice and post-mortem processing on many of the Type 2 (non-interred) burials are conspicuous forms of corpse manipulation, and Casserino (2009) and Kohn (2011) have argued that some of the Type 2 burials have post-mortem processing that is consistent with ceremonial anthropophagy.

The manipulation of human remains and the practice of ancestor veneration have figured prominently in recent interpretations of ritual and religious practices at the site (e.g., Casserino 2009; Kohn 2011; Rakita 2001, 2009). According to Rakita (2009), the manipulation of human remains and limited access to the ancestors was one way that emerging elites at Paquimé established and maintained power and authority. He argues that two cult organizations emerged during the Medio period; one that was concerned with power negotiations and the maintenance of elite authority (the ancestor/political cult) and another that focused on social cohesion and inclusivity (the fertility cult). The ancestor cult was responsible for private mortuary rites, controlling access to the ancestors, sacrifices, and exclusivity. Meanwhile, the fertility cult was characterized by public mortuary rituals, sacrifices, celestial observation, and inclusivity. It should be noted that prior to Rakita's (2001, 2009) mortuary analysis, Ravesloot (1994) also posited the existence of a Cult of the Dead at Paquimé. The general premise that ruling elites legitimized their authority via their association and access to ancestors (i.e., past leaders) was similar to Rakita's (2009) model, but instead of having two cults with separate (but complimentary) ritual "goals," Ravesloot's (1994) model involved only one cult.

Di Peso and colleagues (1974: vol. 8) classified nine of the Paquimé burials (and one fetus) as human sacrifices and implied that other individuals may have been sacrificed as well. The first case of human sacrifice documented by Di Peso et al. (1974: vol. 8) was Burial 23-8, a young child aged 2 to 5 that was placed around the base of a roof support beam in Unit 8, The House of the Well. Burial 9-14, a middle-aged adult female, was found in a pit filled with densely packed red mud, beneath a ceremonial platform of mud concrete, and was also classified as a (probable) human sacrifice. Her skull was crushed and there was a black stain under the head. The final two sacrificial contexts are the focus of this study; the first is Burial Tomb 44-13, which contains the remains of five individuals that Di Peso and colleagues (1974: vol. 8) speculated were "offerings" to other burials in the tomb and the second is the ceremonial ball court in Unit 14, which contained the remains of seven individuals. Both contexts are described in further detail below.

5.2.2.1 Burial Tomb 44-13

According to Di Peso and colleagues (1974: vol. 8), Burial Tomb 44-13 was the most complex burial recovered from Paquimé, in terms of both its contents and structure (Figure 5.1). The tomb was located in Room 3 of Unit 13, also known as The House of the Dead. The unit was so named because it contained a large proportion of the burials at Paquimé, as well as the majority of ceramic handdrums and turkey sacrifices, which Di Peso and colleagues (1974: vol. 8) argued were associated with Mesoamerican death cults. The tomb was approximately 1.5 meters deep and contained at least 12 individuals; seven primary, articulated interments that were deposited in four different burial episodes and the remains of at least five additional individuals, whose bones were found scattered and fragmentary in the uppermost layer of the tomb. A shelf was built into one side of the pit, which was presumed to have supported a perishable covering, as observed in other burial contexts at the site (Di Peso et al. 1974: vol. 5:596). Rakita (2009) has argued that this removable covering, along with the copious amounts of ritual items found in association with Burial Tomb 44-13 (discussed below), is evidence for ongoing ceremonial activity related to this burial.

Figure 5.1. Burial Tomb 44-13. Courtesy of The Amerind Foundation, Inc., Dragoon, Arizona. Alice Wesche, Illustrator.

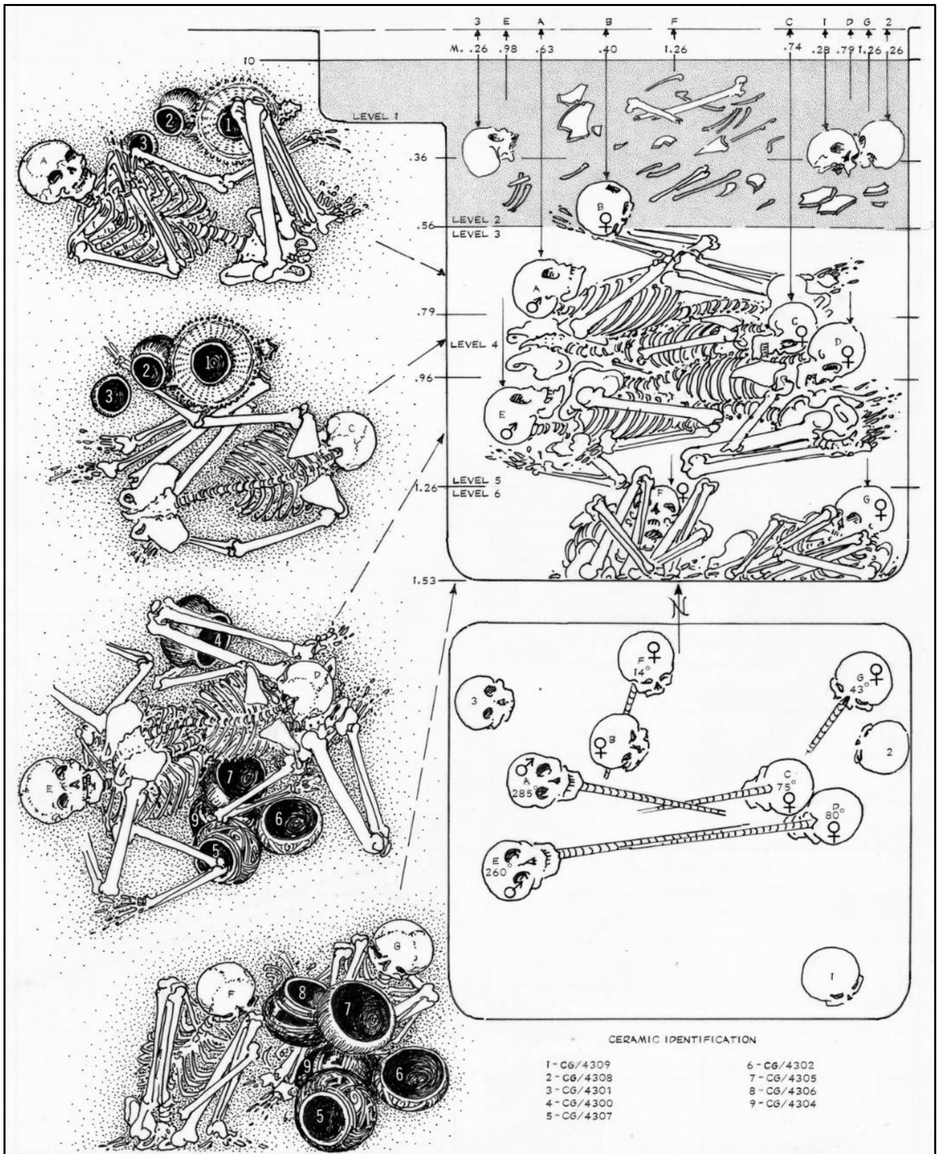


Fig. 383-8. Complex Multiple Burial 44 A-L-13, Room 3-13.

The first burial episode (i.e., the bottom-most layer) consisted of two adult females, 44F-13 and 44G-13, who were both placed in seated, flexed positions. These individuals were interred with dozens of pieces of shell and stone jewelry, a Ramos Polychrome jar, and several utilitarian items. A miniature plainware ceramic ladle was found in direct association with Burial 44F-13. The next burial episode consisted of 44E-13, a robust adult male, and 44D-13, an adult female. Burial 44E-13 was placed in a supine position, legs frogged out to the sides, with Burial 44D-13 face-down on top of him, with her head in his pelvis and vice versa. Her legs were also in the same frogged position. Burial 44E-13 was accompanied by several ceramic vessels, shell tinklers, and a stone pendant made from siltstone. Di Peso and colleagues (1974: vol. 8) suggested that 44E-13 was the most important individual in the tomb, likely because of his robust build, unusual "frog-legged" burial position, and overall complexity of the tomb itself. The next burial layer was comprised of an adult female (44C-13), who was placed on her right side with both legs flexed to her chest. This individual was not found in direct association with any burial accompaniments. The final layer of articulated burials consisted of two individuals, 44A-13, a robust adult male, and 44B-13, an adult female. Burial 44A-13 was interred in a supine position with his legs flexed to his chest and arms crossed over his pelvic region. Burial 44B-13 consisted of a skull only, which was found near the hands of Burial 44A-13. A large quantity of grave goods was placed with/on top of this last burial, including at least eight fragmentary ceramic handdrums, a sacrificial turkey, Ramos Black vessels, polychrome pottery, an effigy vessel, several socioreligious items (concretions, mined deposit materials), and pieces of stone and shell jewelry.

The uppermost layer of the tomb was comprised of the disarticulated and fragmentary remains of at least five individuals (44H-L-13). Burial 44H-13 was a young adult of indeterminate sex, while the remaining four individuals were juveniles between the ages of 10 and 16. The presence of burning on these bones is also referenced in one of the supplemental volumes of data (Di Peso et al. 1974: vol. 7:596). Although Di Peso and colleagues (1974: vol. 8:387) did not classify these burials as 'Type 8 Human Sacrifices', they "…speculate that these incomplete upper level remains represented some sort of secondary offering to honor those below." With the exception of estimating age-at-death, sex, and noting obvious trauma, pathology, and artificial cranial deformation (Di Peso et al. 1974: vol. 8), no further osteological analyses were conducted on these remains until Kohn (2011) examined them as part of a study on sacrifice and cannibalism at Paquimé. In her analysis of Burials 44H-L-13, she found evidence of burning, scalping, defleshing, dismemberment, and extensive long bone fracturing, which she argues is evidence for cannibalism. Kohn (2011) also suggests that these individuals were sacrificial offerings to the elite individuals below because they were found comingled with a decapitated turkey and ritually "killed" ceramic handdrums, which represent other forms of sacrifice. While the evidence presented by Kohn (2011) is certainly compelling, there could be alternative explanations for the observed pattern of post-mortem processing, such as ancestor veneration or burial rites (Pérez 2012).

Although the articulated interments in the burial tomb (i.e., 44A-G-13) are not suspected human sacrifices, they were included in this study to provide a more comprehensive understanding of this unique mortuary context. Additionally, a comparative analysis of the articulated versus disarticulated remains will aid in determining if the uppermost layer of fragmentary remains is indeed a sacrificial offering to those below or if these individuals were part of the elite lineage that has been suggested for this tomb (Di Peso et al. 1974: vol. 8). If the juveniles in the uppermost layer were part of an elite local lineage, they should have local isotope values, as well as mortuary treatment that represents high status.

5.2.2.2 Ball Court Burials

Excavations at Paquimé uncovered three ball courts; two Mesoamerican style I-shaped ball courts and one unique T-shaped ball court. The ball game played an important role in various facets of prehistoric society, including politics, economics, and sport/leisure, but was perhaps most integrally linked with ritual and religious practices (Scarborough and Wilcox 1991). This was likely the case at Paquimé as well. For instance, Whalen and Minnis (1996) have suggested that the Paquimé ball courts were venues where personal or factional rivalries between competing elites were played out in a ritualized context. In their survey of ball courts in northwest Mexico, the authors also found that the majority of courts were located within a day's walk of Paquimé. They argue that this observed distribution is evidence for a high level of factional rivalries amongst elites from communities within the immediate vicinity of Paquimé.

Harmon (2005, 2006) reached a similar conclusion through his phylogenetic analysis of nearly two dozen ball courts in the Casas Grandes region, but also emphasized the role of ball courts in intra-site competition amongst emerging elites at Paquimé and with outside groups (i.e., inter-regional competition). He posited that the three ball courts at Paquimé were controlled by different elite kin groups, who not only used these venues for competition, but also as a means for unification and diffusion of rivalries between clan groups and elites (Harmon 2005, 2006). Harmon (2005, 2006) outlined specific functions for each type of court; the two I-shaped courts involved public displays of athleticism, non-deadly combat, gambling, feasting and socialization with the goal of creating and maintaining social cohesion. Meanwhile, the private T-shaped court was used for ceremonial purposes (including human sacrifice) by a kin group that legitimized itself through its exclusive ritual knowledge and connections to Mimbres ancestors from the American Southwest. According to Harmon (2005), the link to Mimbres stems from architectural similarities between this ball court and Mimbres ceremonial structures, including its T-shape, association with a room block, controlled access, east-facing entrances, and associated burials. Harmon (2005) has also suggested that the T-shaped ball court was constructed during a period of instability in the thirteenth century, which was characterized by climate fluctuations/decreased precipitation, population aggregation from within and outside the region, the emergence of hierarchical social institutions, and a religious transition from shamanism to cult-based priesthoods.

As mentioned above, the two I-shaped courts were located in public spaces, while the much smaller T-shaped court (Figure 5.2) was located within Unit 14, a largely residential compound called the House of the Pillars. The T-shaped ball court is the only documented ball court in northwest Mexico to have been built *into* a room block and is also the smallest court in the region (Harmon 2005, 2006; Whalen and Minnis 1996). Unlike the other two ball courts at Paquimé, the private court contained a central stone marker, which was found embedded within the playing floor and covering a “spirit hole” (Di Peso 1974: vol. 2). This spirit hole, or *sipapu*, is a common element in Southwestern and Mesoamerican cosmology symbolizing a portal between worlds (Harmon 2005, 2006; VanPool and VanPool 2007). The final, and most significant, difference between the public and private ball courts is that the latter was associated with a series of burials along its central axis, which Di Peso (1974: vol. 2) classified as human sacrifices. They were designated as sacrifices because several of these individuals apparently had or were associated with severed body parts (i.e., dismemberment), which the author likened to Mesoamerican ball game cult practices (Di Peso 1974: vol. 2). In addition, he drew parallels between the burial positions of these individuals and various themes from the Mayan Popul Vuh, including the Hero Twins myth and its association with human sacrifice. Based on the features described above, Di Peso (1974: vol. 2) referred to this private ball court as the “ceremonial” or “religious” court. A description of each burial is provided below.

Figure 5.2. Plan view of the Unit 14 ball court with associated burials. Courtesy of The Amerind Foundation, Inc., Dragoon, Arizona. Alice Wesche, Illustrator.

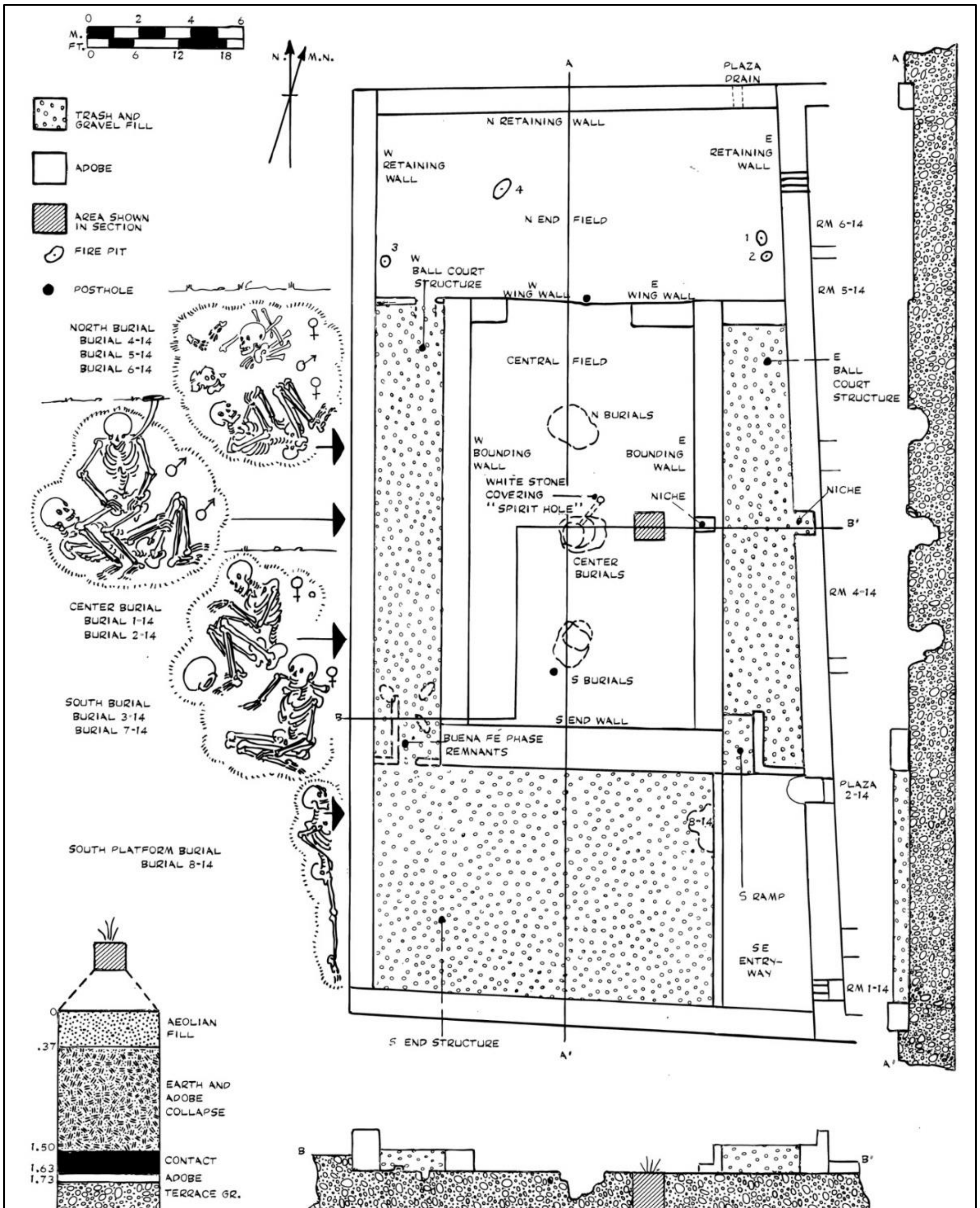


Fig. 91-5. Plan of Ball Court III (Plaza 1-14).

The first set of burials were recovered from the centre of the court in a pit connected to the spirit hole. The lowest burial, 2-14, was an adult male who was placed on his left side, with his legs in a flexed position. Another adult male, Burial 1-14, was placed on top of Burial 2-14 in a seated position facing east, with his legs semi-flexed and hands placed in his pelvic region. A rubbing stone made of andesite was placed with this individual. Di Peso (1974: vol. 2) asserted that this burial position was reminiscent of the Veracruz palma design, which depicts Death sitting atop his victim in association with cornstalks that symbolize fertility. Harmon (2005) also suggests that this position could be associated with the Mayan Hero Twins myth, which involves two brothers who defeat the Lords of the Underworld in an epic ball game.

The pit in the south end of the ball court contained two adult females, Burials 3A-14 and 7-14. Laboratory analysis revealed the presence of fetal remains (3B-14) in association with Burial 3A-14, which indicates that this woman was pregnant at the time of her death. Burial 7-14 was placed in a seated position with her legs flexed to the rear and facing to the east. The right arm of this individual was found detached and draped around her shoulders. The pregnant female was placed on top of Burial 7-14 in a flexed position on her right side, with her head to the east. Several burial accompaniments were found with Burial 3A-14, including an Escondida polychrome bowl, a rubbing stone made from vesicular basalt, unidentified food remains, cotton seed coats, and charcoal. As with the central burial pit, these burials have also been linked to fertility rituals and myths based on the inclusion of a pregnant female (Di Peso 1974: vol. 2; Harmon 2005).

The final pit of burials, located at the north end of the ball court beneath an upright wooden standard, contained one primary and two secondary interments and was filled with terrace boulders. The primary interment, Burial 6-14, was an adult female placed on her left side in a flexed position facing east. Burial 4-14 consisted of a skull, pelvis, long bones, and the articulated bones of a pair of feet, which Di Peso (1974: vols. 2, 8) suggests were severed. This burial was found directly above and 18 cm north of Burial 6-14. Burial 5-14 was a secondary interment consisting of a "crushed skull" and random bones (Di Peso et al. 1974: vol. 8:398). Di Peso and colleagues (1974: vol. 8) assigned all burials beneath the ceremonial ball court to the same phase of the Medio Period (i.e., Paquimé), suggesting they had been interred at the time of the ball court's construction. Not only has Di Peso's (1974: vols. 1-3) site chronology been invalidated (e.g., Dean and Ravesloot 1993; Whalen and Minnis 2009), seriation analysis of pottery sherds recovered from the ball court fill suggests that while the burials may have been interred at the same time, it is also possible that the interments in the south pit (i.e., 3A-14 and 7-14) and Burial 4-14 in the north pit (and possibly Burials 5-14 and 6-14 as well) were deposited after the initial construction of the court (Harmon 2005).

With the exception of the basic osteological information recorded by Di Peso et al. (1974: vol. 8), Benfer (1968), and Butler (1971), a comprehensive bioarchaeological analysis of the ball court burials has not been conducted. In fact, there has been a surprising lack of discourse about whether these burials are indeed sacrifices and if so, who it was that Paquimeños were sacrificing. Instead, discussion of the ceremonial ball court has primarily been devoted to the court itself, the ball game and its role in community integration, and/or the practice of human sacrifice as a component of ritual practices at the site (e.g., Di Peso 1974: vol. 2; Di Peso et al. 1974: vol. 8; Rakita 2001, 2009; Whalen and Minnis 1996). The classification of these individuals as human sacrifices is a crucial factor for interpreting social dynamics within this context. For example, intentional ritual killing has very different sociopolitical implications than if an individual died of natural or accidental causes and was then placed in the ball court as a dedicatory offering. As such, an important facet of this study is the use of multiple lines of evidence to evaluate the classification of these individuals as human sacrifices.

5.3 Materials and Methods

5.3.1 Materials

The materials that were analyzed for this study include the seven ball court burials and the twelve individuals from Burial Tomb 44-13. Osteological analysis was conducted on all individuals from each context. Stable isotope analysis was conducted on five individuals from the 44-13 burial tomb, two of the primary interments and three of the individuals from the comingled burial layer, which are suspected sacrifices. Burials 44F-13 and 44A-13 were selected from the articulated burials because they represent the first and last primary burial episodes, respectively. This sampling strategy was employed to assess the proposition that the burial tomb represents an elite lineage (Di Peso et al. 1974: vol. 8; Rakita 2009). If the burial deposit is that of an elite *local* lineage, we would expect the high status individuals throughout the tomb (i.e., the primary interments) to exhibit local isotope ratios. Meanwhile, if it were a *foreign* elite lineage, the earliest burials would have non-local isotope values, while the other high status individuals could exhibit either non-local or local isotope values, depending on if they were born and raised at Paquimé. Local isotope values in the comingled remains could mean that these individuals were also part of the proposed elite lineage. Meanwhile, three individuals from the ceremonial ballcourt were sampled for isotope analysis. Although it would have been ideal to analyze all of the ball court burials with teeth available, this was not possible due to the sampling strategy of the broader Casas Grandes bioarchaeology research project. Instead, one burial from each of the three pits was selected to provide a representative sample of the ball court burials as a whole.

5.3.2 Methods

5.3.2.1 Osteological Analyses

The skeletal remains of each individual were laid out in anatomical position to assess all bones that were present. The state of preservation for each bone was scored on a scale of 1 to 3 based on the approximate percentage of bone that was intact and available for analysis: 1 = > 75%; 2 = 25% - 75%; 3 = < 25% (Buikstra and Ubelaker 1994). In this study, presence/absence data and degree of preservation are used to reconstruct anthropogenic manipulation of the body after death. Sex estimation of adult individuals was based on morphological characteristics of the pelvis and cranium, as outlined in Buikstra and Ubelaker (1994). Age-at-death estimates are primarily derived from Waller (2017), but data from Di Peso et al. (1974: vol. 8) and personal observations of the skeletal material were also considered. Waller's (2017) estimates were calculated using transition analysis, a Bayesian approach that elicits more precise age-at-death estimates, particularly for older individuals, by minimizing the effects of reference sample mimicry (Boldsen et al. 2002; Milner and Boldsen 2012). These data were preferentially derived from morphological characteristics of the pubic symphysis and auricular surface when available and secondarily, from cranial suture closure, morphological characteristics of the first rib (DiGangi et al. 2009), and degree of sacral closure (Ríos et al. 2008) when os coxae were not available for analysis or when preservation was poor. The transition analysis program statistically weights the data based on the reliability of each indicator and generates a maximum likelihood estimate of age-at-death, along with a 95% confidence interval. In this study, these data are reported as the point estimate and age-at-death range, respectively. Juvenile age-at-death estimates were based on dental development and epiphyseal fusion (Buikstra and Ubelaker 1994).

All individuals were then assessed for lesions resulting from skeletal trauma, namely fractures and dislocations, which were recorded by anatomical location, type, and timing of injury (i.e., antemortem, perimortem) (Lovell 1997). The presence of perimortem trauma is generally discernable from both antemortem and post-mortem injuries because it leaves unhealed wounds, such as fractures, stab marks, or blunt force trauma. In cases of suspected human sacrifice, perimortem trauma often provides the most direct evidence of ritual violence (Tiesler 2007). The presence of healed traumatic lesions, on the other hand, serves as a record of an individual's interactions with their physical and social environs prior to death. For instance, healed fractures of the facial bones (e.g., nasals, zygomatics) may indicate that an individual was assaulted since these types of injuries are typically associated with interpersonal violence (Lovell 1997; Walker 2001).

In addition to the assessment of skeletal trauma, each bone was examined for evidence of post-mortem processing (i.e., anthropogenic modification), including cut marks, chop marks, percussion marks, spiral fracturing, burning, and polishing. Depending on the anatomical distribution of modification, the (intended) outcome of such actions can be inferred. Cut marks and blunt force trauma found around joints typically represent disarticulation and dismemberment, while those located at muscle attachment points along bone shafts are associated with defleshing (Tiesler 2007). Meanwhile, cut marks found on the skull, scapula, and clavicle can be associated with flaying, and those found in the thoracic region (vertebrae, ribs, pelvic girdle) can indicate evisceration. Other forms of post-mortem processing that have been found in archaeological skeletal assemblages include scalping, decapitation, and throat slitting (e.g., Lambert et al. 2000; Milner et al. 1991; Tiesler 2007; Walker 2001; Willey 1990). Scalping is evidenced by a series of sweeping cut marks across the frontal and parietal bones. Decapitation and throat slitting can be inferred when slicing cut marks are found on the anterior surfaces of cervical vertebrae, particularly when present on the odontoid process of the second cervical vertebra. Spiral fracturing is a distinct breakage pattern that occurs in "green" bone where collagen is still present and is often observed in long bones that have been broken apart for marrow extraction (Turner and Turner 1999; TD White 1992). This type of fracturing is common in faunal assemblages processed for consumption, therefore, the presence of spiral fracturing in human skeletal assemblages, when found in conjunction with other types of post-mortem processing, has been used as an indicator of anthropophagy (Turner and Turner 1999; TD White 1992). "Pot polish" is another indicator of processing that is associated with anthropophagy. It refers to the shiny, smooth texture that forms on the ends of long bones that have come into contact with ceramic vessels during cooking (TD White 1992). As with spiral fracturing, the presence of pot polish on human skeletal remains, when observed with other types of anthropogenic processing, may be related to anthropophagy.

Non-anthropogenic taphonomic alteration, including animal gnawing, weathering, deterioration, breakage, abrasion, and polishing was also assessed for each bone (Behrensmeyer 1978; Reitz and Wing 2008). Taphonomy is an important consideration in this study for several reasons; first, it provides information on what happened to a body between death and burial. For instance, the presence of weathering and/or animal gnawing could indicate that remains were not interred immediately after death, but were instead exposed to biotic (e.g., animals) and/or abiotic (e.g., wind, sun) processes. Second, taphonomic and anthropogenic agents can produce similar bone modifications, so it is essential to discriminate between the two processes. For example, spiral fracturing can be caused by both anthropogenic activity and animal gnawing. Similarly, tooth scoring, which is caused by the dragging of teeth across bone, can mimic cut marks produced by tools. In this study, the characteristics of cut marks (V-shaped versus U-shaped, breadth to depth ratio, etc.), as well as their frequency and anatomical distribution, were used to distinguish between taphonomic and anthropogenic modification (Blumenschine et al. 1996).

Finally, all individuals were examined for pathological lesions stemming from infectious, metabolic/endocrine, neoplastic, congenital, joint, and dental disease. The focus of paleopathological analysis in this study was on non-specific indicators of physiological stress, namely porotic hyperostosis and linear enamel hypoplasia. Porotic hyperostosis is characterized by areas of pitting and porosity on the external surface of the cranial vault or on the orbital roofs (called cribra orbitalia) (Walker et al. 2009). Porotic hyperostosis develops in response to various forms of anemia, a pathological symptom resulting from inadequate levels of healthy red blood cells or insufficient hemoglobin (Stuart Macadam 1989; Walker et al. 2009). Acquired anemia is generally caused by inadequate intake or malabsorption of key nutrients such as iron, folic acid, and vitamins A, B_6, and B_{12} (Hercberg and Rouaud 1981). Porotic lesions can be classified as active or healed, depending on whether bony remodeling has occurred (Stuart Macadam 1989). Meanwhile, linear enamel hypoplasia is characterized by bands of reduced enamel thickness resulting from premature cessation of enamel secretion (Goodman and Rose 1990). This condition can be caused by a multitude of factors but is often the result of systemic stress due to malnutrition or disease (Goodman et al. 1991; Sweeney et al. 1971; Pindborg 1982). It is important to note that linear enamel hypoplasia represents episodes of childhood stress since enamel formation occurs prior to adulthood. Along with demographic data and healed traumatic lesions, paleopathological analyses contribute to the reconstruction of an individual's lifetime exposure to disease and physiological stress.

Osteological data from Di Peso et al. (1974: vol. 8) and two doctoral dissertations, Benfer (1968) and Butler (1971), are also incorporated in this study[16]. The data from these sources are invaluable because osteological analysis of the Paquimé skeletal assemblage was conducted shortly after the burials were excavated. As such, the skeletons were undoubtedly in a much better state of preservation than they are today, after decades of handling and curation. Furthermore, skeletal elements, and sometimes entire skeletons, that were cited in Di Peso et al. (1974: vol. 8), Benfer (1968), and/or Butler (1971) are now absent from the Casas Grandes skeletal collection (Casserino 2009; personal observation).

5.3.2.2 Isotope Analyses

The use of isotopic methods to study prehistoric human sacrifice has become increasingly common over the last several decades, particularly at sites in the Americas (e.g., Andrushko et al. 2011; Price et al. 2007; Spence et al. 2004; Toyne et al. 2014; Turner et al. 2013; CD White et al. 2000, 2002, 2007; Wilson et al. 2007; Wright 2005). Isotopes of strontium and oxygen are especially useful for examining the place of origin of

[16] Most of the osteological data presented in Di Peso et al. (1974: vol. 8) is derived from Benfer (1968) and Butler (1971).

sacrificial victims because they are geographic tracers. Results from isotopic studies demonstrate a wide range of variability in terms of whether locals or immigrants were selected for sacrifice. For instance, isotopic analyses of sacrifices from Teotihuacan's Pyramid of the Moon demonstrated that most of the sacrificial victims were foreigners (Price et al. 2000, 2007), while Turner and colleagues (2013) found that sacrifices from the Huaca de los Sacrificios in Lambayeque, Peru were of local origin. Meanwhile, Toyne and colleagues (2014) have documented variability in the geographic origins of Moche sacrificial victims over time, with an earlier sacrificial group consisting primarily of locals and the later group exhibiting high variability in isotope values indicating disparate origins.

Radiogenic strontium and stable oxygen isotope analyses were conducted on five of the twelve individuals from Burial Tomb 44-13 and three of the seven ball court burials. Ideally, two teeth per individual were analyzed, one early-forming tooth and one late-forming tooth. This sampling strategy results in two data points that represent an individual's geographic location at birth and late adolescence. As such, migration that occurred during childhood can be detected if an individual has non-local isotope values in their early forming tooth, but local isotope values in their late forming tooth. Conversely, non-local values in both teeth would indicate that an individual migrated to Paquimé after late childhood/early adolescence. Detailed laboratory methods and isotope results of this analysis are presented in Chapter 3. In short, isotope results from each burial were compared to the expected local $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ ranges at Paquimé to determine whether an individual was born locally or if they immigrated to the site. Individuals with isotope ratios that fell within the local range were classified as local and those outside of it were considered to be non-local. Individuals with non-local isotope values were further classified as regional or extraregional non-locals, with the former exhibiting isotope values consistent with other sites in the Casas Grandes region. Isotope signatures of extraregional non-locals were not consistent with Paquimé or other Casas Grandes sites.

5.4 Results

5.4.1 Burial Tomb 44-13[17]

Results of the bioarchaeological analysis of Burial Tomb 44-13 are presented in Table 5.1. In this section, the data are discussed in chronological order of when the burials were deposited in the tomb, beginning with the first interments (44F-13 and 44G-13) and concluding with the uppermost layer of fragmentary remains (44H-L-13). The burial identification numbers assigned to the 44A-L-13 interments are somewhat confusing due to the complexity of this burial tomb. The primary interments are labeled in reverse chronological order because identifiers were assigned as the burials were encountered by the excavators; Burial 44A-13 was the first burial encountered, but was the last primary, articulated burial placed in the tomb. Meanwhile, Burials 44F-13 and 44G-13 were the last burials encountered by the excavators, but the first to be interred. The co-mingled and fragmentary remains comprising the uppermost layer of the tomb were of course discovered first yet were assigned identifiers of 44H-L-13.

[17] The osteological analysis of Burial Tomb 44-13 has been presented at an academic conference (Offenbecker et al. 2014) and as part of an edited book volume (Waller and Offenbecker (under review). The results presented here are derived from these sources.

Table 5.1. Bioarchaeological data from Burial Tomb 44-13.

Burial	Sex	Age	Age Range (pt. est.)	$^{87}Sr/^{86}Sr$	$\delta^{18}O$ (‰)	Geo. Origin	Trauma	Post-mortem Processing	Pathology	Grave Goods	Notes
Comingled Remains											
44H-13	F?	YA	18-35	-	-	-					
44I-13	I	AD	14-16	0.70669 0.70673	- -5.7	RNL					
44J-L1-13	I	AD	7-13	0.70713 -	-5.9 -	RNL	-	Cutmarks; Chopmarks; Burning; Peeling; Spiral fracturing; Pot Polish	Linear enamel hypoplasia; Porotic hyperostosis	-	44I-13: co-occurrence of spiral fracturing, pot polish, cutmarks, peeling and burning (anthropophagy?)
44J-L2-13	I	AD	7-13	0.70665 -	-6.4 -	L/RNL					
44J-L3-13	I	AD	7-13	-	-	-					
Articulated Burials											
44A-13	M	OA	31-86 (48)	0.70691 -	-4.3 -	L	-	-	Osteoarthritis; Schmorls nodes; tarsal coalition	see footnote[a]	
44B-13	F	YA	12-69 (28)	-	-	-	-	Cutmarks; Burning	Tarsal coalition		Some bones may belong to 44H-13
44C-13	F	YA	20-32 (20)	-	-	-	-	-	Tarsal coalition; brachydactyly		
44D-13	F	MA	17-97 (44)	-	-	-	-	-	Linear enamel hypoplasia		
44E-13	M	MA	30-72 (42)	-	-	-	healed fracture (metatarsal)	-	-	see footnote[b]	
44F-13	F	MA	30-40	0.70719 0.70695	- -5.4	L	-	-	Osteoarthritis	see footnote[c]	
44G-13	F	YA	15-22 (22)	-	-	-	-'	-	Linear enamel hypoplasia		

[a] Villa Ahumada polychrome jar; Ramos Black bowl, jar; Ramos polychrome jar; Casas Grandes tool punched effigy jar; concretion (2); shell tinklers (4); shell bead pendants (2); shell beads (12); stone ring; stone tessera; projectile point; debitage (3); mined deposit material; common turkey; ceramic handdrum; food remains

[b] Casas Grandes plainware jar; Madera black-on-red bowl; Ramos polychrome jar; shell tinklers (5); stone pendant; food remains

[c] Stone beads (39); stone pendant (1); shell beads (39); shell pendant (1); shell tinklers (18); pestle; Ramos polychrome jar; matting; miniature plainware ladle

Burial 44F-13 was a middle-aged adult female, likely in her thirties. Transition analysis yielded an age-at-death range of 15 to 64, with a point estimate of 22 years (Waller 2017), while Di Peso (1974: vol. 8) scored this individual as a middle adult (36 – 50 years). The os coxae were not present, so the two most reliable indicators of age-at-death, the pubic symphysis and the auricular surface could not be scored. Cranial suture closure indicates that this was an older individual, however, this age-at-death indicator is far less precise and accurate than pelvic indicators (Milner and Boldsen 2012; Milner 2010). The point estimate of 22 years is largely based on the observation that the first and second sacral vertebrae were not fully fused, which normally occurs during the mid-twenties to mid-thirties (Passalacqua 2009; Ríos et al. 2008). However, this individual had several degenerative changes that were atypical for a young adult. First, osteoarthritis was present throughout the vertebral column and on the occipital condyles of the cranium. Second, resorption of the right mandibular second premolar, first molar, and second molar had also occurred. When considered in tandem, these data suggest an age-at-death in the thirties.

The bones that were present for Burial 44F-13 were well preserved, particularly the skull and thorax, but the os coxae, sacrum, both femora and the left humerus were missing. Other than the osteoarthritis mentioned above, there were no pathological lesions, trauma, congenital anomalies, post-mortem processing, or taphonomic changes observed in this skeleton. Burial 44F-13 had $^{87}Sr/^{86}Sr$ values of 0.70719 and 0.70695 in her lateral incisor and third molar, respectively, and a $\delta^{18}O$ value of -5.4‰ in the third molar. Oxygen isotope data was not available for the lateral incisor. All isotope values are consistent with the isotope range established for Paquimé, which indicates that this individual was born locally. Burial 44G-13, a young adult female aged 15 to 22 (point estimate of 22 years), was placed alongside Burial 44F-13. All bones were present and well preserved, receiving scores of 1 (> 75% intact) or 2 (25% - 75% intact). There was no evidence of trauma, post-mortem processing, taphonomic alteration, cultural modification, or congenital anomalies, and the only pathological lesion observed was mild linear enamel hypoplasia on the maxillary canines. Isotope analysis was not conducted on this individual.

The next burial event consisted of two individuals, 44E-13 and 44D-13, the former of which is thought to have been the most important individual in the tomb (Di Peso et al. 1974: vol. 8). Burial 44E-13 was a middle adult male aged 30 to 72 (point estimate of 42 years) and was found in a supine position with his legs frogged out to the side with Burial 44D-13, a middle adult female aged 17 to 97 (point estimate of 44 years), placed face down on top of him. The legs of Burial 44D-13 were also frogged out to the side and her face was placed in the pelvis of 44E-13. The skeleton of 44E-13 was largely intact and well preserved. Burial 44D-13 was missing most of the lower limb bones, however, all other bones that were present were well preserved.

An antemortem fracture with evidence of bone remodeling was found on the right fifth metatarsal of Burial 44E-13. The advanced stage of healing suggests that this injury was sustained long before death. Mild osteoarthritis was observed on the lumbar vertebrae and several wormian bones, including an apical bone and lambdoid ossicles, were present along the cranial sutures. There was no evidence of post-mortem processing or taphonomic changes in this skeleton. Burial 44E-13 was extremely robust and had a body mass estimate of 68.5 kilograms, which was much higher than the average male at the site (56 kg) (Offenbecker et al. 2014). Very few teeth were present and those that were exhibited extensive dental attrition, so no samples were collected for isotope analysis. Meanwhile, Burial 44D-13 did not have signs of trauma, post-mortem processing, or taphonomic alteration on the skeleton and the only pathology present was a hypoplastic lesion on the left mandibular incisor. Isotope analysis was not conducted on this individual.

The next burial placed in the tomb was 44C-13, a young adult female aged 20 to 32 (point estimate of 20 years). Most of the skeleton was present and moderately well preserved. No traumatic lesions, post-mortem processing, pathological lesions, or taphonomic changes were observed in this individual. She did, however, have two congenital anomalies of the feet; bilateral tarsal coalition (naviculocuneiform I) and bilateral brachydactyly of the first proximal pedal phalanges. Tarsal coalition was identified by pitting present on the corresponding articular surfaces of the navicular and first cuneiform, which forms as the result of a cartilaginous bridge between the two bones during life (Burnett and Wilczak 2012). Brachydactyly was identified by the abnormal shortness in length of the proximal phalanges relative to the other phalanges (Bell 1951). No samples were collected for isotope analysis.

The fourth and final set of articulated interments consisted of Burial 44A-13, an old adult male aged 31-86 (point estimate of 48 years), and Burial 44B-13, a young adult female aged 12 to 69 (point estimate of 28 years). The skeleton of 44A-13 was mostly complete and in a fair state of preservation, with most bones receiving scores of 2 (i.e., 25% to 75% complete). Like Burial 44E-13, Burial 44A-13 was extremely robust. His estimated body mass was 63.8 kg, which is roughly 8 kg larger than the average male at Paquimé (Offenbecker et al. 2014). Extensive osteoarthritis was found throughout the vertebral column and on several of the tarsals, metatarsals, carpals, phalanges, and left public symphysis. Schmorl's nodes, which are caused by herniated intervertebral disks, were also observed on three thoracic vertebrae. This individual had extensive tooth wear, with two of the teeth (a maxillary canine and a mandibular second molar) being worn through to the pulp chamber. Healed porotic hyperostosis was present on the parietal bones and non-osseous tarsometatarsal coalition of the third cuneiform and third metatarsal (CF3-MT3) was observed in the left foot. The condition may have been bilateral, but the right CF3 and MT3 were not observable. There was no evidence of traumatic lesions, post-mortem processing, or taphonomic alteration. A left mandibular first premolar was sampled for isotope analysis and had a $^{87}Sr/^{86}Sr$ value of 0.70691 and a $\delta^{18}O$ value of -4.3‰, both of which are within the estimated isotopic range at Paquimé, indicating local origins for Burial 44A-13.

Di Peso and colleagues (1974: vol. 8) noted that Burial 44B-13 consisted of only a skull, however, a substantial portion of postcranial remains were labeled as 44B-13. It is likely that these adult postcranial elements were re-associated with the skull during the initial laboratory analysis of the Paquimé skeletal assemblage or that they were mislabeled and actually belong to the young adult in the uppermost layer of disarticulated bones. Several extra juvenile bones were also found with the 44B-13 skeletal remains and likely belong to individuals 44H-L-13. The comingling of Burial 44B-13 with Burials 44H-L-13 is not surprising because 44B-13 was found at the interface of the articulated burials and uppermost layer of fragmentary and disarticulated remains. Some of the bones associated with Burial 44B-13 exhibit evidence of post-mortem processing, including cut marks on several right rib fragments and along the neck of the left femur. Burning was also present on a rib fragment. Non-osseous CF3-MT3 coalition was observed in both feet. There was no evidence of trauma, pathological lesions, or taphonomic alteration and no samples were collected for isotope analysis.

The uppermost burial layer in the tomb consisted of the highly fragmentary and disarticulated comingled remains of five individuals, 44H-L-13. Burial 44H-13 was a young adult (possibly a female), but the remains were too fragmentary for more precise sex and age-at-death estimates. Burial 44I-13 was an older adolescent aged 14 to 16 and the remaining three individuals (44J-L-13) were juveniles between the ages of 7 to 13. Many of the skeletal elements recovered from this context could not be assigned to specific individuals because the bones were highly fragmented, and the similar ages of the individuals made re-association difficult. Despite this limitation, a consistent pattern of post-mortem processing was observed among the 44H-L-13 burial fragments.

The most common type of anthropogenic modification was cut marks, which were found in abundance throughout the comingled burial assemblage. Cut marks were identified on most bones of the skeleton but were most frequently observed on the bones of the cranium (frontal, mastoids and parietals), clavicles, vertebrae, ribs, radii, ulnae, os coxae, and femora. A few isolated cut marks were also found on the bones of the hands and feet, including a first proximal pedal phalanx (Figure 5.3). There was extensive processing on several of the clavicles, with most cut marks occurring on the anterior and inferior surfaces of the bone. One clavicle had at least 25 distinct cut marks near the sternal end of the bone (Figure 5.4). Cut marks were found on the spinous processes of a series of three contiguous thoracic vertebrae, which represent superior-inferior slicing/cutting along the vertebral column. Cut marks were also observed on two left rib fragments near the tubercle and may have been from the same individual. Finally, cut marks on long bones were found near the proximal and distal ends of the shaft and were typically oriented perpendicular to the long axis of the bone (Figure 5.5). Some of these bones also showed evidence of peeling, which occurs when fresh bone fragments are forcefully pulled apart (TD White 1992). Chop marks were not as common as cut marks, but were observed on an os coxa fragment, near the preauricular sulcus. The location of this mark suggests that it was due to post-mortem modification rather than perimortem trauma.

Figure 5.3. Multiple cut marks on a pedal proximal phalanx from Burial 44H-L-13.

Figure 5.4. Clavicle from Burial 44H-L-13 with over 25 cut marks.

Figure 5.5. Ulna fragment with cut marks (red arrows) from Burial 44H-L-13. Possible peeling also evident on shaft.

Long bones from Burial 44I-13 exhibited spiral fracturing, pot polish, and discoloration that may have been due to cooking or burning (Figure 5.6). Burning was also observed on several other bones, including isolated cranial fragments, an acromion process, and femoral shaft fragments. A few long bone fragments placed in the general "44-13" burial bag had an abnormally smooth and glassy texture that may indicate heat exposure, perhaps due to cooking or boiling. Although these fragments were not associated with a specific burial, these fragments likely belong to one of the 44H-L-13 individuals given the overall pattern of post-mortem processing in the uppermost comingled layer (and lack thereof among the articulated burials).

Figure 5.6. Femoral fragment from Burial 44I-13 exhibiting "pot polish" (white arrows) and discolouration (possibly due to burning/cooking) (red arrows).

In addition to extensive post-mortem processing, linear enamel hypoplasia and porotic hyperostosis were common among the comingled burials. Each individual had at least two hypoplastic lesions and several of the parietal fragments exhibited pitting and porosity characteristic of porotic hyperostosis. None of the porotic lesions appeared to be active at the time of death. Burial 44I-13 had four hypoplastic lesions on a single tooth, indicating multiple episodes of physiological stress. There was no indication of either antemortem or perimortem trauma on any of the comingled remains, nor was there evidence of taphonomic modification, such as animal gnawing. Teeth from three of the five comingled burials were sampled for isotope analysis. Burial 44I-13 had two teeth available for analysis, a central incisor and a third molar, which had $^{87}Sr/^{86}Sr$ values of 0.70669 and 0.70673, respectively. There was not enough enamel on the incisor for both strontium and oxygen isotope analyses, so the latter was not conducted. The third molar $\delta^{18}O$ value is -5.7‰. While the $\delta^{18}O$ ratio is within the expected local range (but close to the lower boundary of -5.8‰), the $^{87}Sr/^{86}Sr$ values in both teeth are below the established local range at Paquimé. These values are consistent with sites in the southern Casas Grandes region (Chapter 3), so this individual was classified as a regional non-local.

The other two teeth that were sampled from the comingled remains could not be associated with a specific individual, so they were assigned Burial IDs of "44J-L1-13" and "44J-L2-13". A right maxillary central incisor from Burial 44J-L1-13 had a $^{87}Sr/^{86}Sr$ value of 0.70713 and a $\delta^{18}O$ value of -5.9‰. The $\delta^{18}O$ value for 44J-L1-13 is just outside of the lower boundary of the local range, while the $^{87}Sr/^{86}Sr$ value is consistent with the expected strontium isotope range at the site. As such, this individual was classified as a local/regional non-local. If they were not born at Paquimé, they likely migrated from a nearby location that has similar underlying geology, but with a higher elevation and/or cooler, wetter conditions, the latter of which would cause lower $\delta^{18}O$ values. Possible geographic areas with these conditions include the foothills to the south or west of Paquimé and a few isolated summits to the northeast of the site. Meanwhile, the right maxillary lateral incisor from Burial 44J-L2-13 had a $^{87}Sr/^{86}Sr$ value of 0.70665 and a $\delta^{18}O$ value of -6.4‰. Both the strontium and oxygen isotope values for Burial 44J-L2-13 were below the local range, suggesting this individual was not born at Paquimé, but instead was a regional immigrant from within the Casas Grandes region (Chapter 3).

5.4.2 Ball Court Burials

The results from the ball court burial analysis are presented in Table 5.2. The first individual placed in the centre pit of the ball court was Burial 2-14, an adolescent/young adult male, aged 15 to 24 (point estimate of 15 years). This skeleton was the most complete and well-preserved of all the ball court burials. Di Peso and colleagues (1974: vol. 8:398) noted that Burial 2-14's "skull [was] crushed," but did not elaborate as to whether this refers to trauma or the state of preservation. Upon examination, the neurocranium and jaw were largely intact, however, the frontal bone was not as well preserved. Despite the poor condition of this bone, a very mild depression fracture was visible on the frontal squama. There was no evidence of bone remodeling around the lesion, which suggests that the injury occurred perimortem. There was no evidence of trauma in the remainder of the skeleton, nor were there signs of post-mortem processing on any of the bones. Puncture marks resulting from carnivore gnawing were found on the bones of the hands and feet and on the bodies of several cervical and lumbar vertebrae. Several teeth in the anterior dentition had one hypoplastic lesion each. In addition, this individual had brachydactyly of the first distal phalanx in his left hand. Finally, Burial 2-14 had $^{87}Sr/^{86}Sr$ values of 0.70836 and 0.70832 and $\delta^{18}O$ values of -5.6‰ and -5.0‰ in his lateral incisor and third molar, respectively. The radiogenic strontium isotope values are outliers when compared to the local $^{87}Sr/^{86}Sr$ range at the site (0.70682 – 0.70748), therefore this individual was classified as an extraregional non-local.

Table 5.2. Bioarchaeological data from the ball court burials.

Burial	Sex	Age	Age Range (pt. est.)	$^{87}Sr/^{86}Sr$	$\delta^{18}O$ (‰)	Geo. Origin[a]	Trauma	Post-mortem Processing	Pathology	Taphonomy	Grave Goods	Notes
North End												
4-14	F	OA	23-85 (51)	-	-	-	Blunt force trauma (occipital)	Severed Feet	-	Puncture marks	-	Secondary burial
5-14	M	MA	36-50	-	-	-	-	-	Porotic hyperostosis; Caries	Puncture marks; Scoring	-	Secondary burial
6-14	F	OA	35-91 (76)	0.70625 0.70626	-5.6 -6.1	RNL	Chopmark (vertebra)	-	Porotic hyperostosis; Caries	Puncture marks	-	-
Centre												
1-14	M	YA	27-54 (27)	-	-	-	-	-	Caries; Root caries	Puncture marks	rubbing stone	Sitting on 2-14
2-14	M	AD	15-24 (15)	0.70836 0.70832	-5.6 -5.0	ERNL	Blunt force trauma (frontal)	-	Linear enamel hypoplasia; brachydactyly	Puncture marks	-	-
South End												
3A-14	F	YA	30-33	-	-	-	-	-	-	Puncture marks	rubbing stone; food remains; polychrome jar; cotton seeds; charcoal	Pregnant; Sitting on 7-14
7-14	F	YA	17-42 (26)	0.70719 0.70712	-6.0 -6.3	L/RNL	-	Detached Arm	Caries; Root caries	Puncture marks	-	-

[a] L/RNL=Local/regional non-local; RNL=Regional non-local; ERNL=Extraregional non-local

Burial 1-14, a young adult male aged 27 to 54 (point estimate of 27 years), was found in a seated and flexed position directly on top of Burial 2-14. Both burials were found in close association to a "spirit hole" that was demarcated by a large white stone. The skull of this individual was well preserved, with most of the neurocranium intact. Much of the axial skeleton, as well as the pelvic girdle and both femora, were present and well preserved. However, all other limb bones, except for the left tibia, were missing. Burial 1-14 had similar taphonomic modifications to Burial 2-14, with carnivore puncture marks on many of the hand and foot bones, particularly the metatarsals. Burial 1-14 had extensive decay of the cementum (root caries) on the distal interproximal surface of his upper left first molar just distal to the cementoenamel junction. There was also a thick line of dental calculus along the distal portion of the root trunk, which is further evidence of extensive gingivae (gum) recession and periodontal disease. Carious lesions were observed on the interproximal surfaces of the lower right canine and first premolar. There was no evidence of trauma or post-mortem processing on any of the bones present for analysis. Isotope analyses were not conducted on this individual.

The burial pit at the south end of the ball court contained two individuals, Burials 3A-14 and 7-14. Individual 3A-14 was a young adult female aged 30 to 33[18], who was pregnant at the time of her death, as evidenced by the fetal remains found in association with her skeleton. Most bones present for analysis were well preserved. The skull, femora, and right patella were missing. Benfer (1968) and Di Peso and colleagues (1974: vol. 8) noted that occipital flattening was evident in this cranium, so the skull must have been recovered but was later separated from the rest of the burial. Burial 3A-14 did not have evidence of trauma, post-mortem processing, pathological lesions, or congenital anomalies. Puncture wounds from carnivore gnawing were found on the tarsals, metatarsals, and sacrum. No teeth were present for isotopic analyses.

Burial 7-14 was found directly beneath Burial 3A-14 at the south end of the ball court. This young adult female, aged 17 to 42 (point estimate of 26 years), was placed in a

[18] The age-at-death estimate for Burial 3A-14 was 33 to 83 (point estimate of 58 years). Given that fetal remains were found in association with this individual, it seems unlikely that the point estimate is accurate. As such, a combination of Di Peso's (1974: vol. 8) original age-at-death estimate (30-32 years) and the lower limit of the 95% confidence interval (33 years) calculated from Waller's (2017) transition analysis were used for the age-at-death assigned here.

seated, flexed position and was found with her right arm detached and draped around her shoulders (Di Peso et al. 1974: vol.8). Except for the right os coxa, all bones were present for analysis but varied in their state of preservation. There were no signs of trauma or post-mortem processing. The lack of post-mortem processing around the right shoulder joint was somewhat surprising because the right arm had apparently been detached from the body. The right scapula and clavicle were poorly preserved, so it is possible that cut marks caused by dismemberment may have been eliminated or obscured. However, the proximal end of the right humerus was in an excellent state of preservation yet did not exhibit signs of anthropogenic modification. As with the other ball court burials, there was evidence of carnivore gnawing (puncture marks) on the tarsals and several of the vertebrae. The only evidence of pathology was a carious lesion on the occlusal surface of the right maxillary third molar. Finally, the right mandibular central incisor and right maxillary third molar had $^{87}Sr/^{86}Sr$ values that were consistent with the local range at Paquimé (0.70719 and 0.70712, respectively), but $\delta^{18}O$ values that were slightly lower than expected for this region (-6.0‰ and -6.3‰). As such, this individual was classified as a local/regional non-local.

The burial pit located at the north end of the ball court contained one primary interment and two secondary interments. The primary interment, Burial 6-14, was an old adult female, aged 35 to 91 (point estimate of 76 years). With the exception of the right and left radii, left os coxa, sternum, and lumbar vertebrae, most bones were present for analysis and in a fair state of preservation. A chop mark was found on an isolated spinous process of a thoracic vertebra. There were no signs of bone remodeling, which indicates that the lesion was caused by either perimortem trauma or post-mortem processing. No evidence of post-mortem processing was observed elsewhere in the skeleton. Puncture marks resulting from carnivore gnawing were present on the tarsals, metatarsals, and right patella. The parietal bones exhibited surface pitting and porosity characteristic of porotic hyperostosis. In addition, the teeth of this individual were extremely worn and had carious lesions on the occlusal surfaces of the left mandibular third molar and right maxillary canine, the latter of which extended into the pulp chamber of the tooth. Finally, Burial 6-14 had $^{87}Sr/^{86}Sr$ values of 0.70625 and 0.70626 and $\delta^{18}O$ values of -5.6‰ and -6.1‰ in their right mandibular first premolar and left maxillary third molar, respectively. The

$^{87}Sr/^{86}Sr$ values from both teeth and the $\delta^{18}O$ value from the third molar are outside of the established local isotope range for Paquimé, but consistent with the southern zone of the Casas Grandes region [19], which indicates that this older adult female was a regional non-local.

Burial 4-14, a female aged 23 to 85 (point estimate of 51 years) was one of two secondary burials placed above Burial 6-14 in the north end burial pit. According to Di Peso et al.'s (1974: vol. 8) description of Burial 4-14, it consisted of a skull, long bones, a pelvis, and the articulated bones of a severed pair of feet. However, the storage box for Burial 4-14 did not contain a pelvis or foot bones other than a right calcaneus, but a relatively complete neurocranium and most long bones (expect for the left forearm bones and right ulna) were present and in a moderate state of preservation. Puncture marks from carnivore gnawing were present on the epiphyses of these bones. A slight depression wound was found just above the nuchal crest of the occipital bone, with no evidence of bone remodeling. Anthropogenic modification was not observed on any of the bones. Additionally, no pathological lesions were found on Burial 4-14, though Benfer (1968: figure 4) and Di Peso et al. (1974: vol. 8) recorded anterior fusion of the eleventh and twelfth thoracic vertebrae. These bones were not available for the present analysis.

Burial 5-14, an adult male aged 36 to 50[20], was the other secondary burial placed in the south pit. This burial consisted of a fragmentary skull, right humerus, and hand and foot bones. These bones were quite robust, suggesting this was a large individual. The mandible, humeral shaft, and bones of the hands and feet had puncture marks and scoring that were consistent with carnivore gnawing. There was no evidence of trauma or post-mortem processing and no congenital anomalies were observed. Porotic hyperostosis was present on the parietal bones and enamel hypoplasia was observed on the mandibular canines. In addition to the hypoplastic lesions, the entire dentition was characterized by substantial wear and there was a severe carious lesion on the distal side of the right

[19] As noted in Chapter 3, geological data indicates that areas in northeast Sinaloa along the Chihuahua and Durango borders have $^{87}Sr/^{86}Sr$ values between 0.7047 to 0.7063 (Damon et al. 1983), which overlap slightly with the southern zone of the Casas Grandes region (0.7063 – 0.7067). As such, it is plausible that Burial 6-14 could have come from other parts of Northwest Mexico, but as I have argued previously, short-distance movement from within the Casas Grandes region is more likely given the small degree of overlap in the aforementioned $^{87}Sr/^{86}Sr$ ranges.

[20] Age-at-death estimate from Di Peso et al. (1974: vol. 8).

maxillary first molar at the cementoenamel junction. Stable isotope analysis was not conducted on Burial 5-14. An extra pair of humerii were present in the 4-14/5-14 storage box, though it is unclear whether these were found in the north end burial pit along with Burials 4-14, 5-14, and 6-14 because they were not mentioned in the burial report (Di Peso et al. 1974: vol. 8). There was no evidence of trauma, post-mortem processing, taphonomic alteration, or pathology on these extra bones.

5.5 Discussion

5.5.1 Burial Tomb 44-13

This context was chosen as a case study because it allowed for a direct comparison of burials that are believed to represent the extremes of social status and mortuary treatment at Paquimé: elites and human sacrifices. The goal of this section is to answer the following three questions, which will lead to a better understanding of the identity of the individuals interred in this unique burial context: (1) Was this an elite burial tomb? (2) Were all individuals interred in the tomb part of the same lineage? (3) Do the comingled remains represent a sacrificial offering to the individuals below? Once these questions have been addressed, the relationship between ritual practices, social dynamics, and geographic origins will be discussed.

5.5.1.1 Comparison of Primary Interments and Comingled Remains

It is clear from the results of this study that there are striking differences between the lower layer of articulated interments and the upper layer of comingled remains. The most conspicuous difference between the two sets of burials is the way in which these individuals were treated after death. The articulated burials were purposefully placed within the tomb, some arranged in unique positions and/or interred with elaborate burial goods. Apart from some bones assigned to Burial 44B-13, which might instead belong to the uppermost burial layer, there is no evidence of anthropogenic modification to these remains.

In contrast to the articulated burials, the uppermost layer of comingled remains was disarticulated, fragmentary, and characterized by extensive post-mortem processing. Although many of the bones could not be assigned to specific individuals, all of the individuals in this deposit were heavily processed after death. Several forms of corpse processing are evident from the anatomical distribution of cut marks throughout the skeleton. The slicing cut marks on the clavicles and skull were likely due to flaying since there is minimal soft tissue between the skin and these elements (Medina and Sánchez 2007; Tiesler 2007). Some of the cut marks on the clavicle may also be due to defleshing of muscle tissue, and more specifically, of the sternocleidomastoid muscle. This observation is based on the presence of corresponding cut marks on the anterolateral surface of the mastoid process (sternocleidomastoid muscle insertion point) and on the superior surface of the clavicle (sternocleidomastoid origin). Perpendicular cut marks on long bone shafts also indicate defleshing along muscle attachment points in the limbs (Tiesler 2007). Finally, chop marks near the preauricular sulcus of the os coxa are consistent with dismemberment at the hip joint. The observed pattern of post-mortem processing in the comingled remains is consistent with ethnographic, iconographic, and osteological evidence from Mesoamerica, which indicate that dismemberment, defleshing, and flaying are characteristic of sacrificial deposits throughout the region (e.g., Anda 2007; Graulich 2000; Medina and Sánchez 2007). According to Tiesler (2007), flaying is also particularly common in mass burial deposits in the Maya region.

The lack of taphonomic alteration on any of the 44-13 burials indicates that the individuals in this tomb were likely interred shortly after death and not exposed to taphonomic agents (e.g., scavengers). There was also no evidence of trauma (antemortem or perimortem) on any of the comingled remains, which was somewhat surprising for a deposit of suspected human sacrifices. It is possible that the high degree of fragmentation and poor preservation of the comingled remains could have obscured traumatic lesions. It is also possible that cut marks attributed to post-mortem processing were caused by perimortem trauma, especially given the fragmentary nature of the assemblage. For example, some of the cut marks found on bone fragments from the thoracic region may be stab wounds or trauma resulting from evisceration, both of which have been reported in ancient Mesoamerican human sacrifice (Tiesler and Cucina 2006; Tiesler 2007). However, the evidence at hand does not indicate perimortem trauma on the skeletons in the comingled layer. Among the articulated burials, 44E-13 was the only individual with evidence of trauma. The well-healed fracture on a metatarsal is consistent with accidental injury (e.g., something heavy falling on the bridge of the foot) as opposed to interpersonal violence.

The biological/demographic profiles of the primary interments were also strikingly different from those of the disarticulated burials. All of the articulated burials were adults, whereas the disarticulated individuals were primarily juveniles. The presence of four juveniles together in the same tomb is atypical when compared to expected paleodemographic age-at-death distributions in pre-industrial populations, where late childhood and adolescent mortality is generally low (Hoppa and Vaupel 2002). In short, early adolescence is not a precarious life stage, therefore the presence of four juveniles from this age category is highly unusual, especially given the atypical mortuary context in which they were found.

In addition to demographic variation, the individuals in the comingled burial layer experienced high levels of physiological stress during their short lives. All individuals in the uppermost layer had two or more hypoplastic lesions per tooth, which suggests they experienced multiple episodes of physiological stress. Although approximately 37% of Paquimeños with observable dentitions (N=210) had enamel hypoplasia, only 9% had two or more hypoplastic lesions per tooth (Waller 2017). Thus, the presence of multiple hypoplastic lesions is atypical when compared to the population as a whole. The presence of porotic hyperostosis on many of the cranial fragments suggests that these adolescents were also anemic. It is possible that enamel hypoplasia was also caused by anemia or may have been the result of other, non-related systemic stresses. Whatever the case, it appears that these individuals were in a perpetual state of poor health during their short lives.

Indicators of physiological stress were observed on three of the articulated burials; first, Burial 44A-13 had healed porotic hyperostosis, which indicates that this old adult male experienced anemia as a child. Second, Burials 44D-13 and 44G-13 had one hypoplastic lesion each in their anterior dentitions, which indicates that these individuals experienced physiological stress during early childhood when the enamel on those teeth was forming. It should be noted that the low incidence of enamel hypoplasia could be due to the extensive tooth wear observed among several of the older adults. However, the exceptionally large body mass of Burials 44E-13 and 44A-13 suggests that these individuals had more than adequate access to resources during growth and development.

Furthermore, Burials 44A-13, 44D-13, and 44G-13 experienced childhood stress, yet were able to recover from these insults and survive into adulthood. Thus, although some of the primary interments have evidence of physiological stress during childhood, the comingled burials appear to have experienced higher morbidity.

The results of the radiogenic strontium and oxygen isotope analyses revealed yet another source of variation between the two burial deposits in the 44-13 tomb. Of the two articulated burials that were sampled (44F-13 and 44A-13), both had unambiguously local isotope values, while two of the three individuals from the comingled burial layer had non-local isotope values and the other was classified as a local/regional non-local. Individuals 44F-13 and 44A-13 represent the first and last of the articulated burials deposited in the tomb, respectively. Both individuals were found to be amongst the highest ranking individuals at Paquimé in a previous study (Ravesloot 1988), as well as in the mortuary analysis presented in Chapter 4 of this thesis. Thus, the combined mortuary and isotopic data suggest that these individuals were part of a *local* elite lineage.

Meanwhile, two of the three juveniles from the uppermost layer, 44I-13 and 44J-L2-13, were regional non-locals with strontium isotope values that were consistent with sites in the southern Casas Grandes region. Burial 44J-L2-13 had only a lateral incisor available for analysis and enamel formation in this tooth is complete by the age of 4 to 5.5, which means this individual came to Paquimé sometime after that age, but before the age of 7 to 13, which is their estimated age-at-death. Burial 44I-13 had two teeth available for analysis, a central incisor and third molar, which represent this individual's geographic location at birth/infancy and early adolescence. Both teeth had non-local isotope values, which means they came to Paquimé after the formation of their third molar enamel was complete (i.e., 12 to 13 years-of-age) but before they died at age 14 to 16. Based on these estimates, this individual likely came to Paquimé within a year or two of their death, but possibly immediately prior to their death, which could indicate that they were brought to the site as a captive. The age-at-death of this individual is consistent with captive taking in non-state level societies, where women and children are acquired during raids or small-scale warfare (Cameron 2013), but this scenario is difficult to assess based on the evidence currently available. It is noteworthy that Burials 44I-13 and 44J-L2-13 have isotope values that indicate similar geographic origins because it raises the question of whether relationships between Paquimé and groups from this region were antagonistic. This scenario will be discussed in the following section.

The presence of at least two non-locals among the comingled remains suggests that these individuals were not part of the local elite lineage represented by the articulated burials in this tomb. Burial 44J-L1-13 was classified as a local/regional non-local, so if this individual was born locally, it means that both locals and non-locals were among the suspected human sacrifices in this context. If this is the case, geographic origins was not the only factor that led to their placement in this ritually-charged context. One characteristic that these individuals did have in common was the presence of several non-specific stress indicators (i.e., enamel hypoplasia and porotic hyperostosis) and evidence for multiple episodes of physiological stress per individual. Cucina and Tiesler (2007) have suggested that unhealthy adolescents may have been chosen for sacrifice at sites in Campeche precisely because they were less useful to society. Although case studies from state-level societies in Mesoamerica are not directly applicable to Paquimé, I would argue that the rationale of sacrificing less useful individuals would certainly occur to members of both state- and mid-level societies.

In summary, the elaborate construction of the tomb, unique burial positions (legs frogged), and types and quantities of burial goods associated with this mortuary context indicate that articulated burials belonged to important/high status individuals (Carr 1995; Tainter 1975). Furthermore, these individuals had better health overall when compared to the individuals in the uppermost layer, which suggests they had adequate access to resources and buffering against stress during life. Burials 44A-13 and 44F-13 also have unambiguously local isotope signatures and their placement together in a burial tomb located within a residential room block suggests that these individuals were members of the same kin group. The presence of mid-foot tarsal coalition, a highly heritable congenital anomaly (Burnett and Wilczak 2012), in three of the primary burials provides further support for genetic affinity. Thus, multiple lines of evidence suggest that the primary interments represent a local elite lineage. It is unlikely, however, that the comingled remains belong to this lineage since at least two of the three individuals have non-local isotope signatures.

The final question posed in this section was whether the individuals in the uppermost burial layer were human sacrifices. Kohn (2011) has argued that the entire upper layer of Burial Tomb 44-13 is a sacrificial offering to the individuals below because it consists of the scattered and fragmentary sherds of at least eight ritually killed ceramic hand drums, a decapitated turkey, and the disarticulated remains of at least five individuals. In this study, multiple lines of evidence from the uppermost burial layer point to the same conclusion. These include an atypical demographic profile, extensive mortuary processing characteristic of sacrificial assemblages, poor health, non-local geographic origins, and possible evidence of captive taking. Although no perimortem trauma indicating violent death was identified, the other lines of evidence discussed above are consistent with the practice of human sacrifice in Mesoamerica (Tiesler 2007). I would argue that the strongest evidence for sacrifice, as opposed to other funerary practices, is the atypical demographic profile of the uppermost layer, whereby four (possibly low status) juveniles of around the same age – an age at which mortality is generally low - ended up in this unique mortuary context. This deposit appears to represent a form of attendant or companion sacrifice that was performed in mourning or commemoration of the elites below. Companion sacrifice is typically characterized by the interment of individuals in atypical/disrespectful positions that lack grave goods and are found in association with elite burials (Cucina and Tiesler 2006; McAnany 1995), which aligns well with the characteristics of this burial.

Kohn (2011) also suggested that the extensive post-mortem processing on the comingled remains in Burial 44-13 was indicative of anthropophagy. In fact, both Kohn (2011) and Casserino (2009) have suggested that anthropophagy was practiced at Paquimé throughout the Medio Period. While I am skeptical about some of the other proposed cases of cannibalism, I did observe cut marks, chop marks, burning, spiral fracturing, pot polish, and possible bone peeling on the 44H-L-13 remains (Figures 5.5 and 5.6). These indicators are part of a suite of traits used to evaluate possible cases of anthropophagy from archaeological contexts (Turner and Turner 1999; TD White 1992). It is important to emphasize that these bone modifications are meant to be used as a *suite* of traits, rather than as individual indicators. In addition, they should be used in conjunction with contextual evidence of atypical (non-funerary) mortuary treatment (e.g., association with food refuse or cooking/butchering implements, haphazard or careless disposal of the remains) or empirical evidence for the consumption of human tissue. For example, a human coprolite that contained human muscle tissue was used to buttress claims of anthropophagy that were based on butchered human remains at an Ancestral Pueblo site in the American Southwest (Billman et al. 2000; Marlar et al. 2000).

Although not all bones in the co-mingled deposit could be assigned to a specific individual, Burials 44H-13 and 44I-13 were exceptions. Burial 44H-13 was a young adult and 44I-13 was an older adolescent (aged 14-16), therefore both were distinguishable from the three younger adolescents, 44J-L-13. Multiple indicators of anthropophagy, including cut marks, burning, pot polish, and spiral fracturing were observed on the remains of one individual, Burial 44I-13 (Figure 5.6), while other indicators, such as chop marks and bone peeling, were observed on other bones that could not be attributed to a specific individual. Importantly, there was no evidence of taphonomic alteration (e.g., animal gnawing,) on any of the comingled remains that might mimic anthropogenic modification. The presence of pot polish (Figure 5.6) in conjunction with several other types of post-mortem processing is certainly compelling evidence for the practice of anthropophagy in this sacrificial context. Additionally, the presence of several indicators in one individual (Burial 44I-13), a regional non-local who may have been brought to Paquimé as a captive and at the very least, arrived at the site within a year or two of their death, adds further intrigue to the scenario. If the flesh of these individuals was consumed, it was likely for ceremonial purposes given the ritually-charged nature of this mortuary context. However, it is also possible that the post-mortem manipulation of these individuals may have been related to funerary practices that did not involve anthropophagy. At present, I believe it is reasonable to conclude that ritual anthropophagy *may* have occurred in this context, but comprehensive trauma and taphonomic analyses of the Paquimé skeletal assemblage are necessary before such practices can be generalized to the broader population.

5.5.1.2 Ritual, Social Dynamics, and Geographic Origins

Rakita (2009) has proposed that one of the two cults operating at Paquimé was the ancestor/political cult. This cult was characterized by private mortuary rites, human sacrifices, control of access to the ancestors, exclusivity, and was represented by Ramos Black ceramic vessels. He also suggested that much of the activity of this cult was centred in Unit 13 (The House of the Dead), where the 44-13 burials were located. The evidence presented for Burial Tomb 44-13 (i.e., the tomb's private mortuary context, ongoing ritual activity, a turkey sacrifice, and the inclusion of two Ramos Black vessels) aligns well with the proposed activities of the ancestor cult. The emphasis on private mortuary rites might also explain why there is no evidence of taphonomic alteration on these remains. If the corpses of these individuals had been placed in extramural locations for an extended period after death, we might expect to find taphonomic evidence of exposure to the scavenging or other abiotic processes (e.g., sun, wind). Instead, it appears that interment occurred shortly after the death and mortuary processing of these individuals.

Various scholars have suggested that because Paquimé was a mid-level society undergoing the incipient stages of social stratification, competition for elite status, power, and authority would have been common (e.g., Harmon 2005, 2006; Rakita 2001, 2009; Whalen and Minnis 1996). Rakita (2009) has argued that such rivalries often played out in ritually-charged mortuary contexts, including Burial Tomb 44-13. The presence of at least two non-locals in the comingled burial layer suggests that graveside status competition may have included the sacrifice of rival group members, perhaps as a means to legitimize the authority of the 44-13 kin group within the Paquimé social hierarchy. Previous studies have suggested that sacrificial victims often come from the extremes of the social spectrum in that they either have desirable attributes (e.g., physical beauty) or they belong to marginalized/powerless groups (e.g., women, children, war captives) (Cameron 2013; Schwartz 2017; Swenson 2014). It appears that local Paquimé elites with ritual authority over human sacrifice chose marginalized victims (at least in this context) since the sacrifices consisted of children/adolescents in poor health. It is also possible that these individuals were selected for sacrifice precisely because they were viewed as less useful members of society due to their morbid state.

Another important finding from this case study that has implications for local-immigrant social dynamics is that at least two of the sacrifices have non-local isotope signatures that are consistent with sites in the southern Casas Grandes area. This suggests that relations with groups to the south might not have been entirely amicable. This inference is supported by archaeological evidence that indicates Paquimé's strongest ties, both during and prior to the Medio Period, are with groups in the northern zone of the Casas

Grandes region and not to the south (JH Kelley et al. 2012, 2017; Whalen and Minnis 2001a, 2009). Additionally, Walker's (2006) craniometric analysis demonstrated that individuals at Paquimé had closer biological affinity to Ancestral Pueblo groups from the American Southwest than to Sierra Tarahumara groups from southwest Chihuahua. Finally, sites in the Core and Middle Zones of the Casas Grandes region, particularly to the north of Paquimé, share many cultural characteristics with the primate centre, including religious elements (e.g., ball courts, macaws, religious motifs) (Whalen and Minnis 2009). In contrast, sites in the southern zone share fewer cultural traits with Paquimé and do not appear to have embraced its ideology and associated rituals (JH Kelley et al. 2012, 2017). Perhaps this lack of integration within the Casas Grandes belief system created tension with groups to the south, which in turn made them targets of ritual violence. It is also possible that there was no direct conflict with people from the southern Casas Grandes area, but victims were chosen from these groups simply because they were not close allies or kin. In other words, if a human sacrifice was needed for ritual purposes, it is probably best not to kill someone from a group with which you have favourable sociopolitical relations or kinship connections.

5.5.2 Ball Court Burials

The ball court burials were chosen for this case study because of the power differentials, competition, and rivalries that were associated with the ball game and with the act of human sacrifice itself (Harmon 2005, 2006; JH Kelley 2017; Whalen and Minnis 1996). As such, this is an ideal context in which to study social dynamics at Paquimé. This section first addresses whether the classification of these burials as human sacrifices is supported by the bioarchaeological analyses conducted in this study. Next, I discuss the identities of the individuals interred beneath the ball court, and what that information reveals about ritual, sacrifice, and social dynamics at Paquimé.

5.5.2.1 Evidence for Human Sacrifice?

When compared to the sacrificial deposit in the 44-13 tomb, there is greater variation in the bioarchaeological profiles of the ball court burials. The uppermost layer in the 44-13 tomb contained primarily juveniles of approximately the same age, all of whom exhibited evidence of extensive post-mortem processing. Each of these individuals had signs of physiological stress during childhood and none were found in direct association with burial goods. In contrast, there was no consistent demographic pattern among the ball court burials as a group; the suspected sacrifices consist of both males and females, as well as adults from all age categories and one older adolescent. Furthermore, some of the individuals have perimortem trauma that indicates violent death and/or had body parts dismembered (i.e., severed feet, a detached arm), while others were interred with burial goods. While perimortem trauma and dismemberment are characteristic of sacrificial contexts, the inclusion of grave goods could also signify non-sacrificial reverential treatment (Tiesler 2007). Thus, some of the ball court burials exhibit more robust evidence of human sacrifice than others. Each burial is discussed below, in order of most to least compelling evidence for human sacrifice.

According to Tiesler (2007), the presence of perimortem trauma on skeletal remains recovered from suspected sacrificial contexts provides the most direct evidence for ritual killing. In this study, perimortem skeletal trauma was observed on three of the ball court burials; Burials 2-14 and 4-14 have cranial depressions consistent with blunt force trauma and Burial 6-14 has a chop mark on the spinous process of a thoracic vertebral spine. Although chop marks can be associated with post-mortem processing, the lack of anthropogenic modification elsewhere on this individual (or on any of the ball court burials) suggests that the injury was likely the result of skeletal trauma from a sharp object.

Of the three individuals with perimortem trauma, Burial 2-14 provides the best evidence for human sacrifice. First, the location of the depression fracture on the frontal bone is characteristic of interpersonal violence and indicates that this individual was facing his assailant when the injury occurred (Walker 2001). In addition to the presence of cranial trauma that occurred around the time of death, this individual was also interred in a manner that could be considered disrespectful or that signaled defeat, as Burial 1-14 was placed in a seated position directly on top of him. Di Peso (1974: vol. 2) interpreted the mortuary positioning of these individuals, who were found beneath a “spirit hole” in the centre of the ball court, as reminiscent of the Veracruz palma design, which depicts Death sitting atop his victim. Based on the results of the transition analysis (Waller 2017), the age range for this individual was 15 – 24 years and the point estimate was 15 years, suggesting he was more likely toward the lower end of the estimated age range when he died. Both of his teeth had extraregional non-local isotope values, which means that he came to Paquimé after the cessation of third molar enamel formation, which typically occurs between the ages of 12 to 13 (Hillson 1996). These data indicate that Burial 2-14 had not lived at Paquimé long before his death and it is possible that he was brought to Paquimé as a captive and subsequently sacrificed. In fact, his mobility profile was highly unusual when compared to the other extraregional immigrants in that he was the only one whose isotope values were the same for both teeth; all other extraregional non-locals had different isotope values in their two teeth, with the $^{87}Sr/^{86}Sr$ values in their late-forming tooth closer to the local range at Paquimé than the $^{87}Sr/^{86}Sr$ values in their early-forming tooth (Chapter 3, Figure 3.6). This pattern indicates that these individuals not only traversed long distances but may have done so in a series of moves toward Paquimé. In contrast, Burial 2-14’s isotope profile indicates that he came directly to Paquimé from his homeland, which could mean that he was taken captive and brought directly to the site. Finally, the demographic profile of this individual (i.e., older adolescent/young adult male) is common in Maya sacrificial contexts (Tiesler 2007: Table 2.1) and is consistent with documented cases of predominantly young adult male sacrifices at Teotihuacan (Sugiyama and López 2006). Thus, support for the classification of this individual as a human sacrifice comes from osteological, isotopic, and contextual evidence.

The other two individuals with perimortem trauma are Burials 6-14 and 4-14, the old adult females from the north pit of the ball court. Both individuals had trauma located on the posterior bones of the skeleton, which suggests that unlike Burial 2-14, they were not facing their assailant when the injury occurred. Burial 4-14 was a secondary interment that included an articulated pair of feet, which suggests that if the feet belong to this individual, her death involved both violence and dismemberment. At the very least, the presence of an articulated pair of feet indicates that this ritual deposit involved corpse manipulation. Burial 4-14 was not sampled for isotope analysis, so it is unknown whether she was born locally or non-locally. Meanwhile, both teeth that were analyzed from Burial 6-14 had regional non-local isotope ratios, meaning that she came to Paquimé sometime after adolescence. However, because this is an old adult individual (point estimate of 76 years), it is unclear how long she had lived at the site prior to her death. There is no explicit evidence for the social status of these individuals; neither were interred with grave goods, yet they were also not placed in conspicuously disrespectful positions. Aside from healed porotic hyperostosis on the cranium of Burial 6-14, there was no evidence of physiological stress or disease which would indicate morbidity. Despite the lack of clear evidence for social status, the presence of perimortem trauma, corpse manipulation, and interment beneath a ceremonial ball court provides compelling evidence for classifying Burials 6-14 and 4-14 as human sacrifices.

There was also contextual evidence for corpse manipulation of Burial 7-14, the young adult female whose arm was found detached and draped over her shoulder. Although no cut marks or trauma to the shoulder joint was observed in this study, the photograph from the excavation of this burial (Di Peso et al. 1974: vol. 2: Fig. 126-2) demonstrates that the arm was detached. It is unclear whether dismemberment occurred at the time of death or post-mortem. There was no other evidence of skeletal trauma indicating antemortem injury or perimortem violence, nor were there pathological lesions that would suggest that this individual was in a poor state of health. On the other hand, Burial 7-14 was not interred with grave goods and Burial 3A-14 was placed on top of her, which like Burial 2-14, could symbolize disrespect. The isotope results from Burial 7-14 were ambiguous because her $^{87}Sr/^{86}Sr$ values were consistent with the local range at Paquimé, but the $\delta^{18}O$ values in both teeth were slightly lower than expected for the site, which led to the classification of local/regional non-local. If this individual was a regional non-local, she came to Paquimé sometime between late adolescence and her death, which was estimated to be in her 20s. Based on the findings from this study, there was no unusual or notable skeletal evidence for ritual killing, but there was atypical contextual evidence (placement beneath another individual) and possible osteological evidence (dismemberment/corpse manipulation) that could suggest sacrifice.

The designation of Burial 5-14 as a human sacrifice is also based on contextual evidence alone, though it is more equivocal than for Burial 7-14, as there was no evidence of trauma, dismemberment, or irreverent burial positioning. This middle-aged adult male was, however, represented by only a skull, humerus, and hand and foot bones, which makes the assessment of skeletal trauma difficult due to the paucity of bones available for analysis. It also raises the question of why the majority of his corpse was not interred in the ball court. Among the Maya, isolated body parts from individuals who had experienced violent death were sometimes used as offerings in sacrificial contexts (Vail and Hernandez 2007), therefore it is possible that this secondary interment represents a similar practice. It is also interesting to note that Burial 5-14 exhibited evidence of physiological stress during childhood (linear enamel hypoplasia and porotic hyperostosis) yet survived to middle adulthood and had conspicuously large bones, which suggests that he was able to recover from the childhood stress episode(s) and likely had adequate access to resources, respectively. Thus, while it is possible that this individual was ritually sacrificed, it seems equally possible that he died of natural or accidental causes and was subsequently placed in the ball court for other reasons (e.g., ancestor veneration, non-sacrificial offering).

Finally, two of the ball court burials, 3A-14 and 1-14, do not have compelling osteological evidence for human sacrifice and could plausibly represent non-sacrificial, and perhaps even reverential, interments. Burial 1-14, a young adult male, was placed directly on top of Burial 2-14, the young adult male immigrant with blunt force cranial trauma. Based on Di Peso's (1974: vol. 2) interpretation of this pair of interments from the centre of the ball court, the mortuary positioning of Burial 1-14 could symbolically represent domination over one's victim. Additionally, no evidence of trauma or post-mortem processing was found on this individual and he was interred with a mortuary offering (i.e., an andesite rubbing stone). Burial 1-14 had poor oral health, as indicated by several carious lesions, but otherwise did not exhibit pathological lesions elsewhere in the skeleton that could be related to the cause of death. The lack of evidence for violent death or corpse manipulation, combined with the inclusion of a burial accompaniment and the placement of this individual in a seemingly dominant position over Burial 2-14 could feasibly indicate non-sacrificial reverence.

Burial 3A-14 differed from the rest of the ball court burials in that she did not exhibit any signs of trauma, post-mortem processing, or pathology. Furthermore, this individual was a young adult female who was found in association with fetal remains, which means that she was pregnant at the time of her death. Given the lack of evidence for ritual killing, it is possible that this woman died from complications during pregnancy or child birth. Although a few other fetuses/newborns were recovered from Paquimé, this is the only instance in which they were found in direct association with a female (Di Peso et al. 1974: vol. 8), meaning that Burial 3A-14 was the only pregnant female identified in the skeletal assemblage (N=576). Importantly, Burial 3A-14 was interred with multiple grave accompaniments, including a rubbing stone made from vesicular basalt, an Escondida polychrome jar, food remains, cotton seeds, and charcoal, and was placed directly above Burial 7-14. This mortuary treatment could represent veneration, as sacrificial victims are not typically interred with grave goods (Tiesler 2007). Perhaps the death of this pregnant female and her subsequent placement beneath the ball court was part of a dedicatory ritual related to fertility, as this was a pervasive theme in Paquimé cosmology (Di Peso 1974: vol. 2; Harmon 2005, 2006; Rakita 2001, 2009; Schaafsma and Riley 1999; VanPool and VanPool 2007, 2016). The inclusion of at least one cultigen (cotton seeds) with this pregnant female might also symbolize agricultural fertility. It is also interesting to note that the only ball court burials with grave goods (Burials 1-14 and 3A-14) were each interred with a rubbing stone. According to Di Peso and colleagues (1974: vol. 7:123), the specific use of these artifacts is unclear, as some were found with utilitarian objects, such as polishing stones and awls, while others were found in association with ritually significant objects (e.g., shell, turquoise) or had pigments on them. The authors also suggest that these tools may have been used for grinding foodstuffs. Based on the apparent dual function of these objects (ritual and utilitarian), it seems likely that the placement of rubbing stones with individuals in the ceremonial ball court likely had some type of religious symbolism related to agriculture. The classification of Burial 3A-14 as a human sacrifice is based solely on her placement beneath a ceremonial ball court, with no other lines of evidence to support this inference. As such, I would suggest that it is plausible that this individual may not have been ritually killed.

In summary, the original designation of the ball court burials as human sacrifices was primarily based on contextual evidence alone, including their placement beneath a ceremonial ball court, burial positions, and the presence of isolated body parts (Di Peso 1974: vol. 2). More specifically, Di Peso (1974: vol. 2) argued that these mortuary attributes mirrored various elements of Mesoamerican mythology and ritual associated with the ball game. While these parallels are certainly compelling, differentiating between human sacrifice and funerary practices that do not involve ritual killing (e.g., ancestor veneration, non-sacrificial dedicatory offerings) is best addressed through a multifaceted approach that uses both contextual and skeletal evidence. Based on the bioarchaeological analysis conducted in this study, I have argued that the classification of Burials 2-14, 4-14, 6-14, and 7-14 as human sacrifices is supported by both contextual and osteological evidence. Meanwhile, the evidence for sacrifice in the case of Burial 5-14 is equivocal. Finally, Burials 3A-14 and 1-14 were characterized by a lack of evidence for ritual killing and mortuary treatment that could indicate reverence, which suggests that these individuals may not have been human sacrifices. This is not to say that sacrificial victims could not have received respectful mortuary treatment, such as the inclusion of grave goods. Rather, I am arguing that without skeletal evidence of sacrifice, it is equally plausible that these individuals died from causes that did not involve ritual killing and were then placed beneath the ball court as dedication or symbolic sacrifice.

5.5.2.2 Identity, Ritual, and Social Dynamics

Another goal of this study was to examine the identities of the individuals who were interred in this important ritual context. Various lines of evidence were used to reconstruct each individual's disease experience and interactions with their social and natural environments during life. The data from these analyses did not reveal any consistent pattern among the ball court interments generally, or amongst the individuals with robust evidence for sacrifice. First, no evidence of healed skeletal trauma, representing injuries sustained during life, was observed on any of the burials. Second, the only congenital anomaly was brachydactyly of Burial 2-14's distal hand phalanx. This condition (i.e., short digits) would not have caused physical discomfort or disability and may have been largely unnoticeable (Bell 1951). Second, while pathological lesions were found on all of the ball court burials except for the pregnant female (Burial 3A-14), none of the conditions were severe or potentially fatal. Most cases involved caries (Burials 1-14, 5-14, 6-14, 7-14) and there were also a few instances of healed porotic hyperostosis (5-14, 6-14) and linear enamel hypoplasia (2-14, 5-14). Burials 5-14 and 6-14 were older adults, so the presence of these lesions does not necessarily indicate morbidity since they were able to recover from the childhood stress episodes. Meanwhile, multiple teeth from Burial 2-14 exhibited hypoplastic lesions, so it is possible that this older adolescent experienced multiple stress episodes during his childhood. Thus, two of the probable sacrifices (2-14 and 6-14) and Burial 5-14, who had ambiguous evidence for sacrifice, exhibited the most physiological stress. While this pattern could indicate that increased morbidity played a role in the selection of the ball court sacrifices, more robust evidence is needed to substantiate this inference.

In terms of demographic profiles, interment beneath the ball court was not restricted to one sex or a particular age-at-death category. There was, however, some patterning by burial pit, as the centre pit contained two young males and the south pit contained two young adult females. In each context, one individual was placed directly on top of the other individual; the young adult male (1-14) over the male immigrant with cranial trauma (2-14) and the pregnant female (3A-14) over the female with the detached arm (7-14). In the previous section it was argued that the uppermost burials in each pit may represent non-sacrificial interments, whereas the lower burials, 2-14 and 7-14, have strong and moderate evidence, respectively, for human sacrifice. As such, the findings from this study suggest that the centre and south burial pits could contain one sacrificial victim and one non-sacrificial (and perhaps venerated) interment. Meanwhile, the pit at the north end of the ball court was highly distinct in that it contained older adult individuals of both sexes, as well as primary and secondary interments. This was also the only burial pit to be filled with terrace boulders, which does not appear to be a common feature of the Paquimé mortuary program (Di Peso et al. 1974: vol. 8). In the north pit, the primary interment (6-14) and one of the secondary interments (4-14) were likely sacrifices, while the sacrificial status of the other secondary burial (5-14) was ambiguous.

The demographic patterning by burial pit could indicate differences in the ritual function of each deposit, which may have required specific demographic profiles. Such rituals might have also emphasized the inclusion of demographic analogs (i.e., individuals of the same age and/or sex). Furthermore, the variability between burials pits could indicate that these deposits are not contemporaneous, an inference that is supported by ceramic seriation analysis of the ball court burial fill (Harmon 2005). If this were the case, the nature of human sacrifice and/or the rituals associated with it may have changed over time, perhaps based on the prevailing environmental, sociopolitical, and/or religious circumstances at the time.

There was also a distinct pattern in terms of the geographic origins of the sacrificial victims; two of the three individuals with perimortem injuries (Burials 2-14 and 6-14) had non-local isotope ratios (the other was not sampled for isotope analysis) and the young adult female with the dismembered arm (Burial 7-14) was classified as a local/regional non-local. Burial 6-14's isotope values are below the expected range at Paquimé, but consistent with the southern Casas Grandes region (Chapter 3). Meanwhile, Burial 7-14's $^{87}Sr/^{86}Sr$ values are consistent with the local range at Paquimé, but her $\delta^{18}O$ ratios (-6.0‰ and -6.3‰) are slightly below the local range, which means she may have come from a nearby area characterized by a higher elevation and cooler/wetter conditions, such as the high-elevation basins to the west or south of Paquimé. This finding is noteworthy because it mirrors the isotope profiles of the human sacrifices from the 44-13 burial tomb, where two of juveniles were classified as regional non-locals from the southern Casas Grandes region and the third was classified as a local/regional non-local (with $\delta^{18}O$ values below the expected local range). Thus, isotope data from the ball court burials provides further support for the inference that relationships with groups to the south may have been antagonistic or that sacrificial victims may have been drawn from this area because it was less connected to the Casas Grandes core.

In addition to regional non-locals, an extraregional immigrant was also among the sacrificial victims, as the $^{87}Sr/^{86}Sr$ values from Burial 2-14 are consistent with the Mimbres region of southern New Mexico. Additional support for this finding comes from a recent aDNA study that analyzed a small sample of individuals from Paquimé and found that Burial 2-14 was the only individual characterized by haplogroup D (Morales-Arce et al. 2017). While haplogroup D was rare in this sample of Paquimeños, it was the second most common haplogroup in a comparative sample from Mimbres sites (N=46) (Snow et al. 2011). Thus, the combination of isotopic and genetic data strongly suggest that this individual came to Paquimé from the Mimbres Valley/Mogollon region of southern New Mexico, which was occupied by Postclassic Mimbres groups (e.g., Animas) during this time (Creel 1999). Moreover, when considered in conjunction with the contextual and osteological data from this burial (i.e., perimortem trauma, disrespectful burial positioning), the results suggest that social dynamics between Paquimé and groups from southern New Mexico may have been contentious if an individual from this region was (possibly) taken captive and ritually sacrificed.

The disparate geographic origins of the ball court sacrifices also supports the inference that the ball courts at Paquimé were important venues for both inter- and intra-group competition (Harmon 2005, 2006; Whalen and Minnis 1996). The ritual killing of both extra-regional and regional non-locals suggests that human sacrifice may have been one of the ways in which Paquimé elites asserted their dominance over individuals or groups that were vying for power and/or resources in this newly aggregated community. The ritual sacrifice of foreigners (i.e., "others") may have also been used to promote social cohesion amongst locally-born Paquimeños. Conversely, the dismemberment and possible sacrifice of Burial 7-14, who was born at Paquimé or a nearby site, could be the result of competition among local individuals and/or kin groups. Whalen and Minnis (1996) have posited that the relative abundance of ball courts within a 15-30 km radius of Paquimé indicates high levels of factional rivalries between elites in the Casas Grandes Core. Thus, it is possible that Burial 7-14 belonged to a rival faction or subjugated group from this area.

Harmon (2005) has also suggested that the elite patrons of the ceremonial ball court legitimized their authority by establishing links to Mimbres "ancestors" and through their secret ritual knowledge that involved human sacrifice. The potential link to Mimbres groups is compelling given that Burial 2-14's isotope and aDNA profile suggests he is from that region. However, the intentional incorporation of Mimbres architectural elements as an effort to legitimize elite authority, as Harmon (2005) has suggested, would presumably indicate some degree of reverence for these northern ancestors. Yet the ritual killing and disrespectful mortuary treatment of Burial 2-14 seems at odds with such sentiment. As such, the significance of this connection is ambiguous.

Another aspect of Harmon's (2005) interpretation that warrants consideration is how elite authority is derived from *secret* ritual knowledge. The author does not provide a detailed explanation of what this process might have entailed, but I would argue that while exclusive knowledge about sacrificial rituals seems to be a plausible mechanism for increasing status and authority, the possession of such expertise must first be demonstrated to the people from which power is drawn. Furthermore, if sacrifice was one of the ways in which Paquimé elites established or expressed their dominance over rival groups, as I have suggested above, *public* displays of power and authority would likely be more effective than completely private events. As such, I would argue that at least some component(s) of ritual sacrifice took place in public, an inference that is supported by the taphonomic evidence from this study. Namely, all of the ball court burials had evidence of carnivore gnawing, which indicates that these individuals were not interred immediately after death and that their corpses were placed in an extramural location where scavengers could access them. The anatomical distribution of carnivore activity was extremely consistent across burials, except for the two secondary interments, which had more extensive gnawing indicating prolonged exposure after death. This is not surprising since secondary burials necessarily involve more than one episode of interment. One possible explanation for the observed taphonomic pattern is that the individuals died (or were sacrificed) in a public location, were left outside long enough for scavengers to access the corpses, then brought to the private ball court for interment. Not only does this pattern suggest prolonged interaction with the dead, which was a common theme in Medio Period mortuary ritual (Casserino 2009; Rakita 2001, 2009), it also raises the possibility that the dead were publicly displayed, perhaps for the purpose of intimidation or social control.

It is important to emphasize that my argument does not contradict the interpretation that emerging elites used private rites and/or exclusive ritual knowledge to enhance their authority/status (e.g., Harmon 2005, 2006; Rakita 2001, 2009). I agree that some rites associated with sacrificial rituals were likely performed in private and that only some individuals were privy to ritual knowledge, which is evidenced by the extremely private nature of the ceremonial ball court itself (i.e., limited access and no visibility from the outside). Instead, I am arguing that these individuals were sacrificed and likely displayed in a public location, then brought to the private ceremonial ball court, where additional "secret" rites may have been performed prior to interment.

Finally, the fertility-related themes discussed in the previous section indicate that the ball court burials likely represent communion sacrifice, which is characterized by offerings that are intended to establish communication with deities or powerful beings/forces to secure community well-being, such as agricultural fertility (Tiesler 2007).

Communion sacrifice often consists of captive killings and dedicatory ritual offerings, both of which may have occurred in this context. The focus on fertility, and perhaps community well-being in general, could represent ritual activity related to the proposed fertility cult since its focus was on public mortuary rites, human and non-human sacrifice, and celestial observations (Rakita 2009).

5.6 Conclusion

The goal of this chapter was to examine social dynamics at Paquimé through the bioarchaeological analysis of skeletal remains from two ritually-charged mortuary contexts associated with human sacrifice. It was hypothesized that competition and conflict between locals and in-migrating groups may have led to ritual violence against non-local individuals. Social dynamics were examined through a multifaceted approach that used mortuary, osteological, and isotope analyses to reconstruct various aspects of the life histories, deaths, and post-mortem treatment of burials from the two sacrificial contexts.

The analysis of the skeletal remains from Burial Tomb 44-13 and the ceremonial ball court yielded a rich set of bioarchaeological data for 19 individuals. In the case of Burial Tomb 44-13, it was argued that all individuals from the uppermost comingled burial layer were human sacrifices, while all individuals in the bottom, articulated burial layer belonged to a local elite lineage. In the case of the ceremonial ball court, it was argued that there was convincing evidence that at least four of the seven burials were human sacrifices, but two others may have been revered individuals that were placed in the ball court as dedicatory offerings. Thus, both ritually-charged contexts may have contained a mix of sacrificial and non-sacrificial burials.

While there is bioarchaeological evidence for human sacrifice in both contexts, there are also distinct differences between the ball court burials and the 44-13 tomb. First, the 44-13 sacrifices were predominantly juveniles, while the ball court burials sacrifices included both adult men and women. There was also no evidence of perimortem injuries on any of the juveniles, whereas three of the ball court sacrifices had skeletal trauma. Meanwhile, only the juveniles from the 44-13 burial tomb exhibited direct evidence of post-mortem processing. Such processing involved flaying, defleshing, and dismemberment of the corpses, with possible evidence of ritual anthropophagy. In contrast, the manipulation of human remains in the ball court context involved the dismemberment of specific body parts and the placement of secondary burials beneath the court. Finally, taphonomic modifications indicate that the ball court sacrifices were exposed to scavengers while the 44-13 burial were not, which suggests variation in corpse treatment during the post-mortem interval between death and burial. Taken together, the differences between the two contexts indicate that there was considerable variation in the practice of human sacrifice at Paquimé, both in terms of the motives for sacrifice (fertility rituals versus death cult rituals) and the victims who were chosen.

Significantly, of the six suspected sacrifices that were sampled for isotope analysis, none had unambiguously local isotope signatures; four had non-local isotope values and two were classified as local/regional non-locals. Furthermore, a few of these individuals came to Paquimé just prior to or within a few years of their death, which raises the possibility that they were brought to the site as captives. In terms of specific geographic origins, three of the sacrifices (two from the 44-13 tomb and one ball court burial) had isotope values consistent with the southern zone of the Casas Grandes region, while the other likely came from the Mimbres/Mogollon region of southern New Mexico. The two individuals with local/regional non-local signatures were likely from Paquimé or nearby areas within the Casas Grandes Core. Thus, these results support the hypothesis that non-locals were preferentially chosen as the victims of sacrifice by Paquimé elites. Finally, the finding that three of the human sacrifices have isotope values that are consistent with the southern zone of the Casas Grandes region suggests that sociopolitical relations between Paquimé and these groups were not entirely amicable during the Medio Period and resulted in ritual violence against individuals from this region.

The results from this study also have important implications for understanding Medio Period social dynamics at Paquimé. First, the public sacrifice of both regional and extraregional non-locals and their subsequent placement beneath a ceremonial ball court indicates that the ball courts at Paquimé were indeed venues where factional rivalries were played out, as Whalen and Minnis (1996) have suggested, and that the outcomes of these rivalries were sometimes fatal for the individuals or kin groups involved. I have also argued that ball court sacrifice may have been used by the local elites to assert their dominance over individuals or kin-groups who were competing for power and/or resources in this newly aggregated community. Second, the finding that the sacrifices in Burial Tomb 44-13 were regional non-locals who were in poor health suggests that fringe segments of the population may have been targeted by elites precisely because they were deemed to be less useful to the community or were perhaps brought to the site as forced labourers. Moreover, this finding supports the mortuary results from Chapter 4 of this thesis, which indicate that in-migrating groups likely occupied lower status positions in Paquimé society than locally-born individuals.

Chapter 6
Conclusion

The goal of this thesis was to examine population dynamics in the Casas Grandes region of northwest Chihuahua, Mexico and to study the impacts of migration on Medio Period social dynamics at Paquimé. The presence of objects and ideas from surrounding regions has caused substantial debate over the role of external influences in the cultural trajectory of Paquimé. However, it is difficult to differentiate between direct and indirect foreign influences without empirical evidence for immigrants at the site. This study sought to remedy this issue by using isotopic methods to identify non-local individuals in the Paquimé and Convento skeletal assemblages. This chapter begins with an evaluation of the main cultural development models by synthesizing the findings from this study. This is followed by a discussion of Medio Period social dynamics. A summary of ongoing research is presented, future directions are discussed, and the chapter concludes by highlighting the significance of this study.

6.1 Evaluation of Cultural Development Models

Explanations for Medio Period culture change at Paquimé fall into two main categories; external and internal development models. External development models involve direct and sustained contact with elite foreigners who migrated to the Casas Grandes Valley, inspired (or conscripted) less-sophisticated local populations to build the city of Paquimé, and guided subsequent Medio Period culture developments. Di Peso (1974: vol. 2) and JC Kelley (2000) have pointed to Paquimé's distinctly Mesoamerican traits as evidence for direct contact with traveling merchants from central and West Mexico, respectively, while Lekson (1999, 2015) attributes the rise of Paquimé to the arrival of migrating elites from the American Southwest. Thus, each of these models involves the migration of elite or important foreigners to Paquimé, but from different geographic regions.

Meanwhile, proponents of internal development models have argued that the primary stimulus for Medio Period culture change came from local Casas Grandes populations (e.g., Rakita 2001, 2009; Whalen and Minnis 2001a, 2003, 2009). These scholars believe that aspiring local leaders used foreign connections, goods, and ideology to enhance and legitimize their social status and political authority within the newly aggregated Paquimé community (Rakita 2001, 2009; Whalen and Minnis 2003). Thus, they acknowledged that foreign influences played a critical role in Paquimé's cultural trajectory but see them as secondary to local developments. Others, such as Foster (1999), have taken a more moderate stance by arguing that both local leaders and influential (West Mexican) foreigners helped to shape Medio Period developments.

If external development models are correct, not only should individuals with extraregional non-local isotope signatures be present in the Paquimé burial assemblage, the structure and/or scale of migration should be different from the preceding Viejo Period. Furthermore, immigrants should be from regions predicted by the various external development models, namely Mesoamerica, West Mexico, or the American Southwest (Di Peso 1974: vol. 2; JC Kelley 2000; Lekson 1999, 2015). In terms of identity, these foreigners should have elaborate mortuary treatment that indicates elite status given their pivotal role in sparking a cultural revolution at the site. Conversely, if local development models are correct, most individuals in the Paquimé skeletal assemblage should have isotope values that are consistent with the Casas Grandes area, indicating local population aggregation. In addition to predicting population aggregation from the immediate surrounding region, Whalen and Minnis (2003) have also acknowledged that migration from neighbouring regions may have occurred as well, so extraregional immigrants would not be unexpected under local development scenarios. Such models also emphasize the emergence of local elites, therefore locally-born (or regionally-born) individuals should exhibit high status mortuary treatment when compared to extraregional immigrants.

6.1.1 Migration at Casas Grandes

The first step in assessing the proposed cultural development models was to determine the occurrence, scale, and structure of migration at Paquimé. To accomplish this, radiogenic strontium and stable oxygen isotope analyses were conducted on 82 individuals from Paquimé and 13 individuals from the Convento site. The results of these analyses were compared to the expected local isotope range at Paquimé; individuals whose isotope values fell within this range were classified as local and those with values outside of it were classified as non-local. Non-local individuals were further classified into regional and extraregional immigrant subgroups, based on whether their isotope values were consistent with the Casas Grandes area or with neighbouring regions. Human and faunal samples from four sites within the Casas Grandes region and three sites from neighbouring regions, along with previously published data (e.g., Dudás et al. 2016; Ezzo et al. 1997; Ezzo and Price 2002; Grimstead 2015 Price et al. 2008, 2017; Waller 2009), were then used to identify possible geographic origins of individuals with non-local isotope signatures. In addition, demographic data and mobility profiles were used to determine the timing and structure of migration. These data provide a more comprehensive understanding of migration as a process (i.e., short-distance versus long-distance migration).

The results revealed that the majority (86.6%) of Medio Period individuals were born locally at Paquimé or at nearby sites in the Casas Grandes region. There were also eleven individuals with $^{87}Sr/^{86}Sr$ and/or $\delta^{18}O$ values that were distinct from the local and regional isotope ranges, which provides empirical evidence for the presence of immigrants at Paquimé. The majority of individuals (92.3%) from the Viejo Period Convento site were local to the Casas Grandes area. Only one burial had (oxygen) isotope values that were not consistent with local or regional values, indicating extraregional origins. There were no statistically significant differences in the proportion of non-locals at Paquimé when compared to Convento, meaning that the scale of migration was similar between the Viejo and Medio Periods.

While the proportion of immigrants did not vary significantly over time, the isotope results do indicate a shift in the structure of migration during the Medio Period. More specifically, the Convento sample exhibited a much narrower range of isotope values than the Paquimé sample. In addition, all individuals from Convento had $^{87}Sr/^{86}Sr$ values that were consistent with the Casas Grandes region and the only extraregional immigrant was classified as such based on their $\delta^{18}O$ signature. This means that Viejo Period population dynamics were characterized by short-distance, intraregional migration. Meanwhile, Medio Period population dynamics at Paquimé involved migration from within the Casas Grandes area, as well as long-distance migration from neighbouring regions. Immigrants to Paquimé had isotope values that were both above and below the expected isotope range for the Casas Grandes region, which means these individuals came from disparate geographic locations. Most of the extraregional immigrants at Paquimé had isotope signatures that were consistent with the American Southwest (N=7), though individuals likely came from various parts of this region. Three extraregional non-locals had isotope values that were consistent with other parts of Northwest or West Mexico, such as the highlands of southern Chihuahua/northern Durango or with inland Sonora, and one had $\delta^{18}O$ values consistent with coastal origins, probably in Sonora or northern Sinaloa. In short, both the Convento and Paquimé populations were comprised of a largely local base, but Paquimé was more heterogeneous in terms of the individuals who migrated to the site.

Intra-individual variation in isotope values between the early- and late-forming teeth of extraregional immigrants provides further evidence for long-distance migration because it indicates that these individuals had multiple places of residence during life. This pattern appears to reflect serial migration, a term used by Bernardini (2005) to describe the shorter moves or segments involved in long-distance migration, which was a common form of migration amongst prehistoric groups in the American Southwest. The finding that most of the extraregional immigrants identified in this study have isotope values that are consistent with the American Southwest and that these individuals were highly mobile throughout life fits well with the pattern of widespread mobility in the NW/SW during this time (e.g., Bernardini 2005; Lekson 2008; Plog 2008) and provides direct evidence for population movement from this region into northern Mexico.

6.1.2 Status and Identity of Immigrants versus Locals

The shift from predominantly intraregional population dynamics during the Viejo Period to the arrival of extraregional immigrants during the Medio Period could be interpreted as representing an influx of foreigners, particularly from the American Southwest (Lekson 1999, 2015). First, it should be emphasized again that most individuals at Paquimé are from the Casas Grandes region. Additionally, the proportion of extraregional immigrants is quite low when compared to Grasshopper Pueblo, an aggregated community located in south-central Arizona that was contemporaneous with Paquimé (Ezzo and Price 2002). At Grasshopper Pueblo, strontium isotope analysis revealed that ~34% of the population consisted of extraregional immigrants, which is significantly higher than the ~13% identified at Paquimé. Second, an important facet of external development models is that they involve the arrival of foreign *elites*, who are suggested as being the initiators of Medio Period developments (e.g., Di Peso 1974: vol. 2; JC Kelley 2000; Lekson 1999, 2015). As such, this study also examined the relationship between social status and geographic origins to determine if the foreigners that migrated to Paquimé were high status or important individuals.

Social status was assessed through various types of mortuary analyses, including comparisons of individual mortuary variables (treatment of the body, characteristics of the burial facility, and burial accompaniments), raw artifact counts, and diversity scores (richness, categorical diversity, symbols of rank and authority (SRA)). An important aspect of the research design for this portion of the study was that several of the most elaborate burials at Paquimé, as evidenced by the original site report (Di Peso 1974: vols. 2, 8) and subsequent mortuary analyses (Rakita 2001, 2009; Ravesloot 1988), were deliberately sampled for isotope analysis so that the geographic origins of the most elite individuals at the site could be determined.

The results of the mortuary analyses revealed that none of the extraregional immigrants received burial treatment that indicates elite social status. In fact, only one of the eleven extraregional non-locals was interred with burial goods; an old adult female who migrated from the American Southwest to the northern Casas Grandes region during childhood, then came to Paquimé sometime after adolescence. The results of the diversity score analyses indicate that her mortuary treatment was characteristic of a horizontal social role, as opposed to vertical social status. In fact, she did not have any of the nine Symbols of Rank and Authority that characterize high status burials at Paquimé (Ravesloot 1988). Given her age, burial in a communal plaza, and interment with several stone artifacts, I argued that she was likely a respected elder and/or craftsperson (e.g., lapidary) within the community. The remaining ten extraregional immigrants were not interred with grave goods, nor were they buried in mortuary contexts or facilities that might signify elevated social status.

Meanwhile, locally-born individuals exhibited exceptional mortuary treatment when compared to their extraregional immigrant counterparts. There were also two regional non-locals that scored high in the various diversity measures (Burials 27A-1 and 38-13). Both individuals were old adult males and had strontium isotope values just above the local range that were consistent with the immediate Casas Grandes area to the north of Paquimé. It is possible that these individuals belonged to early in-migrating groups from the surrounding Casas Grandes area, who may have emerged as "apex" families in the community due to their primacy in the region (e.g., Alvarez 1987). It is also possible that these old adult males were the patriarchs of a high status clan or kin-group at the site. Whatever the case, the important finding is that only individuals from the Casas Grandes region (i.e., locals and a few regional non-locals) received elaborate mortuary treatment indicating elevated social status.

The isotope results from Burial Tomb 44-13 serve as an important line of evidence for addressing the debate about foreign elites at Paquimé since the tomb is widely acknowledged as the most complex and elaborate interment at Paquimé (e.g., Di Peso 1974; Rakita 2001, 2009; Ravesloot 1988; Lekson 1999, 2008, 2015; VanPool and VanPool 2007). The lower layer of this tomb contained seven primary interments, while the uppermost layer consisted of the disarticulated and highly processed remains of five individuals. Two large adult males, Burials 44A-13 and 44E-13, appear to be the focus of this mortuary context and have even been referred to as the "Lords of Paquimé" (Lekson 2008:336). Meanwhile, the juveniles in the uppermost layer likely represent companion sacrifices to the elite individuals below (Chapter 5). The tomb contains copious amounts of elaborate mortuary offerings, including ritually-charged items and rare artifacts, and was likely the site of ongoing ritual activity (Di Peso et al. 1974: vol. 8; Rakita 2001, 2009). Lekson (1999, 2015) has argued that the 44-13 Burial Tomb shares several similarities with elite interments from Pueblo Bonito. Although he does not explicitly state where he thinks the high status males in this tomb originated, foreign connections with Chaco Canyon are implied. Importantly, one of the two elite males (44A-13) was sampled for isotope analysis and had local isotope values in both teeth, which means he was born at Paquimé. This individual had the highest score for every mortuary measure used in this study except for one (raw artifact count) and was also the last articulated burial placed in the tomb. Burial 44F-13, the first interment placed in the tomb, was also sampled for analysis and had local isotope values. Thus, the first and last interments in the most elaborate mortuary context at Paquimé, which likely represents an elite lineage, were born locally.

In addition to the 44-13 Burial Tomb, several other local individuals were placed in tombs (which were rare at the site) and/or were interred with socioreligious artifacts or rare accompaniments. Spatial analysis by burial location also revealed that only locally-born individuals were interred in one of the most important ritual locations at the site (The House of the Well). This unit contained an elaborate underground well, ritual paraphernalia, and a suspected child sacrifice. It also housed significant caches/hoards of exotic items including copper from West Mexico, 2.5 million pieces of shell from the Gulf of California, turquoise and Gila polychrome vessels from the American Southwest, which served as important religious, economic, and/or sociopolitical purposes (Di Peso 1974: vol. 2; VanPool and VanPool 2007; Whalen 2013). Not only do these data indicate that locally-born individuals were given the most elaborate mortuary treatment, they also suggest that local lineages derived their elite status from ritual authority, a position that has been argued by others as well (e.g., Rakita 2001, 2009; VanPool 2003). Extraregional immigrants, on the other hand, do not appear to have held high ranking positions in Paquimé society, nor were they interred with ritually significant artifacts.

Locally-born individuals at the Convento site also received superior mortuary treatment when compared to their non-local counterparts. All Convento individuals were interred in simple pits in communal areas, but only some were interred with mortuary offerings. As such, the presence or absence of grave goods was the primary means of social differentiation in Viejo Period mortuary contexts. Of the thirteen burials examined for this study, only three were interred with grave goods and all had local isotope signatures. Furthermore, one of these individuals, Burial CO-50, was interred with an elaborate stone plaque, which was the only one of its kind recovered from Convento or Paquimé. These data, though admittedly limited due to small sample size, hint at the possibility of local leadership during the Viejo Period as well.

Finally, the isotope results indicate that people migrated to Paquimé during childhood and as adults. There were also roughly equal proportions of male and female immigrants. This demographic structure suggests that migratory units likely consisted of kin- or social groups, a pattern that has also been documented at Grasshopper Pueblo using isotopic methods (Ezzo and Price 2002). As mentioned above, Grasshopper Pueblo is located in the American Southwest and is contemporaneous with Paquimé, so it is possible that this structure of migration was common during the late prehispanic period in the NW/SW. The demographic profiles of the immigrants at Paquimé do not appear to align well with the Mesoamerican or Aztatlán models that involve small groups of traveling merchants/traders (Di Peso 1974: vol. 2; JC Kelley 2000). Moreover, the three extraregional immigrants from Northwest/West Mexico migrated to the site as children, which again, is not the demographic profile that might be expected for a traveling merchant.

6.1.3 Ritual Violence against Immigrants

The mortuary analyses presented above demonstrate that: 1) the highest ranking individuals at Paquimé were locals and their status was likely linked to ritual authority; and 2) extraregional immigrants were not high status and were conspicuously absent from one of the most ritually significant units at the site. The final step in evaluating the identity of immigrants, and their place within the Paquimé community, was to examine the apparent link between geographic origins, status, and ritual violence. This was accomplished by conducting a comprehensive bioarchaeological analysis of two ritually-charged mortuary contexts; a ceremonial ball court that contained seven individuals classified as human sacrifices and Burial Tomb 44-13, which included both elites and suspected sacrifices. Based on the results of the mortuary analyses presented in Chapter 4, it was hypothesized that immigrants would be the targets of ritual violence by local elites.

The human sacrifices in Burial Tomb 44-13 were predominantly non-local individuals (two regional non-locals and one local/regional non-local), whereas the two primary interments that were sampled for isotope analysis (44A-13 and 44F-13) were locals. The children who were sacrificed had not lived at the site long before their death and at least one may have been brought to Paquimé as a captive. These individuals were also characterized by chronic poor health and extensive post-mortem processing, some of which was characteristic of anthropophagy (Turner and Turner 1999; TD White 1992). It was concluded that the bottom layer of articulated burials was a local elite lineage, while the individuals in the uppermost layer were human sacrifices that served as retainers (i.e., companion sacrifices) for the elites below. Finally, it was suggested that these individuals were selected for sacrifice because they were foreigners and/or because they were marginalized individuals who were viewed as less useful to society.

The ball court burials were quite distinct from the 44-13 sacrifices in terms of their demographic profiles and mortuary treatment. I argued that these differences reflect variation in the function of human sacrifice at Paquimé; while the 44-13 sacrifices likely served as retainer burials given their association with high status individuals, the ball court burials are more characteristic of communion sacrifice because of their strong association with fertility themes. It was also suggested that two of the ball court burials, 3A-14 and 1-14, may not have been sacrificed. Not only did these individuals lack skeletal evidence of ritual killing or corpse manipulation, they were also interred with grave goods, which could plausibly indicate reverence. However, peri-mortem violence and/or corpse manipulation was associated with the other ball court burials, which provides robust evidence for ritual sacrifice of these individuals.

In terms of geographic origins, two of the three ball court sacrifices that were sampled for isotope analysis were non-local (one regional non-local and one extraregional non-local), while the other was classified as a local/regional non-local. It is notable that both immigrants had peri-mortem skeletal trauma characteristic of interpersonal violence. The extraregional immigrant (Burial 2-14) was also buried in a seemingly disrespectful manner and had not lived at Paquimé long before his death (and may have arrived immediately prior to being sacrificed, perhaps as a captive). Interestingly, Burial 2-14 had isotope values consistent with the Mimbres/Mogollon region of southern New Mexico, which is also supported by aDNA evidence from this individual indicating genetic affinity with Mimbres groups (Morales-Arce et al. 2017). As such, these data suggest that relations with Post-Classic Mimbres groups occupying southern New Mexico at this time (e.g., Animas, Black Mountain phase, Jornada Mogollon) may not have been entirely amicable given the evidence for ritual violence against this individual.

When the results of both case studies are considered together, four of the six human sacrifices were immigrants and the other two were classified as local/regional non-locals. In other words, none of the sacrifices had unambiguously local isotope values. Three of the sacrifices had isotope values consistent with the southern zone of the Casas Grandes interaction sphere, while the other was from the northern periphery (i.e., southern New

Mexico). This suggests that immigrants from distant locations that were less integrated in the Casas Grandes regional system (JH Kelley et al. 2012; JH Kelley 2017; Whalen and Minnis 2001a, 2009) were the predominant victims of ritual sacrifice by Paquimé elites. Thus, not only did immigrants *not* hold high status positions in the Paquimé social hierarchy, they were also the targets of ritual violence. While other selection criteria, such as one's social status or perceived value to the community, may have been a factor, these data certainly suggest that geographic origins were an important component when choosing a sacrificial victim.

6.1.4 Summary

The results of this study indicate that immigrants from neighbouring regions were present at Paquimé during the Medio Period. This should not be surprising given the mix of foreign objects, ideas, and cultural attributes that are present at site and the evidence for genetic affinity between Paquimeños and groups from both the Southwest and West Mexico (e.g., Bradley 1999; Di Peso 1974: vol. 2; Leblanc et al. 2008; Lekson 2015; McGuire 2012; Morales-Arce et al. 2017; Turner 1993, 1999; Vargas 2001). However, the results of this study also demonstrate that immigrants from these regions were not high status individuals and were sometimes even the victims of ritual violence. As such, these data do not support external development models that argue for a direct and sustained presence of important or elite foreigners at Paquimé, including Di Peso's (1974: vol. 2) Mesoamerican *Pochteca* concept, JC Kelley's (2000) Aztatlán hypothesis, or Lekson's (1999, 2015) Chaco Meridian model.

Instead, the findings from this study suggest that local developments were the primary catalyst for Paquimé's Medio Period cultural trajectory. Proponents of local development models have argued that Medio Period culture change stemmed from regional population aggregation, competition between emerging local elites, and the use of exotic items, symbols, and ritual as a means to legitimize elite authority (Rakita 2001, 2009; Whalen and Minnis 2003, 2009). It is important to reiterate that local development models do not deny that external forces played a role in shaping the cultural trajectory of Paquimé. In fact, Whalen and Minnis (2003:328), "…unhesitatingly acknowledge the importance of distant contacts in the rise of Casas Grandes. [They] do so, however, within the context of local initiatives and aspirations." The findings from this study support these arguments. First, the majority of individuals in the Paquimé skeletal sample were born in the Casas Grandes region, which indicates local population aggregation. Second, these individuals also received elaborate mortuary treatment characteristic of elevated social status. Furthermore, the finding that locally-born individuals were often associated with ritually significant objects or burial locations supports the premise that emerging local elites derived at least some of their status from ritual or religious authority (Rakita 2001, 2009). Finally, the sacrifice of predominantly non-local individuals demonstrates that ritual violence may have been one of the sociopolitical strategies used by emerging elites to legitimize and maintain their status and authority over rival groups.

6.2 Medio Period Social Dynamics

While the primary goal of this thesis was to examine the role of interregional interaction in culture change at Paquimé, the results of this study also provide insight into Medio Period social dynamics. Although various aspects of local-immigrant relations were discussed above, this section highlights a few additional findings on the topic, which are summarized from the mortuary analyses and bioarchaeological case studies presented in Chapters 4 and 5, respectively.

The results from Chapter 3 demonstrate that the population at Paquimé consisted of a mix of locals, regional non-locals, and extraregional immigrants. The aggregation of disparate groups undoubtedly led to a complex Medio Period social environment and various strategies for navigating these conditions are apparent from the data presented in this study. First, it is evident that power dynamics between locals and immigrants were likely asymmetrical; locals held positions of elite authority, while immigrants were the primary targets of ritual violence. In the case of the 44-13 burial tomb, the sacrifices were juveniles in a poor state of health, so they may have belonged to a marginalized or low-status segment of the population. Two were regional non-locals whose isotope values were consistent with the southern Casas Grandes region and the other was a local/regional non-local. At least one of the juveniles may have been brought to the site as a captive. Taken together, these data fit well with scenarios of involuntary migration (e.g., captive taking, fission-fusion), where individuals are often marginalized or subjugated by their captors and/or recipient community (Cameron 2013).

It is noteworthy that one of the ball court sacrifices also had $^{87}Sr/^{86}Sr$ values that are consistent with the southern Casas Grandes region, which suggests that sociopolitical dynamics between Paquimé and groups to the south were not entirely amicable during the Medio Period. I have argued that tensions may have arisen because southern groups had fewer cultural similarities to Paquimé and do not appear to have embraced its religious/ritual ideology (JH Kelley et al. 2012, 2017). It is also possible that if human sacrifices were deemed necessary by Paquimé ritual practitioners, it was preferable to draw from groups that were not close allies or kin, regardless of whether conflict existed. The violent ritual sacrifice of a young adult male from the Mimbres/Mogollon region may represent a similar scenario, but with groups in the northern periphery of the Casas Grandes interaction sphere. Thus, Paquimé's relationship with other groups in the Casas Grandes interaction sphere (both to the north and south) involved conflict that resulted in ritual violence against members of these communities. Interactions with these groups may also have involved raiding for captives since at least two of the suspected sacrifices arrived at Paquimé just prior to their deaths.

It has been argued that the ball courts at Paquimé were venues for competition between rival groups, both within the Paquimé community and between Paquimé elites and other groups in the Casas Grandes region (Harmon 2005, 2006; Whalen and Minnis 1996). The non-local and disparate origins of the individuals interred beneath the ball court support this inference and indicate that human sacrifice was probably a strategy used by local elites to assert their dominance over in-migrating groups that were competing for power and/or resources in this newly aggregated community. The taphonomic evidence from the ball court burials also indicates that human sacrifice and/or the display of the corpses occurred in a public space. As such, the ritual killing of socio-political rivals may have been used as a mechanism for social control or as a means for reinforcing local identity and community cohesion amongst (locally-born) Paquimeños. It is also important to note that two of the sacrifices, one from the ball court and one from the 44-13 burial tomb, were likely from Paquimé or a nearby site, which means that ritual violence was also directed at locals or regional non-locals. This finding lends support to the inference that factional rivalries existed at Paquimé and/or within the Casas Grandes Core Zone (e.g., Harmon 2005, 2006; Whalen and Minnis 1996).

Finally, although some immigrants were the targets of ritual violence, it is also noteworthy that most residential units contained a mix of both local and non-local individuals (Chapter 4). Co-residence with local individuals in habitation areas suggests at least some level of community integration of first-generation immigrants (Batiuk 2013). Furthermore, there were no statistically significant differences in mortuary treatment by geographic origin, which means that extraregional immigrants, as a group, received similar mortuary treatment to the average Paquimeño or Casas Grandes native. This apparent variation in the social dynamics between locals and extraregional immigrants – ritual violence against some and the integration or assimilation of others – is probably a reflection of the complex social environment created by the aggregation of disparate populations. The population makeup of Paquimé was more heterogeneous than that of Convento, which would have required the development of new social mechanisms for coping with scalar stress (Rakita 2009). Such mechanisms typically involve cooperation, competition, or both (Cabana 2011; Clark 2011; Rakita 2009). The results of this study suggest that both conflict and integration occurred at Paquimé, perhaps simultaneously or at different times during the occupation of the site.

6.3 Ongoing Research & Future Directions

This study is part of a larger bioarchaeological research project focusing on the Casas Grandes skeletal assemblage that is led by Dr. M. Anne Katzenberg (Primary Investigator) and the late Dr. Jane H. Kelley (Co-Investigator) of the Department of Anthropology & Archaeology at the University of Calgary. In addition to the data presented in this study, AMS radiocarbon dating and dietary analyses are also being conducted on the skeletal samples from Paquimé and Convento. Dr. Katzenberg is spearheading the dating portion of the project, which will serve as a significant contribution toward refining the current chronology of the two sites, including the temporal relationships between burials. When combined with the strontium and oxygen isotope results from this study, these data may provide a better idea of when migration from both within and outside of the Casas Grandes region occurred, which will further enhance our understanding of the role of intra- and inter-regional interaction in Medio Period culture development. In addition, chronometric data may help to resolve some temporal ambiguities from certain mortuary contexts, such as whether the ball court burials date to the same period or if they were interred at different times.

Courtney McConnan Borstad, a Ph.D. Candidate in the Department of Anthropology and Archaeology at the University of Calgary, is conducting stable carbon, nitrogen, and hydrogen isotope analyses to reconstruct and compare Viejo and Medio Period diets. The results of her study will also be used to examine dietary variability among individuals at Paquimé, as well as between Paquimé and other groups in the region. When considered in tandem with the data from this study, the suite of isotope values from each individual ($^{87}Sr/^{86}Sr$, $\delta^{18}O$, $\delta^{13}C$, $\delta^{15}N$, δD) will refine interpretations of mobility and migration since diet can vary by population and geographic location (e.g., Killgrove and Montgomery 2016). Furthermore, isotopes of carbon and nitrogen allow for the estimation of relative food source contributions, which can impact dietary strontium.

In addition to integrating the various components of the current Casas Grandes bioarchaeology project, there are several other potential avenues for future research. First, I plan to explore the link between geographic origins, status, and religion through additional mortuary analyses that focus on identifying how specific artifacts and symbols, particularly those of foreign origin, may have been used to convey ritual authority or enhance the status of local elites. I also plan to conduct a more in-depth analysis of the relationship between geographic origins and burial location. Wilcox (1999) has conducted a preliminary spatial analysis of select architectural units at Paquimé to demonstrate the utility of using graph theory to explore access relationships at the site. The analysis demonstrated that smaller groupings within residential areas (i.e., architectural units), which likely represent distinct social units, could be identified. Thus, integrating the isotope data from this study with more comprehensive spatial analyses has exciting potential for examining social dynamics between locals and immigrants.

Second, comparative isotope data from human and faunal remains from sites in Northwest and West Mexico are needed to establish baseline isotope values for this region. Emphasis should be placed on the northern extent of the Aztatlán area (i.e., northern Sinaloa and Durango) up through southern Chihuahua and Sonora since these areas are the most probable (and proximate) places of origin for West Mexican immigrants to Paquimé (Punzo and Villalpando 2015). The current consensus among scholars working in the region is that Mesoamerican objects and ideas likely made their way to Paquimé through a route up the coast of West Mexico along the eastern flank of the Sierra Madre, then inland from Sonora or northern Sinaloa (e.g., JH Kelley et al. 2012; JH Kelley and Searcy 2015; Punzo and Villalpando 2015; VanPool et al. 2008; Whalen and Minnis 2001a, 2001b). Although some geological $^{87}Sr/^{86}Sr$ data are available for this region, comparative isotope data from human and faunal samples provides a much more reliable estimate of bioavailable strontium isotope values. And while the coastal areas of West Mexico should have distinctly higher $\delta^{18}O$ values than the expected $\delta^{18}O$ range at Paquimé, it is unclear how much variability in $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values exists from the western flank of the Sierra Madre inland to Paquimé. For example, it is important to determine whether isotope values in the southern zone of the Casas Grandes region (i.e., west-central Chihuahua) differ from those in southern Chihuahua/northern Durango. This is an important distinction because in this study, individuals with $^{87}Sr/^{86}Sr$ values between ~0.7062 to 0.7067 were classified as regional non-locals from the southern Casas Grandes region. If, however, areas outside of the Casas Grandes region have similar values, this would mean that these individuals could also be extraregional non-locals. Thus, comparative data from this region is needed to more accurately distinguish between regional and extraregional immigrants originating from the south of Paquimé.

Additional comparative samples are also needed from sites within the Casas Grandes interaction sphere to better define regional isotope variability. The $^{87}Sr/^{86}Sr$ results from this study are promising because there was enough variability within the region to differentiate between locals and regional non-locals in many cases. However, there was some overlap between the local $^{87}Sr/^{86}Sr$ ranges of Paquimé and Cerro Juanaqueña, the latter of which lies approximately 60 km north/northwest of Paquimé in the Middle Zone of the Casas Grandes interaction sphere. Meanwhile, $^{87}Sr/^{86}Sr$ values from Ch-254 and Ch-159 in the southern Outer Zone of the Casas Grandes interaction sphere were distinct from Paquimé. These sites are also located much farther away (~150 km), so it is currently unknown how much $^{87}Sr/^{86}Sr$ variability exists in the geographic space between Paquimé and this area. Ideally, faunal samples should be collected from sites located in each direction of Paquimé, at varying distances. Efforts should also focus on the outer periphery of the Casas Grandes interaction sphere, particularly in southern New Mexico along the present-day US/Mexico border. The results of this study provide compelling evidence that individuals from the Mimbres or broader Mogollon region migrated to Paquimé, but the paucity of comparative data from this area prohibits the identification of more specific geographic origins. Isotope mapping of the Casas Grandes region, as well as neighbouring regions in Northwest Mexico, will not only allow for more refined interpretations of the isotope data presented here, but will also serve as a valuable resource for future isotope studies in this region.

Comprehensive bioarchaeological analyses of the Paquimé skeletal assemblage are also needed to more fully understand the impacts of migration on both the host community and the migratory individuals themselves. The case studies presented in this thesis demonstrate the utility of a multifaceted approach that combines isotopic, osteological, mortuary, and archaeological data in reconstructing identity at different scales of analysis. Such methods allow for a more complete understanding of the social identities and life experiences of individuals living in aggregated communities. The finding that immigrants were more often the targets of ritual violence than locally-born individuals raises the question of whether such discrimination extended to interpersonal violence generally. Casserino (2009) has examined trauma and post-mortem processing in a subset of the Paquimé skeletons but found limited evidence of ante- or peri-mortem trauma in the sample of individuals that he examined (~7%) and only a few of these fractures were characteristic of interpersonal violence (e.g., cranial or facial trauma). Moreover, only 37 of the individuals examined by Casserino (2009) were included in the present study, so a much larger sample size is needed to explore the relationship between migration/aggregation and violence at Paquimé.

6.4 Research Significance

This study has made several important contributions to our understanding of population dynamics in the Casas Grandes region of Northwest Mexico. The role of foreign influences in the cultural trajectory of Casas Grandes has been debated since the site was first excavated nearly 60 years ago, but this is the first study to provide empirical evidence of first-generation immigrants at Paquimé. While the presence of foreigners at the site is not necessarily unexpected, the isotopic analysis of human remains made it possible to determine the structure and scale of migration, which were previously unknown. Sampling multiple teeth per individual was particularly valuable in this regard because it allowed for the construction of individual mobility profiles. These data were used to examine mobility within an individual's lifetime, which led to the finding that most extraregional immigrants had lived at multiple different geographic locations before settling at Paquimé. Mobility profiles were also effective at determining whether migratory units consisted of adults, children, or both. These data enhance our understanding of population dynamics in the broader NW/SW since many of the migratory individuals were born in the Southwest, then moved within the region before permanently settling at Paquimé. The analysis of individuals from both Paquimé and Convento also provided a diachronic perspective on how population dynamics changed from the Viejo to Medio Period, which is a critical component for understanding the role of outside influences in the cultural trajectory of Casas Grandes.

In addition to population-level analyses that enhance our understanding of migration as a process, the use of isotopic methods on human skeletal remains also allowed for individual-level analyses. This level of resolution is not typically available using archaeological evidence alone. In particular, the combination of isotope and mortuary data was valuable for examining the relationship between geographic origins and social status, which is an integral component of cultural development models. We now know that several of the most elaborate burials at Paquimé (e.g., 44A-13, 44F-13) belong to locally-born individuals and not foreign elites. The two cases studies that were conducted also demonstrate the utility of using a multi-faceted bioarchaeological approach in migration studies. Not only were these data useful for determining the geographic origins of the sacrificial victims at Paquimé, they also added to our understanding of the impacts of migration in aggregated communities, as well as social dynamics with specific groups. For example, socio-political relationships between Paquimé and other groups in the Casas Grandes region (and beyond) were likely characterized by some degree of conflict given that non-local individuals were the predominant victims of sacrifice. The results of this study also provide compelling evidence for captive taking during the Medio Period at

Paquimé, a practice that has not previously been identified at the site and that is generally difficult to convincingly identity prehistorically. Thus, this study has demonstrated the utility of using isotopic methods to examine both the process and impacts of migration in archaeological populations.

References Cited

Adams EC. 1991. The origins and development of the Katsina cult. Tucson: University of Arizona Press.

Alvarez RR Jr. 1987. Familia: Migration and adaptation in Baja and Alta California, 1800-1975. Berkley: University of California Press.

Anda G. 2007. Sacrifice and ritual body mutilation in Postclassical Maya society: Taphonomy of the human remains from Chichén Itzá's Cenote Sagrado. In: Tiesler V, Cucina A, editors. New perspectives on human sacrifice and postsacrificial body treatments in ancient Maya society. New York: Springer. p 190-208.

Andrushko VA, Buzon MR, Gibaja AM, McEwan GF, Simonetti A, Creaser RA. 2011. Investigating a child sacrifice event from the Inca heartland. Journal of Archaeological Science 38:323-333.

Anthony DW. 1990. Migration in archeology: the baby and the bathwater. American Anthropologist 92:895–914.

Arakawa F. 2012. Cyclical cultural trajectories: A case study from the Mesa Verde region. Journal of Anthropological Research 68(1):35-69.

Arnold B, Jeske RJ. 2014. The archaeology of death: mortuary archaeology in the United States and Europe 1990 – 2013. Annual Review of Anthropology 43:325-346.

Bäckström Y, Price TD. 2016. Social identity and mobility at a pre-industrial mining complex, Sweden. Journal of Archaeological Science 66:154-168.

Batiuk SD. 2013. The fruits of migration: Understanding the 'longue dureé' and the socio-economic relations of the Early Transcaucasian Culture. Journal of Anthropological Archaeology 32:449-477.

Baustian KM, Harrod RP, Osterholtz AJ, Martin DL. 2012. Battered and abused: Analysis of trauma at Grasshopper Pueblo (AD 1275-1400). International Journal of Paleopathology 2:102-111.

Beard BL, Johnson CM. 2000. Strontium isotope composition of skeletal material can determine the birth place and geographic mobility of humans and animals. Journal of Forensic Sciences 45:1049–1061.

Behrensmeyer AK. 1978. Taphonomic and ecological information from bone weathering. Paleobiology 4(2):150-162.

Bell J. 1951. On brachydactyly and symphalangism. Treasury of Human Inheritance 5 (part 1):1-31.

Benfer RA. 1968. An analysis of a prehistoric skeletal population, Casas Grandes, Chihuahua, Mexico. Ph.D. Dissertation. College Station: University of Texas.

Benson L, Petersen K, Stein J. 2006. Anasazi (Pre-Columbian Native American) migrations during the middle 12th and late 13th centuries – were they drought induced? Climate Change 83(1-2):187-213).

Bentley RA. 2006. Strontium isotopes from the earth to the archaeological skeleton: a review. Journal of Archaeological Method and Theory 13(3):135-187.

Bentley RA, Price TD, Lüning J, Gronenborn D, Wahl J, Fullagar PD. 2002. Human migration in early Neolithic Europe. Current Anthropology 43:799–804.

Bentley RA, Pietrusewsky M, Douglas MT, Atkinson T. 2005. Matrilocality during the prehistoric transition to agriculture in Thailand? Antiquity 79:865-881.

Bentley RA, Tayles N, Higham CFW, Macpherson C, Atkinson TC. 2007. Shifting gender relations at Khok Phanom Di, Thailand: Isotopic evidence from the skeletons. Current Anthropology 48:301-314.

Bentley RA, Cox K, Tayles N, Higham CFW, Macpherson C, Nowell G, Cooper M, Hayes TEF. 2009. Community diversity at Ban Lum Khao, Thailand. Asian Perspectives 48:79-97.

Bernardini W. 2005. Reconsidering spatial and temporal aspects of Prehistoric cultural identity: A case study. American Antiquity 70(1):31-54.

Binford LR. 1971. Mortuary practices: Their study, and their potential. Memoirs for the Society of American Archaeology. 25:6-29.

Blum JD, Taliaferro EH, Weisse MT, Holmes RT. 2000. Changes in Sr/Ca, Ba/Ca and $^{87}Sr/^{86}Sr$ ratios between two forest ecosystems in the northeastern USA. Biogeochemistry 49:87–101.

Blumenschine RJ, Marean CW, Capaldo SD. 1996. Blind tests of inter-analyst correspondence and accuracy in the identification of cut marks, percussion marks and carnivore tooth marks on bone surfaces. Journal of Archaeological Science 23:493-507.

Boldsen JL, Milner GR, Konigsberg LW, Wood JW. 2002. Transition analysis: A new method for estimating age from skeletons. In: Hoppa RD, Vaupel JW, editors. Paleodemography: Age distributions from skeletal samples. Cambridge: Cambridge University Press. p 73–106.

Bourget S. 2016. Sacrifice, violence and ideology among the Moche: The rise of social complexity in Ancient Peru. Austin: University of Texas Press.

Bowen GJ. 2017. The Online Isotopes in Precipitation Calculator, version 3.1. http://www.waterisotopes.org.

Bowen GJ, Ravenaugh J. 2003. Interpolating the isotopic composition of modern meteoric precipitation. Water Resources Research 39:1-13.

Bradley RJ. 1999. Shell exchange within the Southwest: The Casas Grandes interaction sphere. In: Schaafsma CF, Riley CL, editors. The Casas Grandes World. Salt Lake City: University of Utah Press. p 213–228.

Brand DD. 1933. The historical geography of Northwestern Chihuahua. Ph.D. Dissertation. Berkley: The University of California.

Braun DP. 1977. Middle Woodland-(Early) Late Woodland social change in the prehistoric central Midwestern U.S. Ph.D. Dissertation. Ann Arbor: University of Michigan.

Braun DP. 1981. A critique of some recent North American mortuary studies. American Antiquity 46(2): 398-416.

Brettell R, Montgomery J, Evans J. 2012. Brewing and stewing: The effect of culturally mediated behaviour on the oxygen isotope composition of ingested fluids and the implications for human provenance studies. Journal of Analytical Atomic Spectrometry 27:778-785.

Bryant JD, Froelich PN. 1995. A model of oxygen isotope fractionation in body water of large mammals. Geochimica et Cosmochimica Acta 59:4523–4537.

Bryant JD, Froelich PN, Fricke HC, O'Neil JR, Lynnerup N. 1996. Oxygen isotope composition of human tooth enamel from Medieval Greenland: Linking climate and society: comment and reply. Geology 24:477-478.

Budd P, Montgomery J, Barreiro B, Thomas R. 2000. Differential diagenesis of strontium in archaeological human dental tissues. Applied Geochemistry 15(5):687–694.

Buikstra JE, Ubelaker DH. 1994. Standards for data collection from human skeletal remains: Proceedings of a seminar at the field museum of natural history. Fayetteville: Arkansas Archaeological Survey.

Burnett SE, Wilczak CA. 2012. Tarsal and tarsometatarsal coalitions from Mound C (Ocmulgee Macon Plateau site, Georgia):Implications for understanding the patterns, origins, and antiquity of pedal coalitions in Native American populations. HOMO – Journal of Comparative Human Biology 63:167-181.

Burton JH, Wright LE. 1995. Nonlinearity in the relationship between bone Sr/Ca and diet: Paleodietary implications. American Journal of Physical Anthropology 96:273–282.

Burton JH, Hahn R. 2016. Assessing the "local" $^{87}Sr/^{86}Sr$ ratio for humans. In: Grupe G, McGlynn GC, editors. Isotope landscapes in bioarchaeology. New York: Springer. p 113-122.

Butler BH. 1971. The people of Casas Grandes: Cranial and dental morphology through time. Ph.D. Dissertation. Dallas: Southern Methodist University.

Buzon M, Simonetti A, Creaser R. 2007. Migration in the Nile Valley during the New Kingdom period: A preliminary strontium isotope study. Journal of Archaeological Science 34:1391–1401.

Buzon MR, Conlee CA, Bowen GJ. 2011. Refining oxygen isotope analysis in the Nasca region of Peru: An investigation of water sources and archaeological samples. International Journal of Osteoarchaeology 21:446-455.

Cabana GS. 2011. The problematic relationship between migration and culture change. In: Cabana GS, Clark JJ, editors. Rethinking anthropological perspectives on migration. Gainesville: University Press of Florida.

Cabana GS, Clark JJ. 2011. Rethinking anthropological perspectives on migration. Gainesville: University Press of Florida.

Cameron CM. 1995. Migration and the movement of Southwestern peoples. Journal of Anthropological Archaeology 14:104-124.

Cameron CM. 2011. Captives and culture change: Implications for archaeologists. Current Anthropology 52(2):169–209.

Cameron CM. 2013. How people moved among ancient societies: Broadening the view. American Anthropologist 115(2):218-231.

Capo RC, Stewart BW, Chadwick OA. 1998. Strontium isotopes as tracers of ecosystem processes: Theory and methods. Geoderma 82:197–225.

Carr C. 1995. Mortuary practices: Their social, philosophical-religious, circumstantial, and physical determinants. Journal of Archaeological Method and Theory 2(2):105-200.

Casserino CM. 2009. Bioarchaeology of violence and site abandonment at Casas Grandes, Chihuahua, Mexico. Ph.D. Dissertation. Eugene: The University of Oregon.

Chenery CA, Pashley V, Lamb AL, Sloane HJ, Evans JA. 2012. The oxygen isotope relationship between the phosphate and structural carbonate fractions of human bioapatite. Rapid Communications in Mass Spectrometry 26:309-319.

Cheung C, Jing Z, Tang J, Yue Z, Richards MP. 2017. Examining social and cultural differentiation in early Bronze Age China using stable isotope analysis and mortuary patterning of human remains at Xin'anzhuang, Yinxu. Archaeological and Anthropological Sciences 9(5):799-816.

Clark 2011. Disappearance and diaspora: Contrasting two migrations in the southern U.S. Southwest. In: Cabana GS, Clark JJ, editors. Rethinking anthropological perspectives on migration. Gainesville: University of Florida Press. p 86-108.

Coplen TB. 1994. Reporting of stable hydrogen, carbon, and oxygen isotope abundances. Pure and Applied Chemistry 66:271–276.

Coplen TB, Kendall C, Hopple J. 1983. Comparison of stable isotope reference samples. Nature 302(5905):236–238.

Cordell LS, Gumerman GJ. 1989. Cultural interaction in the prehistoric Southwest. In: Cordell LS, Gumerman GJ, editors. Dynamics of Southwest Prehistory. Washington: Smithsonian Institution Press. p 1-18.

Cordell LS, McBrinn ME. 2012. ME. 2012. Archaeology of the Southwest. New York: Routledge.

Cox K, Bentley RA, Tayles NG, Buckley HR, MacPherson CG, Cooper MJ. 2011. Intrinsic or extrinsic population growth in Iron Age Northeast Thailand? The evidence from isotopic analysis. Journal of Archaeological Science 38:665-681.

Creel DG. 1999. The Black Mountain phase in the Mimbres area. In: Schaafsma CG, Riley CL, editors. The Casas Grandes World. Salt Lake City: The University of Utah Press. p 106-120.

Crown PL. 1994. Ceramics and ideology. Albuquerque: University of New Mexico Press.

Crown PL, Hurst WJ. 2009. Evidence of cacao use in the prehispanic American Southwest. PNAS 106(7):2110-2113.

Cruz Antillón R, Maxwell TD. 1999. The Villa Ahumada site: Archaeological investigations east of Paquimé. In: Schaafsma CF, Riley CL, editors. The Casas Grandes World. Salt Lake City: University of Utah Press. p 43-53.

Cruz Antillón R, Leonard RD, Maxwell TD, VanPool TD, Harmon MJ, VanPool CS, Hyndman DA, Brandwein SS. 2004. Galeana, Villa Ahumada, and Casa Chica: Diverse sites in the Casas Grandes region. In: Newell GE, Gallaga E, editors. Surveying the archaeology of Northwest Mexico. Salt Lake City: University of Utah Press. p 149-176.

Cucina A, Tiesler V. 2006. The companions of Janaab' Pakal and the "Red Queen"from Palenque, Chiapas: Meanings of human companion sacrifice in Classic Maya society. In: Tiesler V, Cucina A, editors. Janaab' Pakal of Palenque. reconstructing the life and death of a Maya ruler. Tucson: University of Arizona Press. p 102–125.

Cucina A, Tiesler V. 2007. New perspectives on human sacrifice and postsacrificial body treatments in ancient Maya society: an introduction. In: Tiesler V, Cucina A, editors. New perspectives on human sacrifice and postsacrificial body treatments in ancient Maya society. New York: Springer. p 1-13.

Damon PE, Shafiqullah M, Clark KF. 1983. Geochronology of the porphyry copper deposits and related mineralization of Mexico. Canadian Journal of Earth Sciences 20(6):1052-1071.

Dansgaard W. 1964. Stable isotopes in precipitation. Tellus 16(4):436-468.

Darling W, Bath A, Talbot J. 2003. The O and H stable isotopic composition of fresh waters in the British Isles. 2. Surface waters and groundwater. Hydrology and Earth System Sciences 7:183–95.

Dasch EJ. 1969. Strontium isotopes in weathering profiles, deep-sea sediments and sedimentary rocks. Geochimica et Cosmochimica Acta 33:1521-1522.

Daux V, Lécuyer C, Héran M, Amiot R, Simon L, Fourel F, Matrineau F, Lynnerup N, Reychler H, Escarguel G. 2008. Oxygen isotope fractionation between human phosphaste and water revisited. Journal of Human Evolution 55(6):1138-1147.

Dean JS, Ravesloot JC. 1993. The chronology of cultural interaction in the Gran Chichimeca. In: Woosley AI, Ravesloot JC, editors. Culture and contact: Charles C. DiPeso's Gran Chichimeca. Albuquerque: University of New Mexico Press. p 83–104.

De La Cruz I, Gonzalez-Oliver A, Kemp BM, Roman JA, Smith DG, Toree-Blanco. 2008. Sex identification of children sacrificed to the ancient Aztec rain gods in Tlatelolco. Current Anthropology 49(3):519-526.

Dickin AP. 2005. Radiogenic Isotope Geology, 2nd edition. Cambridge: Cambridge University Press.

DiGangi EA, Bethard JD, Kimmerle EH, Konigsberg LW. 2009. A new method for estimating age-at-death from the first rib. American Journal of Physical Anthropology 138(2):164-176.

Di Peso CC. 1974. Casas Grandes: A fallen trading center of the Gran Chichimeca, Vols 1-3. Amerind Foundation Series No. 9. Dragoon: Amerind Foundation.

Di Peso CC, Rinaldo J, Fenner GJ. 1974. Casas Grandes: A fallen trading center of the Gran Chichimeca, Vols 4-8. Amerind Foundation Series No. 9. Dragoon: Amerind Foundation.

Doolittle WE. 1993. Canal irrigation at Casas Grandes: A technological and developmental assessment of its origin. In: Woosley AI, Ravesloot JC, editors. Culture and contact: Charles C. Di Peso’s Gran Chichimeca. Albuquerque. University of New Mexico Press. p 133-151.

Douglas JE, Quijada CA. 2005. Di Peso's concept of the Northern Sierra: Evidence from the Upper Bavispe Valley, Sonora, Mexico. Latin American Antiquity 16(3):275-291.

Douglas JE, MacWilliams AC. 2015. Society and polity in the wider Casas Grandes region. In: Minnies PE, Whelen ME, editors. Ancient Paquimé and the Casas Grandes World. Tucson: The University of Arizona Press. p 104-147.

Dudás FÖ, LeBlanc SA, Carter SW, Bowring SA. 2016. Pb and Sr concentrations and isotopic compositions in prehistoric North American teeth: A methodological study. Chemical Geology 429:21-32.

Ericson JE. 1985. Strontium isotope characterization in the study of prehistoric human ecology. Journal of Human Evolution 14:503-514.

Evans J, Stoodley N, Chenery C. 2006. A strontium and oxygen isotope assessment of a possible fourth century immigrant population in a Hampshire cemetery, southern England. Journal of Archaeological Science 33:265–272.

Ezzo JA, Johnson CM, Price TD. 1997. Analytical perspectives on prehistoric migration: a case study from East-Central Arizona. Journal of Archaeological Science 24:447-466.

Ezzo JA, Price TD. 2002. Migration, regional reorganization, and spatial group composition at Grasshopper Pueblo, Arizona. Journal of Archaeological Science 29:499-520.

Faure G. 1986. Principles of isotope geology. New York: John Wiley.

Faure G, Powell J. 1972. Strontium isotope geology. New York: Springer-Verlag.

Fish PR, Fish SK. 1999. Reflections on the Casas Grandes regional system from the northwestern periphery. In: Schaafsma CG, Riley CL, editors. The Casas Grandes World. Salt Lake City: The University of Utah Press. p 27–42.

Fisher-Carroll R, Mainfort RC. 2000. Late prehistoric mortuary behavior at Upper Nodena. Southeastern Archaeology 19(2):105-119.

Foster MS. 1999. The Aztatlán tradition of West and Northwest Mexico and Casas Grandes: speculations on the Medio Period florescence. In: Schaafsma CG, Riley CL, editors. The Casas Grandes World. Salt Lake City: The University of Utah Press. p 149-163.

Fullagar PD, Lemmon RC, Ragland PC. 1971. Petrochemical and geochronological studies of plutonic rocks in the Southern Appalachians: part I. the Salisbury Pluton. Geological Society of America Bulletin 82:409-416.

Gaither C, Kent J, Vásquez Sánchez V, Rosales T. 2008. Mortuary practices and human sacrifice in the Middle Chao Valley of Peru: Their interpretation in the context of Andean mortuary patterning. Latin American Antiquity 19(2):107-121.

Gat JR, Gonfiantini R (Eds). 1981. Stable isotope hydrology Deuterium and oxygen-18 in the water cycle. International Atomic Energy Agency (IAEA): IAEA.

Garvie-Lok SJ, Varney TL, Katzenberg MA. 2004. Preparation of bone carbonate for stable isotope analysis: The effects of treatment time and acid concentration. Journal of Archaeological Science 31(6):763-776.

Goldstein LG. 1976. Spatial structure and social organization: regional manifestations of Mississippian society. Ph.D. Dissertation. Evanston: Northwestern University.

Goldstein LG. 1981. One-dimensional archaeology and multi-dimensional people: spatial organization and mortuary practice. In: Chapman R, Kinnes I, Randsborg K, editors. The archaeology of death. Cambridge: Cambridge University Press. p 53-70.

Goodenough WH. 1965. Rethinking “status” and “role”: toward a general model of the cultural organization of social relationships. In: Goodenough WH, editor. The relevance of models for social anthropology. New York: Fredrick A. Praeger Publishers. p 1-24.

Goodman AH, Rose JC. 1990. Assessment of systemic physiological perturbations from dental enamel hypoplasias and associated histological structures. Yearbook of Physical Anthropology 33:59-110.

Goodman AH, Martinez C, Chavez A. 1991. Nutritional supplementation and the development of linear enamel hypoplasias in children from Tezonteopan, Mexico. The American Journal of Clinical Nutrition 53:773-781.

Gowland R. 2006. Ageing the past: examining age identity from funerary evidence. In: Gowland R, Knüsel C, editors. Social archaeology of funerary remains. Oxford: Oxbow Books. p 143-154.

Graulich M. 2000. Aztec human sacrifice as expiation. History of Religions 39:352–371.

Gregoricka LA. 2013. Geographic origins and dietary transitions during the Bronze Age in the Oman Peninsula. American Journal of Physical Anthropology 152:353–369.

Gregoricka LA, Scott AB, Betsinger TK, Polcyn M. 2017. Deviant burials and social identity in a postmedieval polish cemetery: An analysis of stable oxygen and carbon isotopes from the “vampires” of Drawsko. American Journal of Physical Anthropology 163(4):741-758.

Grimstead DN, Quade J, Stiner MC. 2015. Isotopic evidence for long-distance procurement and resource depletion, Chaco Canyon, New Mexico. Geoarchaeology 31:335–345.

Grupe G, Price T, Schröter P, Söllner F, Johnson C, Beard B. 1997. Mobility of Bell Beaker people revealed by strontium isotope ratios of tooth and bone: a study of southern Bavarian skeletal remains. Applied Geochemistry 12(4):517–525.

Hammond GP, Rey A. 1928. Obregóns history of 16th century explorations in western America, entitled 'Chronicle, commentary, or relation of the ancient and modern discoveries in New Spain and New Mexico, Mexico, 1584'. Los Angeles: Wetzel.

Harmon MJ. 2006. Religion and the Mesoamerican ball game in the Casas Grandes region of northern Mexico. In: Van Pool CS, Van Pool TL, Phillips DA, editors. Religion in the Prehispanic Southwest. Lanham: Alta Mira Press. p 185-218.

Harmon MJ. 2005. Centralization, cultural transmission, and "The Game of Life and Death" in Northern Mexico. Ph.D. Dissertation. Albuquerque: University of New Mexico.

Harrod RP. 2012. Centers of control: Revealing elites among the Ancestral Pueblo during the "Chaco Phenomenon". International Journal of Paleopathology 2(2-3):123-135.

Healy PF, Emery K, Wright LE. 1990. Ancient and modern Maya exploitations of the jute snail (Pachychilus). Latin American Antiquity 1(2):170-183.

Hercberg S, Rouaud C. 1981. Nutritional anaemia. Children in the Tropics 133:1-6.

Herr S and Clark JJ. 1997. Patterns in the pathways: Early historic migrations in the Rio Grande pueblos. Kiva 64(2):365-389.

Hillson S. 1996. Dental Anthropology. Cambridge: Cambridge University Press.

Hodder I. 1982. Theoretical archaeology: a reactionary view. In: I. Hodder, editor. Symbolic and structural archaeology. Cambridge: Cambridge University Press. p. 1-16.

Hodder I. 1999. The archaeological process: An introduction. Oxford: Blackwell Publishers.

Hodell DA, Quinn RL, Brenner M, Kamenov G. 2004. Spatial variation of strontium isotopes ($^{87}Sr/^{86}Sr$) in the Maya region: a tool for tracking ancient human migration. Journal of Archaeological Science 31:585–600.

Hoppa R, Vaupel JW, editors. 2002. Paleodemography: age distributions from skeletons. Cambridge: Cambridge University Press.

Hoppe K, Koch P, Furutani T. 2003. Assessing the preservation of biogenetic strontium in fossil bones and tooth enamel. International Journal of Osteoarchaeology 13:20-28.

Howell TL, Kintigh KW. 1996. Archaeological identification of kin groups using mortuary and biological data: an example from the American Southwest. American Antiquity 61(3):537-554.

Hurtado A, Cetina A, Tiesler V, Folan WJ. 2007. Sacred spaces and human funerary and nonfunerary placements in Champotón, Campeche, during the Postclassic Period. In: Tiesler V, Cucina A, editors. New perspectives on human sacrifice and ritual body treatments in ancient Maya society. New York: Springer. p 209-231.

IAEA/WMO. 2015. Global Network of Isotopes in Precipitation. The GNIP Database. Accessible at: http://www.iaea.org/water.

Jimenéz-Betts P. 2000. Archaeology in southern Zacatecas: The Malpaso, Juchipila and Valparaisco-Bolaños Valleys. In: Foster MS, Gorenstein, editors. Greater Mesoamerica: the archaeology of West and Northwest Mexico. Salt Lake City: The University of Utah Press. p 155-180.

Katzenberg MA. 2008 Stable isotope analysis: A tool for studying past diet, demography and life history. In: Katzenberg MA, Saunders S, editors. Biological anthropology of the human skeleton. New York: John Wiley & Sons. p. 305-327.

Kelley JC. 1995. Trade goods, traders and status in Northwestern Greater Mesoamerica. In: Reyman JE, editor. The Gran Chichimeca: Essays on the archaeology and ethnohistory of Northern Mesoamerica. London: Avebury. p 102-145.

Kelley JC. 2000. The Aztatlán mercentile system: Mobile traders and the northwestward expansion of Mesoamerican civilization. In: Foster MS, Gorenstein S, editors. Greater Mesoamerica: The archaeology of West and Northwest Mexico. Salt Lake City: The University of Utah Press. p 137–154.

Kelley JH. 2017. How Paquimé went from trading center to shrine. In: Kelley JH, Phillips DA Jr., editors. Not so far from Paquimé: Essays on the archaeology of Chihuahua, Mexico. Salt Lake City: The University of Utah Press. p 176-192.

Kelley JH, Stewart JD, Macwilliams AC, Neff LC. 1999. A west central perspective on Chihuahuan culture. In: Schaafsma CF, Riley CL, editors. The Casas Grandes World. Salt Lake City: University of Utah Press. p 63–78.

Kelley JH, MacWilliams AC, Stewart JD, Adams KR, Cunningham JJ, Garvin RD, Maillol JM, Reimer PJ, Zborover D. 2012. The view from the edge: the Proyecto Arqueológico Chihuahua (PAC): 1990 to 2010: an overview. Canadian Journal of Archaeology 36:82-107.

Kelley JH, Searcy MT. 2015. Beginnings: The Viejo Period. In: Minnis PE, Whalen ME, editors. Ancient Paquimé and the Casas Grandes World. Tucson: University of Arizona Press. p 17-40.

Kelley JH, Stewart JD, Garvin RD, Phillips DA Jr. 2017. Thoughts on the southern zone. In: Kelley JH, Phillips DA Jr., editors. Not so far from Paquimé: Essays on the archaeology of Chihuahua, Mexico. Salt Lake City: The University of Utah Press. p 166-175.

Killgrove K, Montgomery J. 2016. All road lead to Rome: Exploring human migration to the Eternal City through biochemistry of skeletons from two Imperial-Era cemeteries (1st-3rd c AD). PLoS ONE 11(2): e0147585. doi:10.1371/journal.pone.0147585

King DJ, Searcy MT, Yost CL, Waller K. 2017. Corn, beer and marine resources at Casas Grandes, Mexico: An analysis of prehistoric diets using microfossils recovered from dental calculus. Journal of Archaeological Science: Reports 16:365-379.

Klaus HD, Tam Chang ME. 2009. Surviving contact: Biological transformations, burial, and ethnogenesis in the colonial Lambayeque Valley, north coast of Peru. In: Knudson KJ, Stojanowski CM, editors. Bioarchaeology and identity in the Americas. Gainesville: University Press of Florida. P 126-152.

Knudson KJ. 2011. Identifying archaeological human migration using biogeochemistry: Case studies from the south-central Andes. In: Cabana GS, Clark JJ, editors. Rethinking anthropological perspectives on migration. Gainesville: University of Florida Press. p 231-247.

Knudson KJ, Price TD, Buikstra JE, Blom DE. 2004. The use of strontium isotope analysis to investigate Tiwanaku migration and mortuary ritual in Bolivia and Peru. Archaeometry 46:5-18.

Knudson KJ, Blom DE. 2009. The complex relationship between Tiwanaku mortuary identity and geographic origin in the South Central Andes. In: Knudson KJ, Stojanowski CM, editors. Bioarchaeology and identity in the Americas. Gainesville: University Press of Florida. P 126-152.

Knudson KJ, Goldstein PS, Dahlstedt A, Somerville A, Schoeninger MJ. 2014. Paleomobility in the Tiwanaku diaspora: Biogeochemical analyses at Rio Muerto, Moquegua, Peru. American Journal of Physical Anthropology 155:405-421.

Knudson KJ, Price TD. 2007. Utility of multiple chemical techniques in archaeological residential mobility studies: Case studies from Tiwanaku- and Chiribaya-affiliated sites in the Andes. American Journal of Physical Anthropology 132(1):25-39.

Kohler TA, Turner KK. 2006. Raiding for women in the pre-Hispanic northern Pueblo Southwest? Current Anthropology 47:1035–1045.

Kohn MJ, Schoeninger MJ, Valley JW. 1996. Herbivore tooth oxygen isotope compositions: Effects of diet and physiology. Geochimica et Cosmochimica Acta 60:3889–3896.

Kohn MJ, Schoeninger MJ, Barker WW. 1999. Altered states: Effects of diagenesis on fossil tooth chemistry. Geochimica et Cosmochimica Acta 63(18): 2737-2747.

Kohn S. 2011. Mortuary Practices at Paquimé and in the Casas Grandes region. Paper presented at the 76th Annual Meeting of the Society for American Archaeology. Sacramento, California.

Lambert PM, Billman BR, Leonard BL. 2000. Explaining variability in mutilated human bone assemblages from the American Southwest: A case study from the Southern Piedmont of Sleeping Ute Mountain, Colorado. International Journal of Osteoarchaeology 10:49–64.

LeBlanc SA, Turner CG, Morgan ME. 2008. Genetic relationships based on discrete dental traits: Basketmaker II and Mimbres. International Journal of Osteoarchaeology 18:109–130.

Lee-Thorp J, Sponheimer M. 2003. Three case studies used to reassess the reliability of fossil bone and enamel isotope signals for paleodietary studies. Journal of Anthropological Archaeology 22:208-216.

Lekson SH. 1999. Chaco Meridian: Centers of political power in the Ancient Southwest. Walnut Creek: Altamira Press.

Lekson SH. 2008. A history of the Ancient Southwest. Santa Fe: School for Advanced Research Press.

Lekson SH. 2015. Chaco Meridian: One thousand years of political power and religious power in the Ancient Southwest, 2nd edition. Lanham: Rowman & Littlefield.

Levinson A, Luz B, Kolodny Y. 1987. Variations in oxygen isotopic compositions of human teeth and urinary stones. Applied Geochemistry 2(4):367–371.

Lightfoot E, O’Connell TC. 2016. On the use of biomineral oxygen isotope data to identify human migrants in the archaeological record: Intra-sample variation, statistical methods and geographical considerations. PLoS ONE 11(4): e0153850. https://doi.org/10.1371/journal.pone.0153850.

Longinelli A. 1984. Oxygen isotopes in mammal bone phosphate — a new tool for paleohydrological and paleoclimatological research. Geochimica et Cosmochimica Acta 48:385–390.

Lovell NC. 1997. Trauma analysis in paleo-pathology. Yearbook of Physical Anthropology 40:139- 70

Luz B, Kolodny Y, Horowitz M. 1984. Fractionation of oxygen isotopes between mammalian bone phosphate and environmental drinking-water. Geochimica et Cosmochimica Acta 48:1689–1693.

Marcoux JB. 2010. The materialization of status and social structure at Koger's Island cemetery, Alabama. In: Sullivan LP, Mainfort Jr. RC, editors. Mississippian mortuary practices: Beyond hierarchy and the representationist perspective. Gainesville: University of Florida Press. p. 145-173.

Marlar RA, Leonard BL, Billman BR, Lambert PM, Marlar JE. 2010. Biochemical evidence of cannibalism at a prehistoric Puebloan site in southwestern Colorado. Nature 407:74-78.

Marstellar SJ, Knudson KJ, Gordon G, Anbar A. 2017. Biogeochemical reconstructions of life histories as a method to assess regional interactions: Stable oxygen and radiogenic strontium isotopes and Late Intermediate Period mobility on the Central Peruvian Coast. Journal of Archaeological Science: Reports 13:535-546.

Martin DL. 2008. Ripped flesh and torn souls: Evidence for slavery in the prehistoric Southwest, AD 800–1500. In: Cameron CM, editor. Invisible citizens: captives and their consequences. Salt Lake City: University of Utah Press. p 159–180.

Martin DL, Harrod RP. 2015. Bioarchaeological contributions to the study of violence. Yearbook of Physical Anthropology 156:116-145.

McAnany PA. 1995. Living with the ancestors: Kinship and kingship in ancient Maya society. Austin: University of Texas Pres.

McCafferty GG, McCafferty SD. 2006. Boys and girls interrupted: Mortuary evidence of children from Post-Classic Cholula. In: Arden T, Hutson SR, editors. The social experience of childhood in Mesoamerica. Boulder: University Press of Colorado. p. 25-52.

McDonald JH. 2014. Handbook of biological statistics, 3rd edition. Baltimore: Sparky House Publishing.

McDowell F. 2007. Geologic transect across the northern Sierra Madre Occidental volcanic field, Chihuahua and Sonora, Mexico. The Geological Society of America Digital Chart and Map Series 6:1-70.

McGuire RH. 2012. Pueblo religion and the Mesoamerican connection. In: Glowacki DM, Van Keuren S, editors. Religious transformation in the late Pre-Hispanic Pueblo world. Tucson: University of Arizona Press. p 23-49.

McGuire RH, Villalpando Canchola E, Vargas VD, Gallaga E. 1999. Cerro Trincheras and the Casas Grandes World. In: Schaafsma CF, Riley CL, editors. The Casas Grandes World. Salt Lake City: University of Utah Press. p. 134-146.

Medina C, Sanchez M. 2007. Posthumous body treatments and ritual meaning in the Classic Period Northern Petén. A taphonomic approach. In: Tiesler V, Cucina A, editors. New perspectives on human sacrifice and ritual body treatments in ancient Maya society. New York: Springer. p 102-119.

Mensforth RP. 2007. Human trophy taking in eastern North America during the Archaic Period: The relationship to warfare and social complexity. In: Chacon RJ, Dye DH, editors. The taking and displaying of human body parts as trophies by Amerindians. New York: Springer. p 222-277.

Miller VE. 2007. Skeletons, skulls, and bones in the art of Chichén Itzá. In: Tiesler V, Cucina A, editors. New perspectives on human sacrifice and ritual body treatments in ancient Maya society. New York: Springer. p 165-189.

Milner G. 2010. Transition analysis and subjective estimates of age in adult skeletons. In: Boldsen J, Tarp P, editors. ADBOU 1992-2009 Forskningsresultater. Denmark: Syddansk Universitet. p 15–27.

Milner GR, Anderson E, Smith VG. 1991. Warfare in late prehistoric West-Central Illinois. American Antiquity 56:581–603.

Milner GR, Boldsen JL. 2012. Transition analysis: A validation study with known-age modern American skeletons. American Journal of Physical Anthropology 148(1):98-110.

Minnis PE, Whalen ME. 2005. At the other end of the Puebloan world: Feasting at Casas Grandes, Chihuahua, Mexico. In: Hegmon M, Eiselt BS, editors. Engaged anthropology: Research essays on North American archaeology, ethnobotany, and museology. Ann Arbour: Regents of the University of Michigan. p 114–128.

Minnis PE, Whalen ME, Howell RE. 2006. Fields of power: Upland farming in the prehispanic Casas Grandes polity, Chihuahua, Mexico. American Antiquity 71(4):707-722.

Minnis PE, Whalen ME. 2015. Introduction: The Joint Casas Grandes Expedition in historical context. In: Minnis PE, Whalen ME, editors. Ancient Paquimé and the Casas Grandes world. Tucson: University of Arizona Press. p 3-16.

Montgomery J, Evans JA, Cooper RE. 2007. Resolving archaeological populations with Sr-isotope mixing models. Applied Geochemistry 22:1502-1514.

Morales-Arce AY, Snow MH, Kelley JH, Katzenberg MA. 2017. Ancient mitochondrial

DNA and ancestry of Paquimé inhabitants, Casas Grandes (A.D. 1200–1450). American Journal of Physical Anthropology 163(3):616-626.

Nations JD. 1979. Snail shells and maize preparation: a Lacandon Maya analogy. American Antiquity 44:568-571.

Nelson BA, Villalpando E, Punzo JL, Minnis PE. 2015. Prehispanic Northwest and adjacent West Mexico, 1200 B.C – A.D. 1400: An inter-regional perspective. Kiva 81(1-2):31-61.

Offenbecker AM, Waller KD, Kelley JH, Katzenberg MA. 2014. Mortuary variation at Paquimé and its implications for sociocultural differentiation. Paper presented at the 79th Annual Meeting of the Society for American Archaeology, Austin, Texas.

Pader EJ. 1982. Symbolism, social relations and the interpretation of mortuary remains. Oxford: BAR Supplementary Series 130.

Padilla RJ, Domínguez I, López AG, Mota J, Fuentes AO, Rosique F, Germán EA, Campos SE. 2013. National Autonomous University of Mexico Tectonic Map of Mexico GIS Project, American Association of Petroleum Geologists GIS Open Files series.

Pailes M. 2017. Northwest Mexico: The prehistory of Sonora, Chihuahua, and neighboring areas. Journal of Archaeological Research DOI 10.1007/s10814-017-9103-5.

Parker Pearson M. 1982. Mortuary practices, society and ideology: an ethnoarchaeology study. In: I. Hodder, editor. Symbolic and structural archaeology. Cambridge: Cambridge University Press. p. 99-113.

Parker Pearson M. 1999. The archaeology of death and burial. College Station: Texas A&M University Press.

Passalacqua NV. 2009. Forensic age-at-death estimation from the human sacrum. Journal of Forensic Sciences 61(s1):s22-s29.

Peebles CS. 1974. Moundville: The organization of a prehistoric community and culture. Ph.D. Dissertation. Santa Barbara: University of California.

Peebles CS, Kus SM. 1977. Some archaeological correlates of ranked societies. In: Fagan B, Voorhies B, editors. Essays on Archaeological Problems. American Antiquity 42(3):421-448.

Pérez VR. 2012. The taphonomy of violence: Recognizing variation in disarticulated skeletal assemblages. International Journal of Paleopathology 2:156-165.

Phillips Jr. DA. 1989. Prehistory of Chihuahua and Sonora, Mexico. Journal of World

Prehistory 3:373-401.

Pindborg JJ. 1982. Aetiology of developmental enamel defects not related to fluorosis. International Dental Journal 32:123-134.

Plog S. 2008. Ancient peoples of the American Southwest. New York: Thames and Hudson.

Pollard AM, Pellegrini M, Lee-Thorp JA. 2011. Technical note: Some observations on the conversion of dental enamel $\delta^{18}O_p$ Values to $\delta^{18}O_w$ to determine human mobility. American Journal of Physical Anthropology 145:499-504.

Porčic M, Stefanović S. 2009. Physical activity and social status in early Bronze Age society: The Mokrin necropolis. Journal of Anthropological Archaeology 28:259-273.

Price TD, Johnson C, Ezzo JA, Burton JH, Ericson JE. 1994. Residential mobility in the prehistoric Southwest United States: A preliminary study using strontium isotope analysis. Journal of Archaeological Science 21:315–330.

Price TD, Manzanilla L, Middleton W. 2000. Immigration and the ancient city of Teotihuacan in Mexico: A study using strontium isotope ratios in human bone and teeth. Journal of Archaeological Science 27(10):903–913.

Price TD, Burton JH, Bentley RA. 2002. The characterization of biologically available strontium isotope ratios for the study of prehistoric migration. Archaeometry 44(1):117–135.

Price TD, Burton JH, Wright LE, White CD, Longstaffe F. 2007. Victims of sacrifice: Isotopic evidence for place of origin. In: Tiesler V, Cucina A, editors. New perspectives on human sacrifice and ritual body treatments in ancient Maya society. New York: Springer. p 263-292.

Price TD, Burton JH, Fullagar PD, Wright LE, Buikstra JE, Tiesler V. 2008. Strontium isotopes and the study of human mobility in ancient Mesoamerica. Latin American Antiquity 19(2):167-180.

Price TD, Burton JH. 2011. An introduction to archaeological chemistry. New York: Springer.

Price TD, Plog S, LeBlanc SA, Krigbaum J. 2017. Great house origins and population stability at Pueblo Bonito, Chaco Canyon, New Mexico: The isotopic evidence. Journal of Archaeological Science 11:261-273.

Probst A, El Gh'mari A, Aubert D, Fritz B, McNutt R. 2000. Strontium as a tracer of weathering processes in a silicate catchment polluted by acid atmospheric inputs, (Strengbach, France). Chemical Geology 170:203–219.

Prowse T, Schwarcz H, Garnsey P, Knyf M, Macchiarelli R, Bondioli L. 2007. Isotopic evidence for age-related immigration to Imperial Rome. American Journal of Physical Anthropology 132:510–519.

Punzo JL, Villalpando. 2015. Paquimé: A revision of its relations to the south and west. In: Minnis PE, Whalen ME, editors. Ancient Paquimé and the Casas Grandes World. Tucson: The University of Arizona Press. p 172-191.

Rakita GFM. 2001. Social complexity, religious organization, and mortuary ritual in the Casas Grandes region of Chihuahua, Mexico. Ph.D. Dissertation. Albuquerque: University of New Mexico.

Rakita GFM. 2009. Ancestors and elites: Emergent complexity and ritual practices in the Casas Grandes polity. Vol 6 in the Archaeology of Religion series. New York: Altamira Press.

Rakita GFM, VanPool CS, VanPool TL, Sterling S. 2011. An introduction to the 76 Draw site, Luna County, New Mexico. In: Melinda R. Landreth, editor. Patterns in transition: Papers from the 16th Biennial Jornada Mogollon Conference. El Paso: Museum of Archaeology. p 29-64.

Rakita GFM, Cruz Antillón R. 2015. Organization of production at Paquimé. In: Minnis PE, Whalen ME, editors. Ancient Paquimé and the Casas Grandes World. Tucson: The University of Arizona Press. p 58-82.

Ravesloot JC. 1988. Mortuary practices and social differentiation at Casas Grandes, Chihuahua, Mexico. Anthropological Papers of the University of Arizona, Volume 49. Tucson: University of Arizona Press.

Ravesloot JC, Dean JS, Foster MS. 1995. A reanalysis of the Casas Grandes tree-ring dates: a preliminary discussion. In Reyman JE, editor. The Gran Chichimeca: Essays on the archaeology and ethnohistory of northern Mesoamerica. Brookfield: Avebury Press. p 240–251.

Reitz EJ, Wing ES. 2008. Zooarchaeology. New York: Cambridge University Press.

Ríos L, Weisensee K, Rissech C. 2008. Sacral fusion as an aid in age estimation. Forensic Science International 180(2):111-117.

Robb J, Bigazzi R, Lazzarini L, Scarsini C, Sonego F. 2001. Social status and biological status: a comparison of grave goods and skeletal indicators from Pontecagnano. American Journal of Physical Anthropology 115:213–222.

Roberts SB, Coward WA, Ewing G, Savage J, Cole TJ, Lucas A. 1988. Effect of weaning on accuracy of doubly labeled water method in infants. American Journal of Physiology 254:R622–627.

Román JA. 1991. A study of skeletal material from Tlatelolco. In: Carrasco D, editor. To change place: Aztec ceremonial landscapes. Niwot: University Press of Colorado. p. 9-19.

Saxe AA. 1970. Social dimensions of mortuary practices. Ph.D. Dissertation. Ann Arbor: University of Michigan.

Scarborough VL, Wilcox DR, editors. 1991. The Mesoamerican ballgame. Tucson: University of Arizona Press.

Schaafsma CF, Riley CL. 1999. The Casas Grandes World analysis and conclusion. In: Schaafsma CF, Riley CL, editors. The Casas Grandes world. Salt Lake City: The University of Utah Press. p 237-250.

Schachner G. 2010. Population circulation and the transformation of ancient Zuni communities. Tucson: University of Arizona Press.

Scheeres M, Knipper C, Hauschild M, Schonfelder M, Siebel W, Pare C, Alt KW. 2014. "Celtic migrations": Fact or fiction? Strontium and oxygen isotope analysis of the Czech cemeteries of Radovesice and Kutn a Hora in Bohemia. American Journal of Physical Anthropology 155:496-512.

Schlegel A. 1992 African political models in the American Southwest: Hopi as an internal frontier society. American Anthropologist 94(2):376–397.

Schoeninger MJ, Hallin J, Reeser H, Valley JW, Fournelle J. 2003. Isotopic alteration of mammalian tooth enamel. International Journal of Osteoarchaeology 13:11-19.

Schuh C, Makarewicz CA. 2016. Tracing residential mobility during the Merovingian period: An isotopic analysis of human remains from the Upper Rhine Valley, Germany. American Journal of Physical Anthropology 161:155-169.

Schwartz GM. 2017. The archaeology of sacrifice. Annual Review of Anthropology 46:223-240.

Schwarcz HP, Gibbs L, Knyf M. 1991. Oxygen isotope analysis as an indicator of place of origin. In: Pfeiffer S, Williamson RF, editors. Snake hill: An investigation of a military cemetery from the war of 1812. Toronto: Dundurn Press. p 263–268.

Sealy J, Armstrong R, Schrire C. 1995. Beyond lifetime averages: Tracing life histories through isotopic analysis of different calcified tissues from archaeological human skeletons. Antiquity 69:290–300.

Sillen A, Hall G, Armstrong R. 1998. $^{87}Sr/^{86}Sr$ ratios in modern and fossil food-webs of the Sterkfontein Valley: Implications for early hominid habitat preference. Geochimica et Cosmochimica Acta 62:2463–2478.

Slovak NM, Paytan A. 2011. Applications of Sr isotopes in archaeology. In: Baskaran M, editor. Handbook of environmental isotope geochemistry: Advances in isotope geochemistry, volume 36. New York: Springer. p 743-768.

Snow M, Shafer H, Glenn Smith D. 2011. The relationship of the Mimbres to other southwestern and Mexican populations. Journal of Architectural Science 38:3122–3133.

Somerville AD, Nelson BA, Knudson KJ. 2010. Isotopic investigation of pre-Hispanic macaw breeding in Northwest Mexico. Journal of Anthropological Archaeology 29:125-135.

Spence MW, White CD, Longstaffe FJ, Law KR. 2004. Victims of the victims: Human trophies worn by sacrificed soldiers from the Feathered Serpent Pyramid, Teotihuacan. Ancient Mesoamerica 15:1-15.

Stewart JD, Kelley JH, MacWilliams AC, Reimer P. 2005. The Viejo period of Chihuahua culture in northwestern Mexico. Latin American Antiquity 16:169-192.

Stewart JD, MacWilliams AC, Kelley JH. 2004 Archaeological chronology in West-Central Chihuahua. In: Newell GE, Gallaga E, editors. Surveying the archaeology of Northeast Mexico. Salt Lake City: The University of Utah Press. p. 247-264.

Stickel EG. 1968. Status differentiations at the Rincon site. University of California Los Angeles, Archaeological Survey, Annual Report 10:209-261.

Stojanowski CM, Schillaci MA. 2006. Phenotypic approaches for understanding patterns of intracemetery biological variation. Yearbook of Physical Anthropology 49:49-88.

Stuart-Macadam P. 1989. Porotic hyperostosis: relationship between orbital and vault lesions. American Journal of Physical Anthropology 80:187-193.

Sugiyama S, López L. 2006. Sacrificios de cosagración en la Piramide de la Luna, Teotihuacan. In: Sugiyama S, López L, editors. Sacrificios de Cosagración en la Piramide de la Luna, Teotihuacan. Consejo Nacional para la Cultura y las Artes. Mexico, DF: Instituto Nacional de Antropología e Historia. p. 25–52.

Sullivan A. 2003. Reconstructing relationships among mortality, status, and gender at the Medieval Gilbertine Priory of St. Andrew, Fishergate, York. American Journal of Physical Anthropology 124(4):330-345.

Sweeney EA, Saffir AJ, De Leon R. 1971. Linear enamel hypoplasia of deciduous incisor teeth in malnourished children. American Journal of Clinical Nutrition 24(1):29-31.

Swenson E. 2014. Dramas of the dialectic: Sacrifice and power in ancient polities. In: Campbell RB, editor. Violence and civilization: Studies of social violence in history and prehistory. Oxford: Oxbow. p 28-60.

Tainter JA. 1973. The social correlates of mortuary patterning at Kaloko, North Kona, Hawaii. Archaeology and Physical Anthropology in Oceania 8:1-11.

Tainter JA. 1975. The archaeological study of social change: Woodland systems in west-central Illinois. Ph.D. Dissertation. Chicago: Northwestern University.

Tainter JA. 1978. Mortuary practices and the study of prehistoric social systems. Advances in Archaeological Method and Theory 1:105-141.

Tiesler V. 2007. Funerary or nonfunerary? New references in identifying ancient Maya sacrificial and postsacrificial behaviors from human assemblages. In: Tiesler V, Cucina A, editors. New perspectives on human sacrifice and postsacrificial body treatments in ancient Maya society. New York: Springer. p 14-43.

Tiesler V, Cucina A. 2006. Procedures in human heart extraction and ritual meaning: A taphonomic assessment of anthropogenic marks in Classic Maya skeletons. Latin American Antiquity 17(4)493-510.

Toyne JM, White CD, Verano JW, Uceda Castillo S, Millaire JF, Longstaffe FJ. 2014. Residential histories of elites and sacrificial victims at Huacas de Moche, Peru, as constructed from oxygen isotopes. Journal of Archaeological Science 42:15-28.

Trigger BG. 1989. A history of archaeological thought. Cambridge: Cambridge University Press.

Turner BL, Kamenov GD, Kingston JD, Armelagos GJ. 2009. Insights into immigration and social class at Machu Picchu, Peru based on oxygen, strontium, and lead isotope analysis. Journal of Archaeological Science 36:317-332.

Turner BL, Klaus HD, Livengood SV, Brown LE, Salda F, Wester C. 2013. The variable roads to sacrifice: Isotopic investigations of human remains from Chotuna-Huaca de los Sacrificios, Lambayeque, Peru. American Journal of Physical Anthropology 151:22-37.

Turner II CG. 1993. Southwest Indian teeth. National Geographic Research and Exploration 9:32-53.

Turner II CG. 1999. The dentition of Casas Grandes with suggestions on epigenetic relationships among Mexican and Southwestern U.S. In: Schaafsma CF, Riley CL, editors. The Casas Grandes World. Salt Lake City: University of Utah Press. p 229-233.

Turner II CG, Turner JA. 1999. Man corn: Cannibalism and violence in the prehistoric American Southwest. Salt Lake City: University of Utah Press.

Underwood E, Mertz W. 1977. Trace elements in human and animal nutrition. New York: Academic Press.

Vail G, Hernández C. 2007. Human sacrifice in Late Postclassic Maya iconography and texts. In: Tiesler V, Cucina A, editors. New perspectives on human sacrifice and ritual body treatments in Ancient Maya Society. New York: Springer.

VanPool CS. 2003. The shaman-priests of the Casas Grandes region, Chihuahua, Mexico. American Antiquity 68(4):696-717.

VanPool CS. 2009. The signs of the sacred: Identifying shamans using archaeological evidence. Journal of Anthropological Archaeology 28:177-190.

VanPool CS, VanPool TL. 2007. Signs of the Casas Grandes shamans. Salt Lake City: University of Utah Press.

VanPool TL, VanPool CS, Rakita GFM, Leonard R. 2008. Birds, bells, and shells: The long reach of the Aztatlán trading tradition. In: Nielsen G, editor. Touching the past: Traditions of Casas Grandes. Provo: BYU University Press. p 5-14.

VanPool TL, VanPool CS. 2016. Animating architecture and the assembly of an elite city: Birth and dedication of nonhuman persons at Paquimé, Chihuahua, Mexico. Journal of Anthropological Research 72(3):311-336.

VanPool TL, Kircher KW, VanPool CS, Rakita GFM. 2017. Social interaction, social status, and the organization of Medio period craft production as evidenced in ground stone artifacts from 76 Draw. Lithic Technology 42:77-89.

Vargas VD. 2001. Mesoamerican copper bells in the pre-Hispanic southwestern United States and northwestern Mexico. In: Fields VM, Zamudio-Taylor V, editors. The road to Aztatlán: Art from a mythic homeland. Albuquerque: University of New Mexico Press. p 196-211.

Veizer J. 1989. Strontium isotopes in seawater through time. Annual Review of Earth and Planetary Science 1:141-167.

Walker CM. 2006. The bioarchaeology of newly discovered burial caves in the Sierra Tarahumara. Ph.D. Dissertation. Eugene: The University of Oregon.

Walker PL. 1986. Porotic hyperostosis in a marine-dependent California Indian population. American Journal of Physical Anthropology 69:345-354.

Walker PL. 2001. A bioarchaeological perspective on the history of violence. Annual Review of Anthropology 30:573-596.

Walker PL, Cook DC. 1998. Brief Communication: Gender and sex: vive la difference. American Journal of Physical Anthropology 106:255-259.

Walker PL, Bathurst RR, Richman R, Gjerdrum T, Andrushko VA. 2009. The causes of porotic hyperostosis and cribra orbitalia: A reappraisal of the iron-deficiency anemia hypothesis. American Journal of Physical Anthropology 139-109-125.

Waller KD. 2009. Stable isotope analysis in the Middle San Juan region: The Tommy Site and Mine Canyon Site. MA Thesis. Portales: Eastern New Mexico University.

Waller KD. 2017. Bioarchaeological analyses of Paleodemography and violence at Paquimé, Chihuahua, Mexico. Ph.D. Dissertation. Columbia: University of Missouri.

Waller KD. Under review. Paleodemographic variability at Paquimé, Chihuahua, Mexico. American Journal of Physical Anthropology.

Waller KD, Offenbecker AM. Under Review. Politics and poetics of performance violence at Casas Grandes, Chihuahua, Mexico. In: Osterholtz AJ, editor. The poetics of processing: Memory formation, cosmology, and handling of the dead.

Wassenaar LI, Van Wilgenburg SL, Larson K, Hobson KA. 2009. A groundwater isoscape (δD, $\delta^{18}O$) for Mexico. Journal of Geochemical Exploration 102:123-136.

Waterman AJ, Peate DW, Silva AM, Thomas, JT. 2014. In search of homelands: Using strontium isotopes to identify biological markers of mobility in late prehistoric Portugal. Journal of Archaeological Science 42:119-127.

Webster M. 2001. Prehistoric diet and human adaptation in West Central Chihuahua, Mexico. MA thesis. Calgary: University of Calgary.

Whalen ME. 2013. Wealth, status, ritual, and marine shell at Casas Grandes, Chihuahua, Mexico. American Antiquity 78(4):624–639.

Whalen ME, Minnis PE. 1996. Ball courts and political centralization in the Casas Grandes region. American Antiquity 61:732-746.

Whalen ME, Minnis PE. 2001a. Casas Grandes and its hinterland. Tucson: The University of Arizona Press.

Whalen ME, Minnis PE. 2001b. The Casas Grandes regional system: A late prehistoric polity of northwestern Mexico. Journal of World Prehistory 15(3):313-364.

Whalen ME, Minnis PE 2003. The local and the distant in the origin of Casas Grandes, Chihuahua, Mexico. American Antiquity 68:314-32.

Whalen ME, Minnis PE. 2009. The neighbors of Casas Grandes: Excavating Medio period communities of Northwest Chihuahua, Mexico. Tucson: The University of Arizona Press.

Whalen ME, MacWilliams AC, Pitezel T. 2010. Reconsidering the size and structure of Casas Grandes, Chihuahua, Mexico. American Antiquity 75:527-551.

Whalen ME, Pitezel T. 2015. Settlement patterns of the Casas Grandes area. In: Minnis PE, Whalen ME, editors. Ancient Paquimé and the Casas Grandes World. Tucson: The University of Arizona Press. p 103-125.

White CD, Spence MW, Stuart-Williams H, Le Q, Schwarcz HP. 1998. Oxygen isotopes and the identification of geographical origins: The valley of Oaxaca versus the Valley of Mexico. Journal of Archeological Science 25:643–655.

White CD, Spence MW, Longstaffe FJ, Law KR. 2000. Testing the nature of Teotihuacán imperialism at Kaminaljuyú using phosphate oxygen-isotope ratios. Journal of Archaeological Research 56(4):535-558.

White CD, Longstaffe FJ, Spence MW, Stuart-Williams H, Le Q, Law KR. 2002. Geographic identities of the sacrificial victims from the Feathered Serpent Pyramid, Teotihuacán: Implications for the nature of state power. Latin American Antiquity 13:371–393.

White CD, Spence MW, Longstaffe FJ, Law KR. 2004. Demography and ethnic continuity in the Tlailotlacan enclave of Teotihuacan: The evidence from stable oxygen isotopes. Journal of Anthropological Archaeology 23:385-403.

White CD, Price GD, Longstaffe FJ. 2007. Residential histories of the human sacrifices at the Moon Pyramid, Teotihuacan: Evidence from oxygen and strontium isotopes. Ancient Mesoamerica 18:159-172.

White TD. 1992. Prehistoric cannibalism at Mancos 5MTUMR-2346. Princeton: Princeton University Press.

Whittlesley SM. 1978. Status and death at Grasshopper Pueblo: Experiments toward an archaeological theory of correlates. Ph.D. dissertation. Tucson: University of Arizona.

Wilcox D. 1999. A preliminary graph-theoretical analysis of access relationships at Casas Grandes. In: Schaafsma CF, Riley CL, editors. The Casas Grandes World. Salt Lake City: University of Utah Press. p 93-104.

Willey PS. 1990. Prehistoric warfare on the Great Plains: Skeletal analysis of the Crow Creek massacre victims. New York: Garland Publishing.

Wilson AS, Taylor T, Constanza Ceruti M, Chavez JA, Reinhard J, Grimes V, Meier-Augenstein W, Cartmell L, Stern B, Richards MP, Worobey M, Barnes I, Gilbert MTP. 2007. Stable isotope and DNA evidence for ritual sequences in Inca child sacrifice. PNAS 104(42):16456-16461.

Woo EJ, Sciulli PW. 2011. Degenerative joint disease and social status in the Terminal Late Archaic Period (1000-500 B.C.) of Ohio. International Journal of Osteoarchaeology 23(5):529-544.

Wright LE. 2005. Identifying immigrants to Tikal, Guatemala: Defining local variability in strontium isotope ratios of human tooth enamel. Journal of Archaeological Science 32:555-566.

Wright LE. 2012. Immigration to Tikal, Guatemala: Evidence from stable strontium and oxygen isotopes. Journal of Anthropological Archaeology 31:334-352.

Wright LE, Schwarcz HP. 1998. Stable carbon and oxygen isotopes in human tooth enamel: Identifying breastfeeding and weaning in prehistory. American Journal of Physical Anthropology 106:1–18.

Zazzo A, Le´cuyer C, Sheppard MF, Grandjean P, Mariotti A. 2004. Diagenesis and the reconstruction of paleoenvironments: A method to restore original $\delta^{18}O$ values of carbonate and phosphate from fossil tooth enamel. Geochimica et Cosmochimica Acta 68:2245–2258.

Appendix A

Isotope and Mortuary Data for Paquimé and Convento Burials

LIST OF ABBREVIATIONS

Geographic Origins
L = Local
RNL = Regional Non-local
L/RNL = Local/Regional Non-local
ERNL = Extraregional Non-local

Sex
F = Female
F? = Probable Female
M = Male
M? = Probable Male
I = Indeterminate

Age (Age-at-Death)
CH = Child (3-12 years)
AD = Adolescent (12-20 years)
YA = Young Adult (20-35 years)
MA = Middle Adult (35-50 years)
OA = Old Adult (50+ years)
A = Adult (20+ years)
I = Indeterminate

Burial Type
1A = Subfloor Room Burial in Sealed Pit – Single Articulated Body
1B = Subfloor Room Burial in Sealed Pit – Multiple Articulated Bodies
1D = Subfloor Room Burial in Sealed Pit – Multiple Disarticulated (Secondary) Bodies
1E = Subfloor Room Burial in Sealed Pit – Multiple Articulated & Disarticulated Bodies
2A = Unburied Body – Floor Surface, Articulated
2B = Unburied Body – Floor Surface, Disarticulated
2C = Unburied Body – Fill, Articulated
2D = Unburied Body – Fill, Disarticulated
3A = Subfloor Plaza Burial in Sealed Pit – Single Articulated Body
3B = Subfloor Plaza Burial in Sealed Pit – Multiple Articulated Bodies

4B = Subfloor Room Burial in Sealed Tomb – Multiple Articulated Bodies
4E = Subfloor Room Burial in Sealed Tomb – Multiple Articulated & Disarticulated Bodies
7A = Burials Superimposed on Older, Abandoned Architecture - Single Articulated Body
7B = Burials Superimposed on Older, Abandoned Architecture – Multiple Articulated Bodies
7C = Burials Superimposed on Older, Abandoned Architecture - Single Disarticulated (Secondary) Body
8B = Human Sacrifice – Multiple Articulated Bodies
8E = Human Sacrifice – Multiple Articulated & Disarticulated Bodies
11A = Subfloor Room Burial in Unsealed Pit – Single Articulated Body
11E = Subfloor Room Burial in Unsealed Pit – Multiple Articulated & Disarticulated Bodies

Interment Type
I = Interred
NI = Non-Interred (Type 2: Unburied body)

Form of Disposal
PRMR = Primary Burial
SCND = Secondary Burial
UNKN = Unknown

Degree of Articulation
ARTC = Articulated Burial
DART = Disarticulated Burial

Position
EXTD = Extended
FLEX = Flexed
SEFL = Semi-Flexed
SCFR = Scattered & Fragmentary
UNKN = Unknown

Deposition
SIDL = Left Side
SIDR = Right Side
SIT = Sitting
SUPN = Supine

UNKN = Unknown

Orientation (Head)
NRTH = North
EAST = East
SOTH = South
WEST = West
UNKN = Unknown

Form
ABST = Abandoned Structure
FILL = Room Fill
FLSU = Floor Surface
SPIT = Sealed Pit
STSH = Stone-Filled Shaft
TOMB = Burial Tomb
UPIT = Unsealed Pit

Location
PLAZ = Plaza
ROOM = Room

Number of Individuals
MULT = Multiple
SNGL = Single

Burial Goods
1 = Present
0 = Absent

Burial ID	Geo Origins	Sex	Age	Burial Type	Interment Type	Form of Disposal	Degree of Articulation	Position	Deposition	Orientation	Form	Location	No. of Individuals	Burial Goods
Paquimé														
1A-1	ERNL	F	MA	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	MULT	0
19A-1	ERNL	I	AD	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FILL	ROOM	MULT	0
20-1	L	I	CH	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FILL	ROOM	MULT	0
14-1	RNL	I	AD	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	SNGL	0
8A-1	RNL	F	YA	1B	I	PRMR	ARTC	FLEX	SIT	NRTH	SPIT	ROOM	MULT	1
11A-1	L	M?	I	1B	I	PRMR	ARTC	FLEX	SIT	WEST	SPIT	ROOM	MULT	0
12-1	RNL	M	YA	1A	I	PRMR	ARTC	FLEX	SIT	WEST	SPIT	ROOM	SNGL	1
27A-1	RNL	M	OA	1B	I	PRMR	ARTC	FLEX	SIT	WEST	SPIT	ROOM	MULT	1
1-4	L/RNL	M?	YA	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	SNGL	0
5-4	ERNL	F?	YA	2C	NI	PRMR	ARTC	FLEX	SIDR	UNKN	FLSU	ROOM	SNGL	0
2-6	L	F?	MA	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	SNGL	0
3-6	L	F	AD	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	SNGL	0
6-6	ERNL	M	YA	3A	I	PRMR	ARTC	FLEX	SUPN	WEST	SPIT	PLAZ	SNGL	0
10A-6	L/RNL	F	YA	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	MULT	0
11-6	L	F	I	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	SNGL	0
17-6	ERNL	M?	YA	1B	I	PRMR	ARTC	FLEX	SIDL	NRTH	SPIT	ROOM	MULT	0
24-6	L	F	YA	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	SNGL	0
25-6	L	M	MA	1B	I	PRMR	ARTC	FLEX	SIDR	NRTH	SPIT	ROOM	MULT	1
34-6	ERNL	F	OA	3A	I	PRMR	ARTC	SEFL	SIDL	NRTH	SPIT	PLAZ	SNGL	1
35-6	L	F	YA	3A	I	PRMR	ARTC	FLEX	SIDR	NRTH	SPIT	PLAZ	SNGL	1
2B-8	L	I	CH	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	MULT	0
13-8	L	F	MA	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	MULT	0
21-8	L	I	AD	3B	I	PRMR	ARTC	FLEX	SIDL	EAST	SPIT	PLAZ	MULT	0
22-8	L	I	CH	3B	I	PRMR	ARTC	FLEX	SIDL	EAST	SPIT	PLAZ	MULT	1
27-8	L	I	CH	1B	I	PRMR	ARTC	SCFR	UNKN	UNKN	SPIT	ROOM	SNGL	0
42-8	L	F?	MA	3A	I	PRMR	ARTC	FLEX	SUPN	WEST	SPIT	PLAZ	SNGL	0
43C-8	L	I	CH	3B	I	PRMR	ARTC	SCFR	UNKN	UNKN	SPIT	PLAZ	MULT	1
1-11	L	M	YA	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	MULT	0
8B-11	L	I	CH	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FILL	ROOM	MULT	0

Burial ID	Geo Origins	Sex	Age	Burial Type	Interment Type	Form of Disposal	Degree of Articulation	Position	Deposition	Orientation	Form	Location	No. of Individuals	Burial Goods
9-11	L	I	AD	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FILL	ROOM	MULT	0
18/19-11	L	M	YA	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FILL	ROOM	MULT	0
22-11	ERNL	M	YA	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FILL	ROOM	MULT	0
32-11	L	F	YA	1B	I	PRMR	ARTC	FLEX	SUPN	WEST	SPIT	ROOM	MULT	0
35-11	RNL	F?	YA	7A	I	PRMR	ARTC	FLEX	SUPN	NRTH	ABST	PLAZ	SNGL	0
45-11	ERNL	F?	YA	7A	I	PRMR	ARTC	SEFL	SIDL	EAST	ABST	PLAZ	SNGL	0
54-11	L	M	MA	7A	I	PRMR	ARTC	FLEX	SUPN	WEST	ABST	PLAZ	SNGL	1
19-12	RNL	F	OA	1A	I	PRMR	ARTC	FLEX	SUPN	SOTH	SPIT	ROOM	SNGL	1
26-12	RNL	M	MA	11E	I	PRMR	ARTC	FLEX	SIT	SOTH	UPIT	ROOM	MULT	1
28-12	RNL	I	I	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FILL	ROOM	SNGL	0
31-12	L	F	YA	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	PLAZ	MULT	0
32-12	L	I	YA	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	MULT	0
36-12	L	M	YA	3A	I	PRMR	ARTC	EXTD	SUPN	WEST	SPIT	PLAZ	SNGL	1
37-12	RNL	M	YA	3A	I	PRMR	ARTC	EXTD	SUPN	EAST	SPIT	PLAZ	SNGL	0
1B-13	L	I	AD	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	MULT	0
4-13	RNL	M	MA	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	SNGL	0
19-13	L	F	YA	3A	I	PRMR	ARTC	FLEX	SUPN	EAST	SPIT	PLAZ	SNGL	0
20-13	ERNL	F?	YA	3A	I	PRMR	ARTC	FLEX	SIDL	SOTH	SPIT	PLAZ	SNGL	0
37-13	L	M	AD	1E	I	SCND	DART	UNKN	UNKN	UNKN	SPIT	ROOM	MULT	1
38-13	RNL	M	OA	1E	I	PRMR	ARTC	EXTD	SUPN	EAST	SPIT	ROOM	MULT	1
39-13	L	I	AD	3A	I	PRMR	ARTC	FLEX	SIDL	WEST	SPIT	PLAZ	SNGL	0
44A-13	L	M	OA	4E	I	PRMR	ARTC	FLEX	SUPN	WEST	TOMB	ROOM	MULT	1
44F-13	L	F	MA	4E	I	PRMR	ARTC	FLEX	SIT	NRTH	TOMB	ROOM	MULT	1
44J-L1-13	L/RNL	I	AD	4E	I	UNKN	DART	SCFR	UNKN	UNKN	TOMB*	ROOM	MULT	0
44J-L2-13	RNL	I	AD	4E	I	UNKN	DART	SCFR	UNKN	UNKN	TOMB*	ROOM	MULT	0
44I-13	RNL	I	AD	4E	I	UNKN	DART	SCFR	UNKN	UNKN	TOMB*	ROOM	SNGL	0
55-13	L	M	YA	1E	I	PRMR	ARTC	SEFL	SUPN	EAST	SPIT	ROOM	MULT	1
76-13	L	F	MA	1A	I	PRMR	ARTC	FLEX	SIT	NRTH	SPIT	ROOM	SNGL	1
2-14	ERNL	M	YA	8B	I	PRMR	ARTC	FLEX	SIDL	WEST	UPIT	BCRT	MULT	0
6-14	RNL	F	OA	8E	I	PRMR	ARTC	FLEX	SIDL	WEST	UPIT	BCRT	MULT	0

Burial ID	Geo Origins	Sex	Age	Burial Type	Interment Type	Form of Disposal	Degree of Articulation	Position	Deposition	Orientation	Form	Location	No. of Individuals	Burial Goods
7-14	L/RNL	F	YA	8B	I	PRMR	ARTC	FLEX	SIT	WEST	UPIT	BCRT	MULT	0
24-14	L	I	AD	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	ROOM	SNGL	0
26-14	ERNL	M	MA	2A	NI	UNKN	ARTC	EXTD	SUPN	UNKN	FLSU	ROOM	MULT	0
34-14	L	F	YA	1B	I	PRMR	ARTC	FLEX	SIDR	SOTH	SPIT	ROOM	MULT	1
39-14	L	F	OA	7B	I	PRMR	ARTC	FLEX	SIDL	NRTH	ABST	PLAZ	MULT	0
42B-14	L	I	AD	2B	NI	UNKN	DART	SCFR	UNKN	UNKN	FLSU	PLAZ	MULT	0
58-14	L	F?	YA	2A	NI	UNKN	ARTC	UNKN	UNKN	UNKN	FLSU	PLAZ	SNGL	0
4-15	L	I	AD	2C	NI	UNKN	ARTC	UNKN	UNKN	UNKN	FILL	ROOM	SNGL	0
9A-15	L	F	YA	1D	I	PRMR	ARTC	UNKN	UNKN	UNKN	SPIT	ROOM	MULT	0
1-16	L	F	YA	2C	NI	UNKN	ARTC	EXTD	SUPN	UNKN	FILL	ROOM	SNGL	0
2-16	L	M	YA	4B	I	PRMR	ARTC	FLEX	SIT	EAST	TOMB	ROOM	MULT	1
9-16	RNL	F	YA	2D	NI	UNKN	DART	SCFR	UNKN	UNKN	FILL	ROOM	SNGL	0
18-16	L	F	YA	2C	I	PRMR	ARTC	SEFL	SIDL	WEST	FILL	ROOM	SNGL	0
25-16	L/RNL	M?	YA	1A	I	PRMR	ARTC	FLEX	SIDL	WEST	SPIT	ROOM	SNGL	1
6-19	L	F	YA	11A	I	PRMR	ARTC	FLEX	SIDL	WEST	UPIT	ROOM	SNGL	0
2-20	RNL	M	MA	1A	I	PRMR	ARTC	FLEX	SIDR	SOTH	SPIT	ROOM	SNGL	0
3-20	L	M?	YA	1B	I	PRMR	ARTC	FLEX	SIDR	EAST	SPIT	ROOM	MULT	0
7-20	L	F?	AD	1A	I	PRMR	ARTC	FLEX	UNKN	UNKN	SPIT	ROOM	SNGL	0
1-21	RNL	M?	YA	1A	I	PRMR	ARTC	FLEX	SIT	SOTH	SPIT	ROOM	SNGL	1
3-CP	L	M	YA	3B	I	PRMR	ARTC	FLEX	SUPN	WEST	SPIT	PLAZ	MULT	1
11-CP	L	F	YA	3A	I	PRMR	ARTC	FLEX	SIDL	WEST	SPIT	PLAZ	SNGL	0
19-CP	RNL	I	I	2A	I	PRMR	ARTC	EXTD	SIDR	UNKN	FLSU	PLAZ	SNGL	0
20-CP	L	M?	I	3A	I	PRMR	ARTC	FLEX	SUPN	WEST	SPIT	PLAZ	SNGL	0
Convento														
CO-1	RNL	F	A	3A	I	PRMR	ARTC	FLEX	SUPN	EAST	UPIT	PLAZ	SNGL	0
CO-4	L	M	MA	3A	I	PRMR	ARTC	FLEX	SIDR	EAST	STSH	PLAZ	SNGL	0
CO-5	L	F	YA	7A	I	PRMR	ARTC	EXTD	SUPN	SOTH	ABST	PLAZ	SNGL	1
CO-13	L	F?	A	3A	I	PRMR	DART	SCFR	UNKN	UNKN	UPIT	PLAZ	SNGL	0
CO-16	RNL	F?	A	7A	I	PRMR	ARTC	SEFL	SIDL	EAST	ABST	PLAZ	SNGL	0
CO-18	RNL	F	YA	3A	I	PRMR	ARTC	FLEX	SIDR	EAST	UPIT	PLAZ	SNGL	0

Burial ID	Geo Origins	Sex	Age	Burial Type	Interment Type	Form of Disposal	Degree of Articulation	Position	Deposition	Orientation	Form	Location	No. of Individuals	Burial Goods
CO-21	RNL	I	A	3A	I	PRMR	DART	SCFR	SIDL	UNKN	STSH	PLAZ	SNGL	0
CO-23	L	M	A	3A	I	PRMR	ARTC	FLEX	SIDR	EAST	STSH	PLAZ	SNGL	0
CO-38	ERNL	F	YA	3A	I	PRMR	ARTC	FLEX	SIT	EAST	UPIT	PLAZ	SNGL	0
CO-45	L	M	MA	3A	I	PRMR	ARTC	FLEX	SIDR	SOTH	UPIT	PLAZ	SNGL	0
CO-50	L	M	A	7C	I	SCND	DART	SCFR	UNKN	UNKN	ABST	PLAZ	SNGL	1
CO-53	RNL	I	AD	3A	I	PRMR	ARTC	SEFL	SIDR	EAST	SPIT	PLAZ	SNGL	0
CO-54	L	M?	YA	3A	I	PRMR	ARTC	SEFL	SIDR	SOTH	UPIT	PLAZ	SNGL	1

Appendix B

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Page 2 of 2