FAMILY MATTERS: KINSHIP AND COMMUNITY COMPOSITION DURING THE LATE INTERMEDIATE PERIOD IN ANDAHUAYLAS, PERU

By

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Abstract

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This dissertation uses a multi-method bioarchaeological approach to understand the impact on families and communities during times of socio-political change. Here, I focus on the late prehispanic Chanka, an ethnic group that occupied the South-Central Andean highlands, which coalesced around AD 1000 following the fall of the Wari Empire. After two centuries of local conflict, the region was invaded by the Inca, leading to drastic changes in Chanka society.

Using data generated from skeletal, strontium and oxygen isotopes, and ancient DNA analyses of 140 individuals at four prehispanic sites in Andahuaylas, Peru, I was able to assess social organization and inter-community interactions for the Late Intermediate Period (1000-1400, LIP) Chanka. Comparisons were made within and between sites and periods to assemble a greater understanding of what happened to the Chanka during these critical times of change.

With the sites of Cachi, Ranracancha, Pucullu, and Sondor, the research examines three related questions: 1) How did kinship (based on degree of relatedness and in-migration using isotopes) structure communities during the early LIP (1000-1250 AD)?, 2) Were the cultural traits of cranial vault modification (CVM) styles associated with these kinship patterns?, and 3) How did Chanka society change in the late LIP (1250-1400 AD) when the Inca arrived in

Andahuaylas? The results showed that first-generation migrants to Andahuaylas came mostly from the east, with some in-migration from the west and lower elevations. Once in Andahuaylas, they broke off into fortified hilltop communities with high degrees of violence and competition for resources, as was found in the populations at Cachi, Ranracancha, and Pucullu. The competition led to different behaviors at these sites, with marriage occurring within the site populations and the same CVM styles shared between related individuals. The kinship and community structure found at these sites (using ancient DNA and isotopes), supports the view that the Chanka remained isolated from one another during the early LIP due to a high degree of competition and were less centralized than colonial texts describe. The higher degree of isolated communities influences the strategies the Inca later emplaced on the Chanka when they invaded Andahuaylas in the late LIP (~1250-1300 AD).

By the late LIP, the Inca state was expanding from Cusco and arrived in the nearby Andahuaylas region at the same time populations decreased at the study sites. Despite this, the Chanka still persisted in smaller numbers at the sites of Pucullu and Cachi according to radiocarbon dates and mortuary population sizes. For example, the research was able to trace generations of a family from the early LIP to colonization at Cachi using ancient DNA. However, the late LIP occupation at the site of Sondor showed very different patterns of occupation, with the population composed of people who were forcefully moved or migrated from areas in or around Andahuaylas based on isotopic and genetic diversity results. In one special case, a burial unit held first-generation female migrants and their local next-generation relatives. My research shows evidence of site abandonment at Sondor, but for a time, Chanka from the broader region lived together at Sondor under Inca administrative rule which was physically displayed through architecture and ceramics. Sondor is a reflection of an early Inca imperial strategy aimed at bringing isolated Chanka communities together to maintain cohesive control through less forceful means.

This dissertation contributes to a greater understanding of socio-political influences on communities from an individual, family, and regional level, with an in-depth understanding not possible without the multi-method bioarchaeological approach used here. Overall, these findings confirm the persistence of the Chanka through major transitions and the structural changes that took place to achieve this.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

Dedication

To the memory of my mother, Rita Beck Black

To my father, John Black – I finally did it!

And to my younger self who took me on this journey – I forgive you.

CHAPTER 1. INTRODUCTION

This dissertation explores what happens to families and communities during periods sociopolitical change. During these times, they tend to be confronted with new interactions and migrations of people, which impact the identity, composition, and culture of local communities. The changes can be substantial, resulting in the emergence of a distinct new culture (e.g., ethnogenesis), or they can be more subtle, with the renegotiation of characteristics of culture already present or newly introduced. The pre-Hispanic Andes is an ideal region to focus on sociopolitical change and identity because numerous state systems formed. The expansion and contraction of these socio-political systems resulted in periods of widespread social reorganization, including extensive population movements associated with the reconfiguration of territory, inter-community relationships, and group identity (Reycraft, 2005; Wiley, 1991).

The Late Intermediate Period (LIP; AD 1000-1400) is one such period of extensive social renegotiation, defined as the period between the collapse of the Wari and Tiwanaku states in the Middle Horizon (MH, AD 600-1000) and the emergence of Inca imperialism during the Late Horizon (LH, AD 1400-1532). The LIP saw large-scale demographic and settlement shifts, changes in subsistence strategies, and a transition to less centralized political authority (Arkush & Tung, 2013; Bauer et al., 2010). However, researchers have found distinct differences between the early (AD 1000-1250) and late (AD 1250-1400) LIP, and regional variation (Arkush, 2008; Covey, 2008; Kohut, 2016; Velasco 2016, 2018), indicating the need for more detailed archaeological investigations of social continuity and change throughout the LIP. To this end, this bioarchaeological dissertation focuses on four LIP archaeological sites- Cachi, Ranracancha, Pucullu and Sondor- affiliated with the Chanka cultural group in modern-day Andahuaylas, Peru (Figure 1). Aspects of kinship, community composition, migration, and group identity, were impacted in the region due to the rise of the early Inca Empire/state during the late LIP, and I reconstruct these central components of Andahuaylas communities using a combination of genetic, isotopic, and osteological analyses.

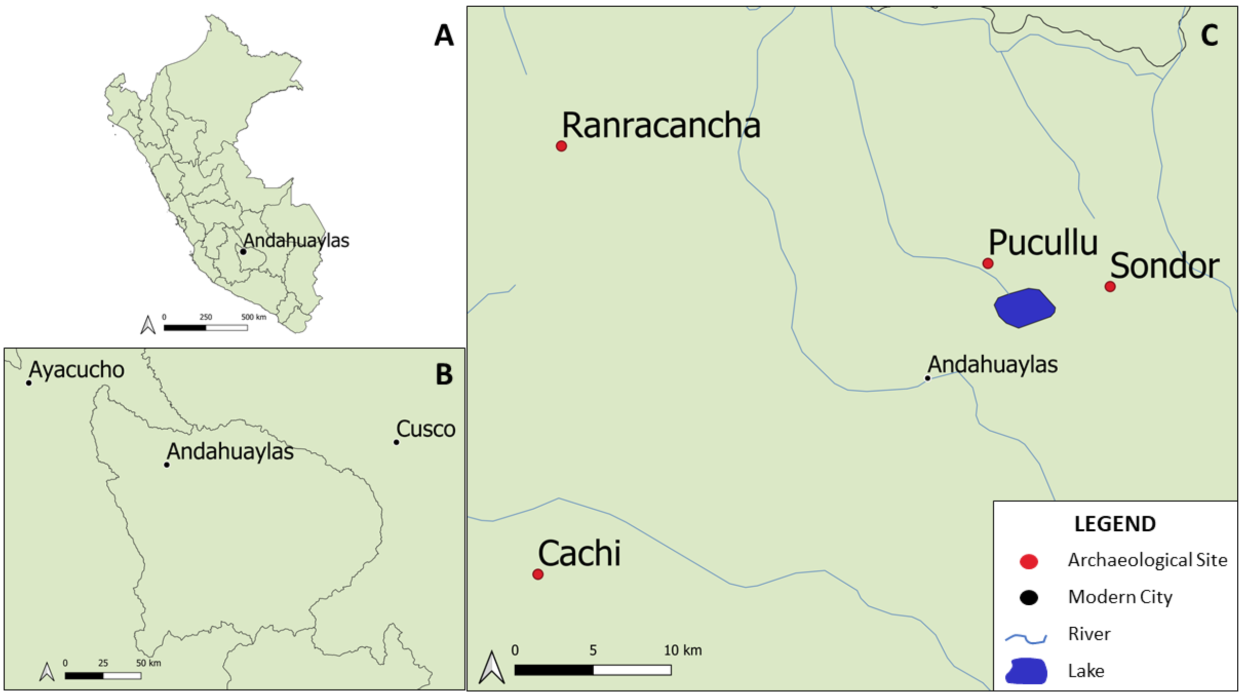

Figure 1. Map of study area showing: A) location of Andahuaylas within Peru, B) location of Andahuaylas in the Department of Apurímac, and C) location of the archaeological study sites.

Bioarchaeology of Social Structure

Archaeological burial practices reflect choices past people made to display and organize their dead based on culturally specific associations and meanings (Johnson & Paul, 2016). They materialize aspects of social organization by reifying patterns of kinship and descent, social divisions, group identity, and community or cultural territory (Bloch & Parry, 1982; Joyce, 2001; Salomon, 1995). Bioarchaeological approaches combining multiple lines of evidence to reconstruct past mobility, kinship, and group identity are particularly successful at providing fine-grained perspectives on community and social group organization and the lived experiences of past individuals (e.g., Davidson et al., 2021; Johnson, 2020; Knudson & Stojanowski, 2008; Kurin, 2016; Torres-Rouff & Knudson, 2017; Velasco, 2018). For example, isotopic strontium ($^{87}Sr/^{86}Sr$) and oxygen ($\delta^{18}O$) analyses have been used throughout the Andes to identify past mobility and migration (Andrushko et al., 2009; Buzon et al., 2012; Conlee et al., 2009; Dahlstedt et al., 2021; Knudson et al., 2013; Knudson & Price, 2007; Tung & Knudson, 2011; Turner et al., 2009; Turner, 2021). Within Andahuaylas during the LIP, such proxy data can determine the degree to which cultural and community changes primarily involved local cultural reformulations or large-scale population displacements or migrations.

Bioarchaeological methods also have great potential to reconstruct detailed aspects of kinship and post-marital residence patterns (e.g., Corruccini & Shimada, 2002; Ensor et al., 2017; Nystrom & Malcom, 2010; Racimo et al., 2020; Shimada et al., 2004; Stojanowski & Schillaci, 2006). For example, ancient DNA (aDNA) can document genetic relatedness within and between sites to look at marriage practices and how closely related individuals were across sites (e.g., Baca et al., 2012; Ringbauer et al., 2020). When combined with isotopic analyses of mobility, genetic studies can more precisely reconstruct kinship and post-marital residence patterns by identifying sex-specific migration patterns, the organization of mortuary assemblages along patrilineal or matrilineal lines, and whether first-generation migrants were having offspring within local communities (Baca et al., 2012; Carnese et al., 2010; Kennett et al., 2017; Mendisco et al., 2018; Ringbauer et al., 2020; Russo et al., 2016). Reconstructing these aspects of kinship from the archaeological record informs our understanding of past intergroup alliances and economic or socio-political interaction.

Acknowledging that kinship and group membership is variably constructed via both biological and social (non-consanguineous) relationships, mortuary assemblages provide a basis for determining the degree to which biological affiliations shaped community social groups and identity (Johnson & Paul, 2016; Knudson & Stojanowski, 2008; Nystrom, 2006; Stojanowski, 2005). Communal burial grounds represent socially significant groupings of individuals who may or may not be biologically related. By comparing genetic diversity within and across cemeteries, bioarchaeologists can assess whether cultural and community boundaries were structured by biological kinship connections, or whether socio-political divisions cross-cut biologically-affiliated groups (Baca et al. 2012; Russo et al., 2016).

Early to Late LIP Chanka

The cultural and socio-political transformations of the early LIP occurred alongside large-scale migrations and population displacements (Arkush & Tung, 2013). State collapse has spurred mass migrations in many parts of the world, as people reorganize themselves into new socio-political groups and renegotiate access to resources and territory (Schwartz, 2006). Following the Wari collapse (~900-1100 AD), regional settlements in Andahuaylas were relocated from valley bottoms to more defensible sites on ridgetops (Bauer et al., 2010) and written accounts suggest migrations into Andahuaylas from other regions (Cieza de León, 1976 [1553]; Julien, 2002). As LIP sites in Andahuaylas were fortified and expanded, Wari ceramics were abandoned and replaced by new local varieties (Bauer et al., 2010; Meddens & Pomacanchari, 2018). Human skeletal remains from this period show a dramatic increase in markers of trauma and poor health (Kurin, 2016), indicating that the early LIP was an unsettled time characterized by conflict over territory and resources (Kurin, 2012). To solidify land ownership and cultural boundaries during the tumultuous early LIP, many communities in Andahuaylas constructed funerary structures (*machays*) as visible social boundary markers (Arkush & Tung, 2013; Bauer et al., 2010; Kurin, 2016). Cranial vault modification (CVM) was an additional means of visibly displaying newly renegotiated social identity during the LIP. CVMs were not practiced in Andahuaylas during the Middle Horizon (AD 600-1000), making it a novel practice during the LIP that marks a distinct break with Wari traditions (Kurin, 2016).

Significant socio-political transitions occurred in the second half of the LIP, which may have impacted human mobility and community organization (Arkush, 2008; Covey, 2008; Kohut, 2016; Velasco, 2016, 2018). Within the Chanka heartland of Andahuaylas, many sites show less use, or smaller populations, during the late LIP except for Sondor, a site showing continuous occupation from the late LIP into the Late Horizon (Bauer et al., 2010). Colonial texts document a variety of stories about what happened to the Chanka during the Late Horizon, such as movement out of the region and foreign workers being brought to Sondor specifically, or populations moving to the Amazon (Carabajal 1974 [1586], Julien, 2002, Markham, 1871; Ramos Gavilan 1988 [1621]). The modern population of Quechua-Lamistas in the San Martin region of the Peruvian Amazon claim to be descended from the Chanka in Andahuaylas, but a uniparental genetic comparison of modern populations did not show any connection between the regions (Sandoval et al., 2016). However, it showed that those identifying as Chanka in Andahuaylas are closely related to other Andean groups within the same area (Sandoval et al., 2016). Does this mean some Chanka remained? Excavation and radiocarbon dating at Sondor has revealed Inca, Chanka, Inca-Chanka hybrid, and unidentified (i.e., foreign) ceramics, and varied burial styles dating to the late LIP (AD 1220–1430) (Bauer et al., 2010; Perez et al., 2003;

Tenorio, 2021). The site of Sondor is thus critical to understanding the nature of economic, demographic, and socio-political changes during the late LIP, which may not be accurately represented in the surviving written records.

Researchers have defined the Chanka as an example of ethnogenesis due to the rapid disappearance of Wari influence in the region and the quick emergence of Chanka identity and culture (Kurin, 2016). An alternative to ethnogenesis is the movement of new populations of agro-pastoralists into the region in response to changing climatic and/or socio-political conditions (Bauer et al., 2010). Either way, the Andahuaylas region saw significant changes in the early LIP. In addition, the direct and indirect effects of the rise of the early Inca Empire on the Andahuaylas region during the late LIP further changed what had developed during the early LIP. For the early LIP, the question of how burial location, cranial modification styles, and kinship associations (e.g., marriage) were organized within Chanka society, and how these were altered during the late LIP with the expansion of the Inca state remain and are addressed in this dissertation.

Research Questions and Predictions

This research addresses the following questions related to Chanka community, kinship, and social organization during the LIP in the Andahuaylas region of Peru through integrated osteological, isotopic, and genetic analyses.

1) How did migration and kinship affiliations structure community composition and interaction in Andahuaylas during the early LIP? The early LIP is characterized as an unstable time with heightened levels of migration following the Wari collapse. Despite this, previous

osteological studies in Andahuaylas do not support widespread population movement or replacement (Kurin, 2016; Lofaro et al., 2018; Pink, 2013). This dissertation more than doubles the number of individuals from Andahuaylas isotopically analyzed for $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ as a means of identifying first-generation migrants and determining whether specific segments of the population (e.g., males versus females) were more likely to have been non-local.

Ancient DNA analyses of the same individuals analyzed for isotopes document the extent of biological relatedness between early LIP communities to clarify kinship boundary formation and community interaction. Greater biological affinity across sites indicates more extensive kinship-based interactions. In contrast, genetic separation of one or more communities indicates greater community isolation and potentially increased competition and conflict. Sex-specific patterns of genetic relatedness within *machays* can also reveal if burial locations were organized according to matrilineal or patrilineal descent groups. Together, this informs a broader understanding of LIP social organization in Andahuaylas by integrating the proposed isotopic work with genetic and burial location data to see how kinship was used to negotiate and define power, territory, resources, and identity.

2) <u>How do patterns of cranial vault modification (CVM) articulate with kinship and geographic origins within early LIP Andahuaylas communities</u>? Previous bioarchaeological work in Andahuaylas found heterogenous CVMs within LIP mortuary contexts (Black & Kurin, 2021; Kurin, 2016), but the reasons for this heterogeneity are unknown. This dissertation generates isotopic data to combine with genetic (aDNA) data to determine if CVM patterns correlate with sex, biological relatedness, and/or geographic origin. This tests whether CVM heterogeneity in *machays* resulted from marriage patterns involving the exchange of partners across communities,

resulting in closely related individuals with similar CVMs being buried in different *machays*. Similarly, I test if the presence of non-local individuals can explain the heterogeneity. If no correlations exist with sex, genetic relatedness, or geographic origins, CVM may have instead reflected group identity based on other local, non-consanguineal affiliations. This would not be unexpected due to the complexity of Andean social systems, which contain non-consanguineal kinship relationships and multiple, nested levels of group affiliation (e.g., ethnic group, *ayllu*, community, lineage, household, sex/gender, occupation).

3) How do patterns and rates of migration change in Andahuaylas between the early and late LIP? Isotopic analysis ($^{87}Sr/^{86}Sr$, $\delta^{18}O$) of mortuary populations from the late LIP site of Sondor are used to compare rates and patterns of migration between the early and late LIP. Although past migration and community composition has been studied at other sites in Andahuaylas, Sondor has not yet been investigated. This dissertation thus contributes novel information regarding the effects of the emerging Inca state on local community composition in the Andahuaylas region.

Ethics Statement

Excavation of the study sites was conducted with the permission of the Peruvian government (via permits from the Peruvian Ministry of Culture), and with both the permission and participation of local communities with cultural heritage connections to the archaeological settlements. Since this research involves human remains, discussions were conducted with local community members, Andahuaylas bioarchaeologist Guni Baslut Monteagudo Espinoza, and the co-PI from the Sondor excavations, Peruvian bioarchaeologist Beatriz Lizarraga Rojas, to confirm that there is currently no local resistance to, nor restrictions on the study or visual depictions of human skeletal remains from the region. Export of samples for destructive analysis was approved by the Peruvian Ministry of Culture in Abancay, and all sample remainders will be returned for repatriation. Due to the community's deep interest in local Chanka archaeology, including the study of mortuary remains, discussions were conducted with local community members and the local Peruvian Ministry of Culture in Abancay to determine what outreach materials local communities would like to receive about the specific findings from my dissertation research. Products of interest are two downloadable PDF infographics at a grade school and adult level covering research methods and results in Spanish and Quechua. A website will be developed and shared with the community, which will include infographics and other information about the work, such as a video presentation in both Spanish and English.

Structure of Dissertation

Chapter 2 describes the region of Andahuaylas, Peru, including the social environment and archaeological patterns from the Middle to Late Horizon, supplemented with relevant details from ethnohistoric and colonial texts. The chapter focuses primarily on the Chanka, including more information about previous research on these communities' social structure, lifeways, and mortuary activities. The rise of the nearby Inca state will also be covered, specifically what is previously known about the Inca influence in Andahuaylas during the late LIP and Late Horizon. Chapter 3 presents the theoretical framework employed to address the research questions and analyses through the lens of social structure, which is established through the ethnic units of kinship, identity, social divisions, and boundaries. This section also explains the complexity of these types of studies in the Andes, particularly when *ayllu* social units are incorporated, and how Inca imperial strategies disrupted social structure across the Andes. Chapter 4 describes the materials and methods used in this dissertation to answer questions about identity and kinship from these archaeological contexts. The chapter covers the study site contexts, excavation methods, osteological analysis, sampling procedures, lab methodology, and analysis for isotopes and aDNA. Chapter 4 also includes more detailed findings from the excavations at Sondor, since excavation was done by me and structured around answering my research questions. Chapter 5 presents the osteological findings for contexts excavated by Kurin (2012) and for the more recently excavated mortuary contexts from Sondor. Osteological analysis informs us about the past choices people made about mortuary location and groupings, and how cranial modification was used as a visible indicator of social identity. The osteological information also informs our interpretation of the isotopic and genetic studies presented in later chapters. Chapter 6 presents a multi-isotopic analysis ($^{87}Sr/^{86}Sr$ and $\delta^{18}O$) aimed at reconstructing LIP migration patterns and how non-local individuals were integrated into the Andahuaylas communities. Chapter 7 establishes the broader scale genetic context of the populations in Andahuaylas, Peru, with diversity and structure within the sites revealing past behavior and interaction. The degree of relatedness, combined with the osteological and isotopic data, provides a fine-grained assessment of kinship within and between sites. Chapter 8 summarizes these findings, using this information to reflect on and answer the main research questions.

CHAPTER 2. REGIONAL BACKGROUND

This chapter summarizes the regional background for this dissertation and places the study within its temporal context. I begin by introducing Andahuaylas, Peru, including its location and environment. Following that are sections covering what is known about the region based on colonial and ethnohistoric texts and then archaeological studies. The background provides an understanding of how the Chanka came to be, how they lived, and the changes observed in the region in the late LIP and Late Horizon.

Andahuaylas, Peru

The Andahuaylas region is in the South-Central Highlands (or *Sierra Central*) of Peru. Andahuaylas is part of the Apurímac department, which is composed of the Andahuaylas and Chincherros provinces, with Ayacucho to the west and Cuzco to the east (Figure 1). The region has a valley spanning approximately 25 km and bordered by the Pampas, Chica-Sora, and Pachachaca Rivers, with drainage from the Chumbao River. Going up from the valley are peaks that range from 1800-5000 masl. The three main modern-day towns are Talavera (2,820 masl) at the western end of the valley, Andahuaylas (2,920 masl) in the mid-valley, and San Jerónimo (2,950 masl) at the eastern end of the valley (Bauer et al., 2010; Kurin, 2012).

The Andahuaylas region spans four ecological zones, which were designated based on the cultural and biological landscape and land use: *yunga* (<2700 masl), *kichwa* (2700-3500 masl), *suni* (3500-3800 masl), and *puna* (>3800 masl) (Kellett, 2010; Vidal, 1996). The sites within this study are located within the *kichwa* and *suni* zones. The *kichwa* zone is best for agriculture (past and present) because it is warm and semi-arid with fertile soil. Currently, maize, alfalfa, onion, peas, carrots, tomatoes, wheat, oats, common beans, and some potatoes and other tubers are commonly grown in the zone. Below 3,200 masl, irrigation is used, but above this crops are dry farmed, watered through natural rain. The *suni* zone is located above the *kichwa* and along the valley slopes. It is best known for its potato and tuber production, as well as quinoa, kiwicha, wheat, barley, oats, common beans, fava beans, lentils, and tarwi. The *puna* zone is a grassland with colder temperatures and strong winds. Some species of potato, tubers, and quinoa are grown here, but it is primarily used for the grazing of domesticated llamas (*Lama glama*) and alpacas (*Vicugna pacos*) (Kellett, 2010).

Andahuaylas seasons follow the norms for the *sierra central*, which has an annual wet and dry season. The dry season is cooler and occurs between May and October (southern hemisphere winter), while the warmer wet season occurs between November and April (southern hemisphere summer). The same seasons were likely observed during ancient times, but paleo-ecological evidence shows that round 2,000 years ago, the environment became increasing hotter and more arid (Hillyer et al., 2009). Whether this contributed to the Wari collapse is debated, but overall the LIP was more arid than the MH (Bauer et al. 2010; Kurin, 2012). In addition, a sediment core taken from Laguna Pacucha (within the Andahuaylas region near the sites of Sondor and Pucullu), showed evidence of a drought at ~1200 AD, in the middle of the LIP (Hillyer et al., 2009), which would have had a large impact on the region and land use.

Chronicles and Ethnohistoric Accounts

Despite the potential for bias and inaccuracies in colonial period chronicles and ethnohistoric accounts (Bauer et al., 1992; Guevara-Gil & Salomon, 1994; Julien, 2002), archaeologists would be remiss not to sort through these texts to obtain useful information about past societies, and to draw comparisons with evidence gleaned through archaeological investigations. The next section thus covers what is currently known about the Chanka from 16th and 17th century chronicles and oral histories.

The origin story of the Chanka people says they emerged from Laguna de Choclococha (4800 masl) in modern day Castrovirreyna, Huancavelíca, hundreds of km northwest of Andahuaylas (Bauer et al, 2010; Garcilaso de la Vega, 1961). The founders of the Chanka are large sacred stones (*huacas*) that were dressed and honored by the Chanka (Cristóbal de Albornoz in Duviols, 1967). Other accounts say that two brothers founded the upper and lower Chanka moieties, one emerging from Laguna de Choclococha, and the other from Laguna de Urcococha (also in Huancavelíca) (Sarmiento, 2007[1572]). Usco Vilca became the leader of the *Hanan* (upper) Chanka moiety and Anco Vilca became the leader of the *Hurin* (lower) moiety (Gonzalez Carré, 1992; Sarmiento, 2007[1572]). Other chronicles say the Chanka came from Huamanga (Wari heartland) (Sarmiento, 2007 [1572]), and that the Pocras and Iquichanos (Chanka-affiliated groups) still lived in Huari in the 16th century (Ciezo de Leon, 1976 [1553]).

As a people, the Chanka appeared during the Age of *Auca Runa* (warlike men) (Garcilaso de la Vega, 1968 [1613]), which corresponds to the LIP, when the Wari Empire collapsed and many Andean regions became increasingly territorial and violent (Arkush & Tung et al., 2013; Kurin; 2012, 2016). The groups of Utunsulla (western Ayacucho/Huancavelíca), Huancohualla (Chincheros), Uillcas (Vilcashuamán), and Uramarca (Chincheros province) may have been part of the Chanka, or at a larger scale, groups that joined the Chanka in their monumental, but ultimately unsuccessful, battle against the Inca for control over Cusco (Kellett, 2010). The confusion stems from the fact that certain archaeologists use Chanka (The Chanka

Confederation) to describe all groups around Ayacucho during the LIP, while the cultural group Chanka are those who occupied Andahuaylas (Garcilaso, 1961[1609]; Julien, 2002; Kellett, 2010). Within this dissertation, I use Chanka only to refer to the people of Andahuaylas.

The Andahuaylas Chanka were said to be composed of small groups (*ayllus*) of varying levels of alliance and cooperation. The Chanka moiety divisions of the *Hanan* (upper) and *Hurin* (lower), may have included the *Quichuas* (Julien, 2002). Alternatively, the *Quichuas* may have been the cultural group that occupied Andahuaylas before the Chanka arrived and were defeated by the Chanka and driven out of the region or incorporated (Cieza de León, 1976 [1553]; Kurin, 2016). The *Quichua* being a part of the Chanka, while also fighting other Chanka, still fits within descriptions of the Chanka having high degrees of violence between villages (Polo de Ondegardo, 1873). At the base level, the villages may have been considered different ethnic or kinship groups, with violence between them, while still being part of the larger regional Andahuaylas Chanka that joined forces against more distant rivals. It should be noted that there are no archaeological differences between the designated *Quichua* and Chanka sites (Bauer et al., 2010; Kellett, 2022). Based on Hostnig et al. (2007) transcribed documents, Kurin (2016) argues the *Quichua* became another Chanka *ayllu* called the *Achan Quichuas*, and a lower moiety. However, the *Quichua* being driven from the area also fits, since the Chanka were known to attack non-locals. That form of identity carried into colonial times, where court proceedings showed violence between Andahuaylas Chanka and non-local people (Hostnig et al., 2007; Kurin, 2012).

The idea that the Chanka arrived in the region during the LIP and were violent towards others is prevalent throughout colonial texts. Chanka migration is termed by some archaeologists as the “Chanka Hegemony” of the region (Gonzalez Carré, 1992; Vargas, 1939). However, according to Gonzalez Carré, there may have been two migrations. The first would be what we think of as Andahuaylas Chanka during the early LIP, while a second migration occurred during the early 1400s when the Chanka moved east towards the Quechua (Inca) territory, ending in the Chanka-Inca war (Kellett, 2010).

An important part of history for the Inca and Chanka, described in numerous ways in chronicles and historic texts, is the major battle to end the Chanka-Inca war, which is summarized here (Betanzos, 1987 [1551]; Brundage, 1963; Cieza de Leon, 1976 [1553]; Cobo,1964 [1653]; Garcilaso, 1966 [1609], Gonzales Carré, 1982, 1992; Gonzalez Carré et al., 1987; Pardo, 1969; Quintana. 1967; Rowe 1946, Sarmiento 2007[1572]). The Chanka and Inca (Quechuas) conflict may have begun with early movement of the Inca into Andahuaylas in the late 1300s, when the Chanka agreed to cooperate with them. A few hundred years later, the Chanka put together an army of 30,000-40,000 men led by brothers Hanco Ayllu, Tumay Huaraca, and Astu Huaraca and made their way towards Cusco. Ruler Inca Viracocha fled the city, but one of his son's, Inca Yupanqui, along with other officials, defended the capital through multiple bloody battles, with supernatural support to help them win. Defeat of the Chanka at the Battle of Yawarpampa (the "Battlefield of Blood") has been cited as the catalyst for Inca imperial expansion (Bauer et al., 2010; Betanzos, 1996 [1557]; Meddens, 2005). In the end, the Chanka gave in to Inca demands and complied with Inca rule. This aided in placing Inca Pachacuti (Inca Yupanqui) as a divinely chosen ruler and powerful force in battle (Garcilaso, 1966[1609]). However, local Andahuaylas beliefs argue that the Chanka won the war against the Inca (correspondence with contemporary Chanka). The Chanka-Inca war is likely a legend used by both groups to fit their narrative, that stems from drawn-out early conflict over the Andahuaylas territory.

What happened to the Chanka during and after this conflict is also not clear. Records indicate that the Chanka were displaced. One outcome claims that the Chanka became slaves or *mitimaes* (courveé laborers) in distant parts of the Inca Empire, such as a small group sent to Copacabana to work on ritual complexes (Ramos Gavilan, 1988 [1621]). Another says a Chanka chief and his people were banished to the lowland jungles (Carabajal, 1974 [1586]; Julien, 2002; Markham, 1871; Ramos Gavilan, 1988 [1621]). A different group of the Chanka was sent to Lircay and Julcamarca near Ayacucho (Carabajal 1974 [1586]). In addition, *mitimaes* from other regions were said to be sent into Andahuaylas, including people from Aymaraes and Cusco (Bauer et al., 2010). One text said female *mitimaes* were sent to the site of Sondor for labor (Julien, 2002). However, colonial documents also state the Chanka still lived in Andahuaylas during the 1500s when 63 Chanka towns (*pueblos*) were recorded in the 1539 *encomienda*. A portion were able to be identified and attached to modern villages (Julien, 2002; Kellett, 2010). Other populations besides the Chanka were reported by the time the *encomienda* was written, such as the Inca, Yungas, Yauyos, Chachapoyas, Aymarayes, and Quichua (Rowe, 1956). The diversity of people supports the possibility that the Inca moved people for labor.

Andahuaylas Archaeology

The archaeological study of the Chanka and Andahuaylas region began slowly, but has been steadily growing over the past few decades. The earliest archaeological investigations in Andahuaylas were conducted by Arco Parró (1923) and Navarro de Águila (1937) who provide general descriptions of the Chanka and ancient sites in the region. Hugo Pesce (1942) published the first extensive list of archaeological sites in Andahuaylas. In 1954, John Rowe and Oscar

Núñez del Prado surveyed and recorded fifteen sites and defined a preliminary Andahuaylas chronology of ceramic styles (Rowe, 1956). Between 1969 and 1971, Rowe's student Joel Grossman (1972, 1983) did his dissertation on the Formative Period and excavated the site of Waywaka. Grossman put together a more extensive ceramic sequence for Andahuaylas and found that Waywaka, using radiocarbon dates, was one of the earliest villages in the region.

Archaeology in Andahuaylas stopped during the 1980s because of Shining Path terrorism occurring throughout the Andes. Towns, agricultural fields, and the people themselves were attacked in and around Andahuaylas until the region was declared an Emergency Military Zone and troops were sent to intervene. Between the 1980s and early 1990s, the region was devastated with loss of life and infrastructure collapse, which Andahuaylas is still recovering from to this day. Despite the lack of archaeology, Gonzalez Carré and Pideda (1988) were able to register LIP Chanka sites within the departments of Huancavelica, Ayacucho, and Apurímac, protecting archaeological sites such as Sondor and Huachhualla. Archaeological studies following the early 1990s refined and provided details of the cultures and timing of crucial sociopolitical changes.

From 2002 to 2004, Brian Bauer and Lucas Kellett surveyed the Andahuaylas region and examined colonial documents about the Chanka. They recorded hundreds of sites and determined periods of use through the observation of structures and ceramic types (Table 1). They found that Andahuaylas was first occupied by hunters and gatherers during the Archaic Period. Slowly there was a shift to the use of domesticated crops with the appearance of petroglyphs across the region. During the Muyu Moqo period, people began to inhabit lower elevations in the valley and establish small hamlets and villages with increased cultivation and population growth continuing into the Qasawirka Period. The Qasawirka Period showed a focus on valley bottom agriculture, including crops such as maize, with over 400 hamlets and villages. During the Middle Horizon, the region showed interaction with the Wari state/empire, based on the increase of imported Wari ceramics. However, the influence was minimal since the Wari did not build any regional centers in the valley indicating indirect control.

Table 1. Andahuaylas Precolonial Cultural Periods (Bauer et al., 2010)	
Archaic	9500-2100 BC
Muyu Moqo	2100-300 BC
Qasawirka	300 BC - AD 1000
Wari Influence	AD 600-1000
Chanka	AD 1000 - 1400
Inca Occupation	AD 1400 - 1532

After the collapse of the Wari state, the region was dominated by Chanka sites. People in Andahuaylas abandoned the lower elevation sites from earlier periods and moved up to higher elevations, common throughout the Andes during this time. The evidence of increasing aridity and the collapse of the Wari likely contributed to this trend. There were fewer sites than the Qasawirka period, but this is due to the villages being larger and more densely populated. These villages were found along ridgetops with natural and man-made defenses and fortifications like walls and ditches. The Chanka switched to an agro-pastoral lifestyle at higher elevations, with evidence of corrals at Chanka sites. Households were small and circular in shape, with basic ceramics and no continued Wari influence (Bauer et al., 2010). A more detailed study of Chanka ceramics found that there are different ceramic styles during the early LIP, but they cannot be directly tied to divisions in Chanka society (Meddens & Pomacanchari, 2018).

Excavations by Danielle Kurin and Enmanuel Gomez provided a more detailed study on Chanka burial caves (*machays*) during the early LIP (Kurin, 2012; 2016). Kurin, a bioarchaeologist, examined the human remains excavated from the Middle Horizon site of Turpo, and the early LIP sites of Natividad, Cachi, Ranracancha, and Pucullu. Her comparison between the MH and early LIP showed a striking increase in violence, the adoption of cranial modifications not seen in earlier periods (Kurin, 2012; 2016), and evidence that all individuals (aside from a few) were local (Kurin, 2016; Lofaro et al., 2018).

It is becoming increasingly more common to separate the LIP into the early LIP (AD 1000-1250) and late LIP (AD 1250-1430) due to increased recognition of major socio-political changes occurring throughout this time period (Kellett, 2017; Kurin, 2016; Meddens and Vivanco, 2018). The early LIP in Andahuaylas is associated with the movement of people to the highlands and formation of Chanka societies (Bauer et al., 2010; Kellett, 2010; Kurin et al., 2012, 2016). In contrast, the late LIP and beginning of the Late Horizon shows evidence of early Inca state expansion into Andahuaylas (Bauer et al., 2010). During the early LIP, the Inca began to form a state just west of Andahuaylas within the Cuzco Valley of Peru (Figure 1) (Covey, 2003). In this initial period of consolidation, the Inca increased local populations through intentional resettlement, and established a hierarchical and unified economic and socio-political system centered in the Cuzco Basin (Bauer & Covey 2002). As Inca-affiliated populations increased, labor expanded their agricultural exploits, with maize as the main crop. to entice nearby communities into joining the state or exploit land for agriculture (Bauer & Covey, 2002). Also, with expanded labor forces, the Inca were able to build additional infrastructure (e.g., roads, agricultural terraces, irrigation systems, storage facilities) and produce needed commodities (e.g., clothing, tools, weapons) (Nair & Protzen, 2015). Therefore, by the late LIP

(AD 1250-1400), Cuzco-born Inca leaders began to incorporate surrounding groups in earnest, which likely had significant impacts on the nearby Andahuaylas region.

Studies on early Inca state expansion show differential rule and strategies of integration. Early rivals such as the Pinahua and Ayarmarca had to be taken by force, while others, such as groups to the south, were easily incorporated (Bauer & Covey, 2002; Covey, 2003). Further south, the Soras territory in the Chica Valley showed evidence of extensive occupation by the Inca. For example, almost every major site and hill had Inca architecture on it or built over Soras architecture (Meddens & Shreiber, 2010). This was a common strategy the Inca employed in resistant areas, the materialization of ideology, by physically removing sacred landscape elements and structure to replace it with their own, therefore making a visible shift from local identity to the state (Buikstra & Nystrom, 2015; Silverblatt, 1988). The sites were also incorporated into the road system with irrigation and terraces added to increase productivity. However, close to the Soras in the Sondondo Valley, no monumental architecture was built, and the only indicators of Inca presence were the road system and storage centers (Meddens & Shreiber, 2010). Another extreme example of an early Inca rival was the Yunkaray culture, located near the Cuzco Valley during the LIP. These sites show no evidence of Inca architecture or objects and instead indicate abandonment of the sites. This may indicate the forceful removal of the population for relocation (Quave et al., 2018).

Within Andahuaylas, there is less archaeological evidence than you would expect based on the stories told of the great Chanka-Inca war. A small number of Andahuaylas sites (n=76) were documented as having Inca ceramics, but settlement archaeology shows the Inca may have resettled a large portion of the Chanka populations. This is observed through the abandonment of most of the early LIP hilltop settlements by at least AD 1300, indicating a large reduction in

Chanka populations during the late LIP (Bauer et al., 2010; Kellett, 2010, 2022). In addition, the ceramics found within the early LIP, while more variable than what was previously believed, are far more homogenous that what is found in the later LIP (Meddens and Vivanco, 2018).

LIP Mortuary Style

Excavations of early LIP Chanka *machays* showed evidence of ancestor veneration, reinforcing *ayllu* practices. Kurin (2012; 2016) found that the sites of Cachi, Ranracancha, and Pucullu used burial caves or rock shelters (*machays*) (Kurin, 2012). *Machays* are found within natural caves or built with internal walls or exterior patios (Kellett, 2022). The *machays* excavated by Kurin contained the commingled remains of males and females of all ages. The exterior of the *machays* had lips of rocks with ancestral offerings to the individuals within the caves. Offerings often included camelid bones, ceramics that may have held ceremonial drinks, and utilitarian items. Kurin (2012) also found that in some *machays* containing Wari artifacts, a sterile layer of soil had been added over the Wari remains before LIP artifacts were deposited on top (Kurin, 2012; 2016). This suggests material communication of a distinct cultural break between the Wari and Chanka use of these burial contexts.

Bauer et al. (2010) did a survey of the Andahuaylas region and found that the Chanka also commonly used *chullpas* and cist tombs, especially at higher elevations (>3800 masl) where natural caves are scarce. The use of *chullupas* in the higher elevation *puna*, however, may also reflect past populations' desire to erect visible boundary markers in these highland plain environments (Kellett, 2022). *Chullpas* are piles of rocks placed in a circle creating a space for the placement of human remains. Although most of these highly visible structures are looted, the foundations are present and measure 1.3-4 meters in diameter and are found in groups of 4-10 structures. *Chullpas* also tend to be found along the ridges of high elevation hills around 3,600 masl (Kellett, 2022). Kurin (2012) argues the *chullpas* were not final burial locations, and instead were used to desiccate mummies before placement into *machays*. In-ground cist tombs are found approximately 2 meters below the surface and are 0.5-1.5 meters in diameter. Cist tombs are found in clusters of 3-7 structures or alone on ridges/hilltops or flat areas/ravines, at elevations greater than 3,600 masl (Kellett, 2022). Unfortunately, these structures were not excavated and were heavily looted/destroyed.

Sondor is located within the *suni* zone, similar to early LIP sites. Excavations that targeted Inca influenced sectors found adult individuals with fatal injuries and child sacrifices (*capacochas*) (Perez et al., 2003). Excavations in 2016 found additional *capacochas* in various contexts at Sondor, but of particular interest are the infants placed upon household floors in the habitation areas, which may indicate abandonment rituals. Variations of adult burials were also identified, with one in a Chanka ritual sector with offerings, and the other within the habitation area beneath the ground and within a circular enclosure (Gómez Choque and Kurin, 2016).

This chapter shows what is understood about the Chanka thus far through archaeological and chronicle descriptions, which do not match in all cases. The next chapter will lay the foundation for how this dissertation framed its questions to fill in the gaps of knowledge pertaining to Chanka kinship and changes in the late LIP.

CHAPTER 3. THEORETICAL BACKGROUND

This chapter summarizes the theoretical framework that structures how the results of this study are interpreted. The section begins with how anthropologists understand and assess the multifaceted concept of social identity within community structuring. Then, I provide an explanation of the *ayllu*, a form of Andean social organization. Finally, the section ends with how imperial influence can have large impacts on local social structures. Understanding how a community defines themselves and how that is reflected in the archaeological record provides the opportunity to then assess how changes can impact these social identifiers.

Chanka Hegemony or Independent Communities

Determining the social structure of the early LIP Chanka society is complicated, but must be established before the differences in social structure once the Inca expanded into the region can be explored. In general, societies tend to fluctuate between periods of smaller-scale local autonomy and larger-scale sociopolitical centralization, with local conditions determining the outcome of social structure in a region throughout these various transitions. The process of state formation is generally one of consolidation of power with the end goal of creating social cohesion and common identities under the state, but how that manifests itself and the strategies used by the state can vary depending on proximity to central authority and degrees of resistance during state expansion. The periods without a centralized state, as with the Chanka, are key times to observe identity and community formation, which leave different archaeological signals than those of state authority. Whereas the Inca Empire, the most expansionist state system in prehistoric South America, is a prime example of the way states can utilize different strategies of incorporation and change previously formed regional identities.

The Chanka, for a long time, were famously known as a powerful group that went to battle with the Inca in the Chanka-Inca war, with the Chanka defeated at the Battle of Yawarpampa (Bauer et al, 2010; Betanzos, 1996 [1557]; Meddens, 2005). For this to be true, the Chanka would need a cross-site political organization in place to bring together communities during warfare. State systems differ depending on the region and period, but all tend to share the common features of having a hierarchy of control with institutions in place to control the activities and decisions for the lower levels of the hierarchy, creating a centralized authority over a larger population (Wright & Johnson, 1975). However, this complex system does not appear overnight. There is a lengthy process of state (or imperial) formation before the main culture in the system can begin to incorporate local and distant groups. First the hierarchical system has to be established, generally starting with a centralized personage or office establishing control and power by gaining supporters (the autonomous part of state formation) (Flannery, 1999). From there, other levels to the hierarchy (political system) can be built to provide the basis for larger institutions such as the economy, which is essential for resource control, craft specialization, and trade (D'Altroy, 2002). Another key aspect is the formation and use of an ideological system. Once these elements are in place, the beginning of state formation can be seen through the nucleation of populations at a center (the capital) since larger populations can now be managed (Flannery, 1999). There must be incentive to move though, so the state tends to have something to offer such as resources, protection, or ideological attraction (Bauer & Covey, 2002; D'Altroy, 2002).

Early archaeological analysis of the Chanka claim they migrated to the region and took over, termed “Chanka Hegemony” (Gonzalez Carré, 1992; Vargas, 1939), with some claiming Chanka power expanded into Ayacucho through The Chanka Confederation (Garcilaso, 1961 [1609; Julien, 2002). If the Chanka arrived to Andahuaylas as a cohesive group that occupied various sites with an overarching power to connect them, we would see the markers of state formation. However, more recent archaeological studies argue there is no evidence for social hierarchy in the region, and that the Chanka were composed of independent communities (Bauer & Smit, 2015; Bauer et al., 2010). The archaeological evidence is observed through isolated communities with heavy fortification on the tops of ridges (Bauer et al., 2010) and with high rates of violence (Kurin, 2012). An alternative argument is that the Chanka were protecting themselves from outside aggressors, with each community showing low rates of outsiders (Kurin, 2012). Whether or not the Chanka was a pseudo state or independent communities that combined against external forces such as the Inca, it is still unknown if they interacted with each other on a regular basis. One way to explore the inter-connectedness between communities during the early LIP is to determine if there are kin alliances between communities. Kinship can be observed through identity and community structure.

Social Identity

Identity and kinship are closely tied and are part of the concept of ethnicity. Ethnicity, at the basic level, is defined as starting primarily at the biological level (consanguineal kin) but also includes shared fundamental cultural values that make up a community which interacts with each other based on those shared values. The culture and behaviors are generally seen through political organization, language, customs, adaptations to local ecology, historical ties to the landscape, and local community structure (Naroll, 1964). Since communities do not live in isolation though, cultural or ethnic units must be identifiable from other units, even with interaction between them. Barth (1969) emphasizes that ethnicity can only be characterized through ethnic boundaries; how a group identifies themselves with respect to others. *Even with interaction with others, it is these identifiers that maintain boundaries through time and space, serving as signals of group affiliations*. Whatever signals persist despite interactions with other cultures are those that are most fundamental to ethnic distinction and organization (Barth, 1969). The intensity with which a group maintains and broadcasts these signals can also reflect the degree of stress from other close contact groups (geographically close, invading culture, etc.) (Barth, 1969, Roosens, 1989). Blom (1969) adds to this idea by pointing out that ethnicity is not just defined by cultural differences and diversity between groups, but by the meaning those cultural ideals hold. The differences reflect the features of social organization (or structure) within a society since persistent cultural signals serve as idioms of identification for a particular group (Blom, 1969). When considering this in the archaeological record, we cannot ask the people about the meaning behind these differences but can keep in mind that the cultural diversity is attached to a larger social meaning in communities.

Instead of only looking at patterns within anthropological studies, the field made a push to look at the phenomena from multiple different angles within those patterns, which was termed "structure." Using structure within ethnicity studies prompts the researcher to examine ethnicity from historical, theoretical, and ideological angles. Ethnicity is composed of many criteria, and the structure of each aspect makes up the whole of ideals (or social organization/structure) for cultural communities (Cohen, 1978). Once again though, we also have to keep in mind that these signals of social structure are all defined in relation to other groups, which influences how these boundaries are created and define membership (Barth, 1959; Cohen, 1978). Another important point to make is that these signals and markers of ethnicity and social structure are flexible, depending on changing conditions. This is particularly true in cases of political manipulation— if there are benefits to joining an alternative association or group (Roosens, 1989). If the benefits outweigh the costs socially and/or economically, then there is no reason not to incorporate one's group (Barth, 1969).

These ethnic signals of social structure are attached to all forms of identity such as customs, rituals, appearance, and who one sees as family. As mentioned, who we consider our family or kin can become complicated and how "family" is defined varies (Johnson & Paul, 2016). Kin groups can be any social groupings based on kinship ties. As mentioned, consanguineal kin are those that are blood-related while fictive kin are a socially defined equivalent of consanguineal ties. Kinship could be a combination of consanguineal and fictive kin, be bilateral, unilateral, or cognatic (no emphasis on either), and/or involve different levels of ties (Schusky et al., 1965). As complicated as all of this can become, at the basic level, the rules for these associations are governed by the ethnic signals set in place when a group is defining their community and cultural boundaries. *Studying the cultural signals that persist or change through time reflects social structure, which in turn also provides information on identity and kinship ties*.

Ethnicity concepts are difficult to study in contemporary cultures because of the multiethnic nature of most modern political structures (e.g., nation-states), but even more difficult when pertaining to past cultures. Thankfully, bioarchaeology provides the unique opportunity to undertake these types of studies at the level of socially defined groups, by studying mortuary contexts. This is a form of materialized organization defined in the ground by the people themselves. There are rules and reasons as to why certain people are buried with each other, rules that reflect the social groups who created these cemeteries (Johnson & Paul, 2016). Identity and kinship are social constructs of human experience because of the societal and cultural standards set into place, and studying the remains can provide us with an understanding of social life in the past (Johnson & Paul, 2016; Knudson & Stojanowski, 2008).

Within bioarchaeological methods, ways to study these relationships include biodistance studies (using DNA or other markers) to infer population history and structure, burial goods and styles which reflects cultural choices, isotopes to infer place of origin, and cultural markers left on the body such as cranial modifications, which are said to reflect social identity and affiliations. All markers are inter-related and nested, and therefore should be addressed to gain an understanding of the full spectrum of social identity and structure in order to avoid a strictly biological assumption to kin relations. Within Chanka society, these factors will be observed to determine community structure and any indications of community interaction. If communities are interacting, there will be a higher rate of non-locals present, which was not found in previous studies, and close kin between communities. Once it is established whether these traits of kin and identity were shared between Chanka communities, the assessment of whether the Chanka were independent communities or a consolidated entity can be determined.

Bioarchaeological methods for identity and kinship can be applied broadly, but it is also important to take into consideration the history and circumstances of regions, therefore these studies should be done on a case-by-case basis (De Vos & Romanucci-Ross, 1975). The area of study for this study is the precolonial Andes. Based on ethnohistoric and ethnographic texts, we have a starting point of what social structure might have appeared like in mortuary contexts, that can be combined with or disproved by the colonial texts and ethnohistoric accounts of social structure and interaction.

The Ayllu

When discussing identity, kinship, and community structure within the Andes, the concept of the *ayllu* cannot be overlooked. The *ayllu* is a distinctive Andean form of social organization that at its core is a group of people with a common ancestor and origins that share resources and land. The ancestors are what control all elements of the system: social groups, communal resources, and the ranking of kin (a multi-level system). This system is also a flexible extended kin group that changes based on local conditions, such as the social or political system, or environment, but is still centered around the founding ancestors—the authorities of tradition, activities, and organization (Hyland, 2016; Isbell, 1997; Skar, 1982). I attempt to explore the markers of *ayllu* membership in the archaeological record since the organization is what structures and defines boundaries of group membership. However, the term *ayllu* is used broadly and is applied to multiple Andean societies through time, and has to be understood generally as a social strategy used differently by each group.

The earliest examples of *ayllu* systems are seen during the Early Intermediate Period in the north highlands of Peru, a time of uncertainty after the collapse of local state-like cultures that caused the need for a system with strict kinship and group boundaries. This is similar to what we see for the LIP after the Wari and Tiwanaku empires/polities collapsed (thus the similar terminology for their names), when we see the *ayllu* system greatly increase in usage across the Andes. Archaeologically, material indications of an *ayllu* kinship system include veneration of the dead, particularly the visible display of the dead themselves or their burial structures, since they were apparent and present in everyday activities (Isbell, 1997). During the LIP, also a time of increased violence within and between groups, burial structures were placed in visible areas around sites to demarcate social borders and ownership of territories (Arkush & Tung, 2013; Bauer et al., 2010).

The richest source of information about the *ayllu* kinship system derives from colonial texts about the Inca (Betanzos,1996[1557]), but these accounts are biased. For the Inca, the body organized their worldview with multiple stages of life, including death as an active stage of life. The body and ancestors were believed to tie directly to the landscape and structure of the universe (Lozada, 2019). Betanzos' chronicles state that Cuzco was not just the capital of the Inca Empire, but the center for all social and ceremonial traditions and the origin of their people (where their ancestors reside) (Betanzos, 1996[1557]). Within this, the *cama* is seen as a force within all people and objects, connecting them to their land of origin (Cuzco), with *huacas* being the physical manifestation of those objects. Therefore, *huacas* can be objects on the landscape (sun, mountains, streams, etc.), mummies of ancestors, and more. *Huacas* are essentially objects with ancestor veneration properties that could be used to lay claim to those *ayllu* boundaries and physical structures. This is also why ceremonies (veneration) were common for all these elements, including preserving and parading the mummies (physical entities of ancestors) around in the streets and leaving them offerings (Tantaleán, 2019). Even certain rocks were a symbol of commemoration, linking one to their origin, and a communication point between the living and dead when used to build altars for veneration (Kaulicke, 2019).

A big question here is how these ancestors are defined within this kinship system. We do not want to assume it is based strictly on biological descent patterns. In fact, given various definitions of *ayllu* and the flexible nature of this system, kinship has been said to be both consanguineal and fictive (Isbell, 1997; Skar, 1982). So, there is no clear understanding as to how this might manifest itself in the various communities that used the system, but we can once again turn to the Inca ethnohistoric texts for a starting point on the organize of marriage and associations within *ayllus*. All levels of the *ayllu* are connected to the Inca rulers and Cuzco landscape, but this was also divided into upper and lower moieties, depending on your place within that greater system (degree of closeness to the ruler), political position, and/or occupation. People were said to marry within *ayllus*, but across moieties (families). Ideally, how this worked was through sister exchange; one woman would marry into a family in another moiety and that family would send a female (groom's sister) to marry into the moiety of the original bride (bride's brother). If there were no sisters then someone else within that moiety (same age/sex) could substitute, all while avoiding any marriage closer than third cousin (Isbell, 1997). With females being exchanged, this led to patrilocal residency (Schusky et al., 1965), but with parallel descent since females track their lineage through the maternal side and men through the paternal side (Isbell, 1997). What this then meant for who was deemed a third cousin is different from the western bilateral system (Schusky et al., 1965). That could also mean different occupations and roles in society for men and women if they defined their ancestors strictly through biological relatedness, but that does not match the attachment to landscape via ancestors. There is also said to be an *ayllu* for your household, village, population, region, and so forth, which can also alter marriage patterns and defining one's ancestors (Isbell, 1997). Basically, despite having the basics of the system from chronicles, the worldview of the Inca and other Andean groups is so far detached from our own that it is difficult to make any definite claims about the system without analyzing it on a case-by-case basis.

The same boundaries and attachment to the landscape, ancestors, and other elements of the local environment and basic marriage patterns (patrilocal and avoidance of inbreeding) were said to be seen in most cultures using an *ayllu*-like kinship structure, which would include many of the small communities that formed during the LIP (Isbell, 1997). According to ethnographic and colonial texts, the Chanka used the *ayllu* system up until colonial times, with a total of ten *ayllus*. The levels of the Chanka *ayllus* begin at the *wasifamilia*, which are household units that share work responsibilities and resources. Further up the system, *ayllus* were divided into upper (*Hanay*) and lower (*Uray*) moieties, composed of multiple *wasifamilia*. Which *ayllu* one belonged to depended on their leader, which could change depending on who led the community at the time. The different moieties were also said to alleviate tensions during such a competitive time through ritual fighting. Also, these different levels of the *ayllus* (on the scale larger than moiety) did not come together or interact except for important rituals or to battle a common enemy. As for marriage, Chanka's practice is said to not have been as strict as the Inca system, and post-martial residence could be patrilocal or matrilocal. This was based solely on convenience, newlyweds needed to be able to inherit land to plant crops, so wherever there was extra land (the male or female's home moiety) is where they moved. This was a bit more flexible and complex, with more variation, which makes sense for smaller communities with changing conditions, but overall, the Chanka *ayllu* is said to be a "mirror image" of the Inca *ayllu* (Skar, 1982).

Even though colonial texts state that the Chanka had ten *ayllus*, these cannot be distinguished within the archaeological record due to similar cultural features throughout the sites. In fact, there may not even be material items directly linked to one *ayllu* or another since *ayllus* are based on work and land ownership, not material items. Even with colonial and ethnographic information explaining details of the system, *allyus* are challenging to observe in the archaeological record. However, one common understanding is that the *ayllus* were ancestor-based, which may point to genetic relatedness being a factor in *ayllu* association. Isbell (1997) said to observe *ayllus*, one must look at visible or displayed places of ancestor worship, such as *chullpas* and *machays*. The appearance of these structures in the archaeological record is why the *ayllu* system is dated to the Early LIP, but this continues to be debated (Kellett, 2022). Using Isbell's (1997) approach, site boundaries and ancestral associations can be observed through the placement of cist tombs (in- and above-ground burial structures), *machays* (natural and built caves), and *chullpas* (above-ground burial structures) around the site borders that hold the physical ancestors of the people from these newly formed settlements (Bauer et al., 2010; Kurin, 2016).

Conflict in the region corresponds to the Wari collapse, an increasingly arid environment, reliance on animal husbandry and agro-pastoralism, movement to the higher elevations, and the formation of new communities. All of this likely favored more strict definitions of *ayllu* associations within the region, so everyone clearly knew their place in the newly formed societies and which communities held obligations to help others during conflict (Kellett, 2022). With evidence of raiding and interpersonal violence, the agreements between communities can be seen through the layout of sites. Each site was highly visible on the landscape, with inter-site visibility, so they could physically see if another site was at risk.

Unlike the Inca, these divisions indicate a heterarchical society, not a hierarchical arrangement. Aside from cooperation against external threat, the Chanka ridgetop sites surrounded the same valley, indicating shared agro-pastoral lands. The ridgetop sites also do not display differences in artifacts or wealth (no status differentiation), and all had the same basic architectural features such as small circular houses, patio groups, similar masonry techniques, and a lack of public spaces (Bauer et al., 2010). The LIP sites of Achanchi and Luisinayoc, for example, also show no internal status differentiation such as elite and commoner households. Therefore, it is important to note that they were peer- or micro-polities, even with divisions such as *Upper* and *Lower* moieties, lacking indications of status differentiation (Kellett, 2022). Using the burial structures (*machays* in the case of the Chanka) as a starting point, incorporating genetic relatedness within and between *machays*, sites, evaluating the degree of non-locals present (isotopic analyses) can illuminate and add to our understanding of how the Chanka structured their kin organization/*ayllu* in the early and late LIP.

There is still confusion about Chanka *ayllus* and if they can ever be observed through the archaeological record. Once again, it is important to note that *ayllu* is a very broadly used term, with a great deal of definitional variability. This dissertation understands it as a term used to represent a single settlement, group of settlements, and multiple communities, with varying landscape boundaries, because of the multi-scalar nature of the *ayllu* system (Kellett, 2022). *Ayllus* should therefore not be confused with an individual identity, community or cultural affiliations, or the ethnicity of a region (Kurin, 2012). It is a specific form of social organization with ties to occupation, land, above-ground burial structures, and ancestors by people of multiple communities that may not directly connect to kinship (Kellett, 2022). Due to the difficulty of attaching the *ayllu* to archaeological material, this dissertation focuses on what can be directly observed, such as genetic relatedness, mortuary context, and cultural markers of identity, while being careful not to assign to detailed *ayllu* categories.

Imperial Influence on Social Structure

Once the early LIP Chanka social structure is properly assessed and understood, the type of Inca influence on the region can be evaluated. As mentioned, state systems take a while to develop social cohesion across regions, with different strategies invoked based on the current social environment of an area. Generally, when a state expands to an area, if there are major differences in local social/political structure or resistance to incorporation, states tend to enact larger changes. This may begin with militaristic action to display the power of the state followed by the movement of part or whole populations to divide families and alliances, constructing visible public monuments such as shrines or government buildings, state iconography on ceramics and other objects, a standardization of objects, and may ultimately alter the local social identities and infrastructure set in place before the state. The greater the amount of change, the more the state had to enforce change due to resistance (Kolata, 2006). A large amount of change may not always indicate resistance though, it may be due to there being a lack of centralized political structure in a region, which the expanding state then must set in place themselves.

To be able to differentiate all three of these signals of state activities (slight change, large change due to resistance, and large change due to lack of structure), one has to observe the local patterns for a community before the state takes over (Shreiber, 1987). If the area is minimally impacted, they were likely easily incorporated and lacked of sovereignty. Here you might see a combination of local architectural and ceramic styles along with the state's styles (hybridization) (Tenorio, 2019). If massive changes are enacted in a region, this will indicate a hegemonic (with sovereignty) takeover, but whether it is due to resistance or lack of structure will be determined from the cultural indicators present previously, resulting in the large-scale changes mentioned above (Shreiber, 1987).

One last factor that may influence the type of rule an archaeological record is the timing of regional incorporation. Those incorporated early will likely have the largest changes over time, while those that are incorporated late will have less (Bray, 2015). In this case, dating of material to look at changes are key to see when changes occurred.

Once formed, states can eventually form into empires, expanding rapidly to incorporate groups of different political or social structures, especially when the groups are small and isolated (Marcus, 1998). Rapid territorial expansions were used by the Roman, Aztec, Achaemenid, and Inca Empires (Bauer & Covey, 2002; Berdan et al., 1996; Harris, 1979; Kuhrt, 2001). Once expansion occurs, this is when other strategies and systems are put in place to maintain stability and control. The model says there is a core polity that controls periphery regions (with a semi-periphery as a transitionary region between the two), with the core establishing its power through the uneven distribution of resources and use of labor with the periphery (economic exchange). To expand more quickly, the empire or state will often leave local political infrastructure in place while incorporating it into the larger hierarchy, creating less conflict.

Wallerstein (1974) proposed the world systems model as a framework for these patterns, which was originally used to describe the modern European economy (Wallerstein, 1974), but has since been used to describe prehistoric states (Chase-Dunn & Hall, 1994). One main difference that Chase-Dunn and Hall (1994) introduced when applying this to prehistoric states is the unit of analysis. Instead of observing societies as homogenous, the modes of accumulation, or the variation across world-system types, are taken into consideration. This is establishing the structure to the exchanges within and between the societies instead of viewing them as whole entities (Chase-Dunn & Hall, 1994).

Along those lines, criticisms of the world systems model are that it is too simplistic and focused on the "top-down" view of relations between the core and periphery. When acknowledging that viewing this as a homogenous landscape around the core is inaccurate (Chase-Dunn & Hall, 1994), some say this should be a networks and nodes approach to understand the forms of social differences and leadership. Instead of broad maps representing an isolated place in time with a similar landscape of relationships, the networks and nodes can represent the interaction not just between the periphery and core, but all interactions between the groups conquered as well, especially through time (Feinman & Neitzel, 1984; Smith 2005). With expansive empires, there also tend to be multiple "cores" (nodes), which will have more interaction between them than surrounding networks, all of which fluctuates through time (Smith, 2005). This creates a complex and changing landscape during state formation and expansion.

Peripheries are not just passive but are the loci of variable interaction with the state based on their social history and the structure already set in place (Boswell & Knabb, 2022). Distance to the cores, capitals, or nodes are not necessarily the driving factor in how an expanding empire treats communities, but their degree of resistance to being incorporated. Depending on the social and political structure already set in place, it may be easy to incorporate a community into the state system (Shreiber, 1987). For example, a local politician can be given a position, marry into the kinship system, and other such acts to bring that community into the state, where they are then obligated to participate in state structures (like trade). With this, there is no reason for a state to enforce massive changes or rule in the region.

To assert presence in everyday life and maintain continued control, especially in communities and territories further away from the capital, having a physical reminder of the state is important, such as iconography on ceramics, presence of state architecture, etc. However, what these objects mean to the people viewing them is the main reason this enforces control- a change in ideology. To fully penetrate a community's core worldview, ideologies and their associated activities need be changed to those of the state (Buikstra & Nystrom, 2015; DeMarrais et al., 1996). This is called the process of materialization, where ideology is given a concrete form that can be utilized to control, manipulate, and conform ideology to communities incorporated into the state (DeMarrais, 1996). Ideology is used as social power since it is a central form of cultural systems, which shapes how groups define and build their identity and kinship boundaries (Barth, 1969). Ideology is present in communities through state-instituted and visible ceremonial events; symbolic objects and icons on people, buildings, and in the home; and public monuments. The materialization of culture is ongoing and creates shared experiences in a community, therefore homogenizing state control (DeMarrais, 1996).

The Inca, for example, began by building a state within the Cuzco Valley of modern-day Peru during the Late Intermediate Period (LIP, AD 1000-1400) (Covey, 2003). The Inca built up state structures (hierarchy/political organization) using what was already present in the region from the Wari Empire/polity. This is called template regeneration (McEwan, 2006). The Inca showed all indicators of being a state during the LIP such as the establishment of a hierarchical system with an increase in population size from resettlement of populations to Cuzco, and the development of an economic, infrastructure, and an ideological system (D'Altroy, 2002). Once the population increased in Cuzco, there was more labor available to expand their agricultural exploits, with maize as a main crop. This was used as one of the benefits present to nearby communities for joining the Inca state (soon to be empire) (Bauer & Covey, 2002). Also, the Inca used the available labor to build a road network, agricultural terraces, irrigation systems, storage facilities, clothing, weaponry, and more (Nair & Protzen, 2015). The placement of shrines and roads all connected to the center of Cuzco, which was the center of creation and controlled their kinship system called the *ayllu* (Isbell, 1997; Tantaleán, 2019). An important point about their ideology is that the landscape and its features are part of the sacred realm, even the rocks used to make the shrines are sacred (Kaulicke, 2015). As the Inca Empire expanded out of Cuzco, these buildings and infrastructure were set in place for new communities, making a physical and visible connection between the newly incorporated region, Cuzco, and Incan ideology (center of their ideology) (Smith, 2005).

Since the Inca had to change their strategy of incorporation based on the community structures already in place, peripheries should not be seen as homogenous (Andrushko, 2007). Along the same lines, the term "intermediate" for time periods is problematic since it implies a population is just waiting around for another state system (Smith, 2005), such as the Late Intermediate Period after the Wari Empire and prior to Inca invasion (Bauer et al., 2010). However, these periods tend to hold a tremendous amount of novel cultural and ethnic boundary formation (Barth, 1969). After centralized political structures collapse, there is a period of reorganization and the movement physically and/or socially of community boundaries in order to create a new manageable system.

This takes on many forms as well, depending on the degree of rule a state or empire had in the region prior to collapse. In communities that were more heavily regulated and changed, some argue a sort of Stockholm syndrome may take place and these groups will leave previous institutions in place or make them their own. On the other hand, areas that were generally left to their own devices might reject the previous institutions and choose to elevate their own cultural traditions (Kolata, 2015). However, the opposite could occur with ethnogenesis, the quick formation of completely novel cultural groups (Schwartz, 2015). It is hard to say what exactly the choices will be since the reasoning behind collapse and the choices communities make are unique to each region. Once again, to view changes in the archaeological record, the patterns observed in the previous time period must also be recorded.

The Chanka showed evidence of rejecting Wari iconography as they formed their new identities in the early LIP (Kurin, 2012; 2016). On the other hand, the Inca used Wari hierarchical structures set in place in Cusco to become a new node of control (Conlee et al. 2009). The Chanka and Inca therefore had very different social structures in place in the late LIP. The local history of the communities being targeted for expansion can be utilized in different ways for an expanding state like the Inca. The smaller communities in place before expansion have their own important and novel identity and community formations that will be distinct in the archaeological record. Overall, the most persistent and influential way for a state to maintain control and homogeneity over the conquered is through altering their ideology via highly visible and prevalent structures and material across the landscape.

When the Inca state began to expand, they were also able to exploit the *ayllu* social structure already being used in a lot of Andean communities. With similarities between the Inca *ayllu* kinship system and all other communities around the Andes, it was not difficult for the Inca to convince communities to join with promise of advantages (such as traded goods, crops, and protection) by having their *ayllu* leaders marry into the Inca kinship structure (Buikstra & Nystrom, 2015; Silverblatt, 1988). Local headmen of kinship groups were also given roles in the Inca government and this job came with its own Inca ideological history and worshipping practices, thus a new ayllu (Silverblatt, 1988). It is not uncommon for people to change their ethnic associations if they can profit from doing so, and the Inca provided that opportunity (Barth, 1969).

Other than marriage alliances, the Inca built monumental architecture over local ceremonial architecture, resettled population to other regions for labor (*mitimaes*), and other various negotiations depending on the conditions (Arkush & Tung, 2013; Bauer & Covey, 2002; D'Altroy, 2002). Landscape and even rocks were attached to ancestor veneration, so building over these structures using Inca style architecture was one way of erasing the previous identity in place for that culture and community, physically manifesting the cultural replacement by Inca authority. Changing a community's ancestors to one centered around Inca ideologies was a way of manipulating social memories. This is called *dead body politics* (Verdery, 1999). The Inca not only took over new regions and their resources, but erased any local identity and replaced it with their own ancestors or *huacas* (Buikstra & Nystrom, 2015; Silverblatt, 1988). Once incorporated, the Inca ideology became part of all aspects of life, with Inca control emphasized daily through activities and material, such as ceremonial events, symbolic objects and icons, and public monuments and landscapes (DeMarrais et al., 1996). To reinforce their authority over the land and resources, the Inca built over Chanka ceremonial areas, as seen at the site of Sondor where a sacred hill is covered in Inca architecture (Bauer et al., 2010). The Inca were even said to steal Chanka *huacas* (mummified ancestors), to parade them around the Cuzco square, and kept them away from the Chanka, another form of erasing identity (Bauer et al., 2010).

In addition to changing the landscape in Andahuaylas, when the Inca appeared in the region, there was a large drop in population size with the site of Sondor having a larger population than other sites. The question still remains- are the Chanka still there after the Inca state invades the region? The chronicles say the Chanka were enslaved and moved out of the region to work as laborers (Ramos Gavilan, 1988 [1621]), with other laborers brought to Sondor from far away regions (Julien, 2002). However, based on ceramics found at Sondor, there was a period of time where the Chanka and Inca co-existed, since Chanka, Inca, and hybrid ceramics were found together, indicators of a minimally impacted society. Overall, there were large-scale changes to the region, but the nature of whether this was due to a powerful Chanka resistance or lack of unification between Chanka communities is explored here. To observe what occurred, and if agreements changed through time between the Chanka and Inca, the Chanka social organization has to be compared between the early and later part of the LIP into the LH. Genetic diversity and isotopes establish if the Inca brought in laborers from far away, or the genetic diversity sees an introduction of Inca regional diversity from marriage alliances. Genetic relatedness and mortuary patterns within and between burial contexts at Sondor, and between Sondor and the earlier sites, determines if we see the same kinship structure and what type of structure this was. Either way, a complex picture is emerging, and the methods can be used to unravel the interactions and strategies between the Chanka and Inca.

CHAPTER 4 – MATERIALS AND METHODS

The methods described here are based on questions about mortuary contexts from the LIP in the Andahuaylas region of Peru. The methods include excavations of cliffside mortuary contexts and a household structure, followed by osteological, isotopic, and genetic analyses. Samples of human skeletal remains were collected and analyzed with permission from local communities and the Peruvian Ministry of Culture (see Ethics Statement at the end of Chapter 1).

Study Sites

The research questions will be addressed using excavated mortuary populations from four primarily LIP sites in Andahuaylas, Peru: Cachi, Ranracancha, Pucullu, and Sondor (Figure 2). Excavation of these sites occurred between 2010 and 2017 and yielded 11 mortuary contexts. Cachi, Ranracancha, and Pucullu were excavated by Kurin (2012; 2016) under the Andahuaylas Bioarchaeology Project. The Sondor Bioarchaeology project took place in 2017 with co-directors Danielle Kurin and Beatriz Lizarraga, with excavation protocols developed by me based on my research questions.

The sites of Cachi, Ranracancha, and Pucullu were selected for this study because they represent life in Andahuaylas during the early LIP. Cachi and Ranracancha are said to be the upper and lower moieties of the same ayllu, while Pucullu has been argued to be a separate community (Kurin, 2016). Exploring the dynamics of how these early LIP communities were connected to each other through genetic relatedness and number of outsiders allowed within them, will reveal the type of social structure that developed once the Chanka formed in Andahuaylas. The addition of Sondor explores the question of what happened to the Chanka during the late LIP/Late Horizon in response to Inca imperialism. During the late LIP/Late Horizon, many Chanka sites including Cachi, Ranracancha, and Pucullu were depopulated suggesting regional out-migration and/or the consolidation of local populations at the site of Sondor.

Mortuary contexts from the study sites were dated through ceramic typologies and direct radiocarbon dating of human remains. Previous radiocarbon dates from individuals at the sites of Cachi, Ranracancha, and Pucullu (Kurin, 2012) were supplemented by the radiocarbon dating of an additional 19 individuals from these sites (Table 2; Appendix A). Twenty teeth from Sondor were also submitted for AMS radiocarbon dating (accelerated mass spectrometer ^{14}C calibrated dates) since this site had not been previously analyzed. Radiocarbon samples were processed and analyzed by UC Irvine's W.M. Keck Carbon Cycle AMS facility. All dates were calibrated using the Bronk Ramsey Bayesian analysis website called OxCal v4.4.4 with a 95.4% (2σ) probability range (Bronk Ramsey, 2021; Reimer et al., 2020). Radiocarbon dates from the study sites confirm previous interpretations, which place the height of Chanka influence in the region within the early LIP (Bauer et al. 2010; Kurin 2012). This is followed by a drastic decline in population size during the late LIP, with the exception of Sondor, which expands during this time period with the rise of Inca influence.

Table 2. Radiocarbon dates from tooth samples at Cachi, Ranracancha, Pucullu, and Sondor, with Kurin (2012) dates in grey.

Lab Code	Site	Sector	Unit	Cultural Period	calAD 95.4% prob
MCH.01.01	Cachi	Mina	-	Late LIP	1279-1384
MCH.01.01.xx*	Cachi	Mina	-	MH	681-885
MCH.01.01.xy*	Cachi	Mina	-	MH	773-988
MCH.01.03.02*	Cachi	Mina	-	Late LIP	1312-1428
MPM.01.01.01	Cachi	Mina	-	Early LIP	1205-1264
MPM.01.03	Cachi	Mina	-	Early LIP	1040-1165
MPM.1.13	Cachi	Mina	-	Early LIP	1054-1267
MPM.01.01.16*	Cachi	Mina	-	MH	772-974
MPM.01.18	Cachi	Mina	-	Early LIP	1259-1285
SON.01.Rinco*	Cachi	Sonhuayo	Cave 1		1220-1282
SON.01.01.05	Cachi	Sonhuayo	Cave 1	Early LIP	1220-1266
SON.01.01.11	Cachi	Sonhuayo	Cave 1	Early LIP	1162-1219
SON.02.02.05*	Cachi	Sonhuayo	Cave 2	Early/Late LIP	1229-1378
SON.02.02.11	Cachi	Sonhuayo	Cave 2	Early LIP	1165-1224
SON.02.02.12	Cachi	Sonhuayo	Cave 2	Late LIP	1296-1394
SON.02.03.25	Cachi	Sonhuayo	Cave 2	Early LIP	1164-1220
SON.02.04-1.48	Cachi	Sonhuayo	Cave 2	Early LIP	1221-1268
SON.02.04.57	Cachi	Sonhuayo	Cave 2	Early LIP	1052-1263
SON.03.01.06	Cachi	Sonhuayo	Cave 3	Late LIP	1279-1384
SON.04.01.2008*	Cachi	Sonhuayo	Cave 4	LH/colonial	1474-1638
SON.05.01.05	Cachi	Sonhuayo	Cave 5	LH/colonial	1457-1624
SON.07.01.02	Cachi	Sonhuayo	Cave 7	Late LIP	1306-1401
RCC.01.01.04*	Ranracancha	-	-	Early LIP	1054-1267
RCC.01.01.24	Ranracancha	-	-	Early LIP	1158-1228
RCC.01.01.42	Ranracancha	-	-	Early LIP	1041-1162
PCU.01.01.03	Pucullu	-	-	Late LIP	1321-1410
PCU.01.01.10	Pucullu	-	-	Early LIP	1030-1155
PCU.01.01.13	Pucullu	-	-	Late LIP	1298-1396
PCU.01.01.26	Pucullu	-	-	Early LIP	1178-1276
SOD_1_1	Sondor	Muyu Muyu	1	Late LIP	1289-1394
SOD_1_I1	Sondor	Muyu Muyu	1	Late LIP	1327-1430

SOD_1_2	Sondor	Muyu Muyu	1	Late LIP	1276-1384
SOD_1_3	Sondor	Muyu Muyu	1	Late LIP	1275-1388
SOD_1_I3	Sondor	Muyu Muyu	1	Late LIP	1276-1388
SOD_1_6	Sondor	Muyu Muyu	1	Late LIP	1296-1396
SOD_1_7	Sondor	Muyu Muyu	1	Late LIP/LH	1408-1442
SOD_1_9	Sondor	Muyu Muyu	1	Late LIP	1303-1401
SOD_1_10	Sondor	Muyu Muyu	1	Late LIP	1227-1293
SOD_1_C2	Sondor	Muyu Muyu	1	EIP/MH	543-786
SOD_1_C3	Sondor	Muyu Muyu	1	Late LIP	1289-1394
SOD_2_I1	Sondor	Muyu Muyu	2	Late LIP	1296-1396
SOD_2_I2	Sondor	Muyu Muyu	2	Late LIP	1229-1291
SOD_2_I3	Sondor	Muyu Muyu	2	Late LIP	1323-1431
SOD_2_1	Sondor	Muyu Muyu	2	Late LIP	1275-1383
SOD_2_2	Sondor	Muyu Muyu	2	Late LIP	1276-1384
SOD_5_1	Sondor	Suyturumi	5	Late LIP	1283-1390
SOD_5_3	Sondor	Suyturumi	5	Late LIP	1290-1395
SOD_5_5	Sondor	Suyturumi	5	Late LIP	1278-1389
SOD_5_7	Sondor	Suyturumi	5	Late LIP	1276-1388

*Individual not included in the genetic/isotope analyses reported in this dissertation

Cachi

Cachi is in the San Antonio de Cachi District of Andahuaylas, Peru, and said to be the home for the upper Chanka moiety (Betanzos, 1996; Kurin, 2016). The site was excavated by Kurin (2012; 2016) and broken into three sectors: Sonhuayo, Masumachay, and Mina Cachihuancaray. The site is a heavily fortified to protect important natural resources such as clay and a salt mine. The lifeways of the people of Cachi likely revolved around mining salt and protecting the resource. Prehistoric terraces were identified around the site and the burial caves excavated were found in modified natural rock outcrops. Previous radiocarbon dates from separate *machays* date to cal AD 1123–1290 (2σ), along with ceramic style, indicate that site's *machays* were used sequentially during the early LIP (Kurin, 2016:77). The 14 excavated *machays* at Cachi contained the remains of at least 338 individuals (Kurin, 2012).

The Sonhuayo sector of Cachi (3365 masl) is a fortified habitation with seven burial caves or *machays*. The burial caves are located along the defended hill under rock overhangs and built into the bedrock. Sonhuayo was excavated by Kurin (2012) due to its proximity to the main habitation area of Cachi. The Sonhuayo individuals included in this study come from Caves 1, 2, 3, 5 and 7. The remains in Cave 4 were too badly preserved to be included. The Sonhuayo sector shows occupation beginning in the early LIP. Radiocarbon dates from Cave 1 fall exclusively within the early LIP, while in Cave 2, ~67% of the individuals are from the early LIP, and 33% are from the late LIP (Kurin 2012) (Table 2). Caves 3, 5 and 7 contained fewer individuals (i.e., 2-6 individuals) in comparison in Caves 1 (17 individuals) and 2 (39 individuals), and may have been used primarily in the late LIP (caves 3 and 7) and Late Horizon/colonial period (cave 5).

The Mina sector of Cachi consists of a salt mine, several *machays*, agricultural terraces, a plaza, and a few residential structures. The Mina *machay* was included in this study due to its unique location, sizable mortuary population (31 individuals) and the results of a non-metric cranial morphology study done by Pink (2013), which found potential connections between the Mina sector of Cachi (Mina) and the distant Wari heartland (Pink, 2013).

The Mina sector has a broader temporal range extending into the Middle Horizon (cal AD 690–1430; 2σ), but individuals dating to the Middle Horizon, as determined by Kurin (2012), were excluded from this study. Additional radiocarbon dates from the Mina sector date primarily to the early LIP, but one individual dates to the late LIP (Table 2).

All burial caves at Cachi were looted in recent times with commingled remains of various ages and sex. Cachi burial context contained a total of 154 crania with 15 juveniles, 65 males, and 74 females. Cranial modifications, a new LIP practice, was found at a rate of 75%. A rate of 51.9% of individuals had some form of trauma, with more individuals with cranial modifications experiencing trauma than unmodified individuals.

Ranracancha

The site of Ranracancha is said to be home to lower Chanka moiety (Betanzos, 1996; Kurin, 2016). Despite this, Ranracancha is in an isolated region and was deemed a hostile wilderness by chronicler Betanzos (2004). The section of the site excavated by Kurin is called Llatanacu, which has a large natural cave named *Ayamachay* (3436 masl). It was looted and poorly preserved but still shows LIP Chanka ceramics associated with human burials. The individuals at Ranracancha were included in this study due to their association with the Chanka *ayllu* kinship system and questions regarding how the population at Ranracancha interacted with other Chanka populations despite its isolated location. Radiocarbon dates from the site indicate early LIP use of the site's single burial cave (AD 1160-1260, 2σ). The MNI at Ranracancha is 42, with 5 juveniles, 19 males, and 17 females found in 1 *machay*. Based on crania, Ranracancha has 41 individuals. A high rate of 62.1% of individuals had trauma with 100% of individuals found with cranial modifications (Kurin, 2012).

Pucullu

Pucullu is in the Pacucha District of Andahuaylas. It is discussed in the 1539 *Encomienda* as the Quichua polity, not Chanka, but there are no artifacts or structures to distinguish this group archaeologically. Another source claims the Pucullu population was another lower Chanka moiety (Bauer et al., 2010). Pucullu is very close to and shares a major water source (Laguna Pacucha) with the individuals at Sondor. Kurin excavated in the Manchaybamba sector of Pucullu, in a looted cave in a rocky outcrop along a steep hillside. The individuals of Pucullu are included in this study because of the lack of archaeological evidence distinguishing this group from the Chanka and the hope to determine whether these individuals were part of the Chanka or whether they formed a separate distinct group (possibly the Quichua). The MNI of Pucullu is 34, with 12 juveniles, 15 males, and 10 females found in 1 *machay*. Based on crania, Pucullu has 21 individuals. The rate of trauma for these individuals was 68%, with 62% having cranial modifications. Direct radiocarbon dates from four of these individuals ranges from early LIP (2 individuals) to late LIP (2 individuals).

Sondor

Sondor is located near Pucullu in the Pacucha District of Andahuaylas, a short distance from and overlooking Laguna Pacucha. The site is prominent along the landscape and is a popular tourist destination. It is designed as a protected site by the Peruvian Ministry of Culture because of its cultural significance. Sondor is found along the royal Inca Road and defined as one of the largest Inca sites in the region (Bauer et al., 2010; Perez et al., 2003). However, the contemporary local community defines it as a Chanka site, and it was originally occupied by the Chanka and their ancestors (Bauer et al, 2010). Excavation at Sondor has revealed Inca, Chanka, Inca-Chanka hybrid, and unidentified (i.e., foreign) ceramics, and varied burial styles dating to the late LIP (AD 1220–1430) and Late Horizon (Bauer et al, 2010; Perez et al., 2003; Tenorio, 2021; this study). It is unknown whether these changes in material culture and burial styles reflect population movements, or whether they reflect adoption of new cultural influences by local populations.

There are two main sectors on separate hills, *Suyturumi* and *Muyu Muyu*. *Suyturumi* showed habitation structures typical of Chanka with Chanka ceramics along the surface. *Muyu Muyu* has terraces along the hill with a shrine on top, and was heavily modified by the Inca (Bauer et al, 2010). An earlier excavation at Sondor focused on a structure near the base of *Muyu Muyu*, at the entrance of the site, and dated to the Late Horizon. The structure uses Inca cut stones and excavations found imperial Inca ceramics along with human sacrifices (Perez et al, 2003). Unpublished excavations from 2016 excavated a similar structure as Perez et al. (2003) at the base of the *Suyturumi* hill and found more human sacrifices (Gomez Choque & Kurin, 2016). The excavations for this dissertation took place in the summer of 2017, with two excavation units in hillside burial caves on *Muyu Muyu* (Units 1 and 2), and one unit within a household on *Suyturumi* (Unit 5), to look at variation between these two sectors.

Radiocarbon dates from Sondor human crania included in this study fall within the late LIP with the exception of one individual who dates to the Early Intermediate Period/Middle Horizon (AD 543-786) (Table 2). The dates show a narrow timeframe for these burial contexts and thus provide a glimpse into the behaviors of the Sondor Chanka during a period of major socio-political change in the region with the territorial expansion of the Inca state.

At Sondor, the mortuary styles were different in each burial context excavated. Unit 1 consisted of two *machays* similar in style to early LIP Chanka *machays* at Cachi, Ranracancha and Pucullu. Unit 2 consisted of two highland style cist tombs, and Unit 5 had individuals buried both within and outside a residential structure. These contexts are described in more detail in the paragraphs below since they were excavated as part of this dissertation and have not been discussed in other publications.

Unit 1 is along a cliffside of the *Muyu Muyu* sector. The larger *machay* in Unit 1 (Quad 1, Context 1) was placed in a small space below an extremely large and prominent flat face boulder, approximately 1.5-2 meters in height (Figures 2 and 3**)**. Radiocarbon dates place the individuals found within this context during the late LIP, calAD (95.4% prob) 1227-1442. The inside of the *machay* appears disturbed because of the consistent soil color and texture, whereas outside the *machay* has stratigraphic levels identifiable in the soil. There are indicators of natural disturbances such as roots and burrowing rodents. Additional support for the *machay* being disturbed is the range of calibrated C14 dates at various levels, with some earlier dates found at more recent levels and some later dates found at lower levels. The amount of disturbance is likely due to looting, a very common practice in history and currently for the region.

Some partially articulated remains were observed, which may be remnants of mummy bundles placed within the cave before disturbance. Mummification was a common Chanka practice, but it is rarely preserved. At the Chanka Museum in Andahuaylas, two intact mummy bundles are on display with the individuals in a flexed position with ropes and cloth wrapped around them to keep them as bundles. In Kurin's (2012) excavations, she found remnants of ropes and cloth with the commingled remains. No cloth or ropes were found in the context 1 *machay*, but there is evidence of legs in a flexed position beginning at Capa C, level 2.

Throughout the excavations of Capa A through D, commingled human remains of various ages and sex were exposed within the *machay* (Figure 4). Outside the *machay* was a half-circle of rocks with offerings, such as camelid bones, ceramics, and lithic material, found within and outside the half circle. *Machays* with a patio half circle of rocks with offerings is very typical of the early LIP Chanka sites found in the region and excavated by Kurin (2012). The offerings cannot be tied to any particular individual, but show that ancestor veneration was practiced at the site of Sondor, just like the sites of Cachi, Ranracancha, and Pucullu. The *machay* may have been used by one lineage or kin group over generations with offerings left during certain rituals or times of year to pay respect or ask for good fortune. All contexts are displayed in Figure 5.

Figure 2. Unit 1 after brush was cleared and before excavation, with the large boulder above the Unit 1, Context 1 *machay* visible.

Figure 3. Unit 1 after excavations were complete, with both rock shelters visible.

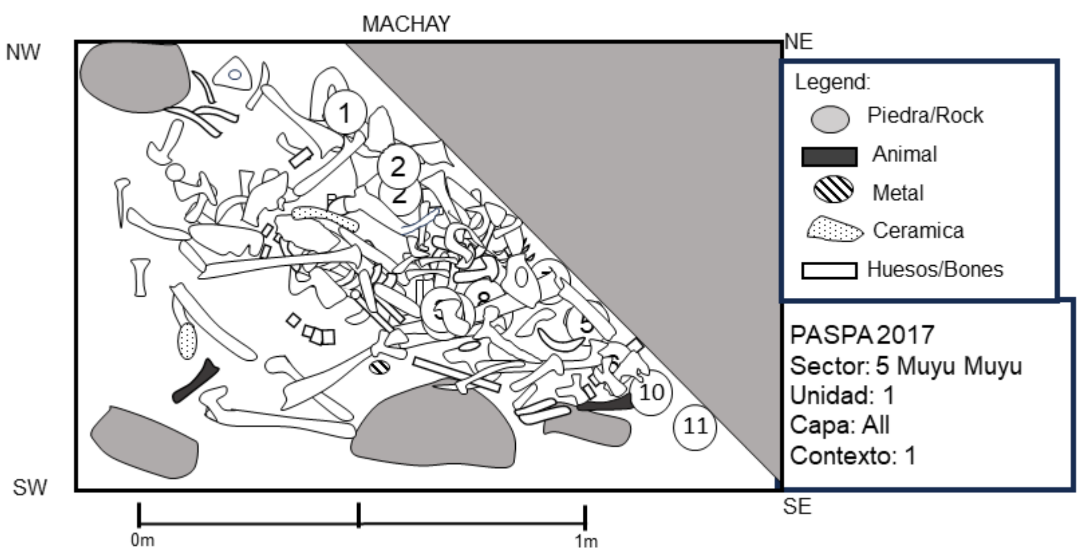

Figure 4. The Unit 1 *machay* with commingled remains.

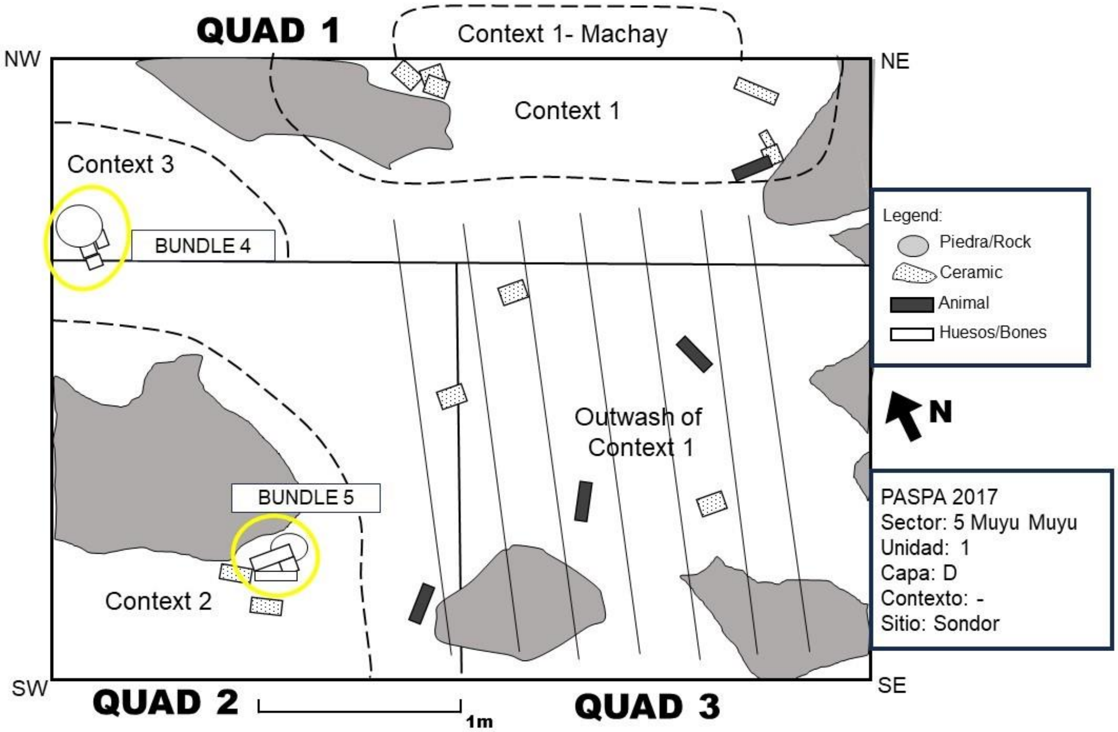

Figure 5. All contexts identified during excavations in Unit 1.

A significant find associated with Unit 1 is a child burial bundle dated to calAD (95.4% prob) 1289-1394. The 1-3 year-old child (SOD_1_C3) was interred northwest of the context 1 *machay* in a flexed position, but there were no remnants of rope or cloth (Context 3). The child bundle cannot be directly associated with the *machay*, but the bundle may have been a child sacrifice (*capacocha*) offered to the individuals in the *machay*, or the sacred spirits of the mountain. Other likely *capacochas* were identified in other sections of Sondor in association with Inca presence at the site (Perez et al., 2003). *Capacocha*-sacrificed children are usually brought from various regions of the Inca Empire and interred with high status items (Andrushko, 2011). The child burial associated with Unit 1 was not found with high status offerings, but their atypical burial outside a burial cave suggests that they were used as a ritual sacrifice. The child's potential non-local origins will be assessed through isotopic analysis.

The smaller *machay* in Unit 1, Context 2 identified during excavations was found underneath a smaller boulder and dated to the Qasawirka Phase calAD (95.4% prob) 543-786. Taphonomic processes match the earlier date due to more degradation compared to the *machay* in Context 1. Based on ceramics, a Qasawirka occupation at Sondor was previously identified, but what makes this finding special is that it extends the *machay* tradition further back in time. Prior to this study, only 2 cist tombs and 1 *chullpa* were recorded for the Qasawirka Phase. Only a single individual (SOCD _1_C2) was sampled from this burial context so the majority of individuals from Sondor date to the late LIP.

Unit 2 is found in the *Muyu Muyu* sector just below Unit 1 (Figures 6 and 7). Unit 2 contained two cist tombs built against the cliffside dated the late LIP, calAD (95.4% prob) 1229-1431. The cist tombs reflect mortuary patterns more common for the higher elevation (lower *puna*) camelid pastoralists (Kellett, 2022). In addition to commingled remains, one cist tomb (context 1) contained a partially articulated juvenile (1-3 year old) placed in the tomb in an upright flexed bundle position. This individual was not analyzed for isotopes or genetics. The second cist tomb contained two fully articulated adult individuals, one middle-aged (SOD-2-1/Individual 1) and one a young adult (SOD-2-2/Individual 2) in identical flexed positions with an intact Chanka ceramic vessel. Unlike the juvenile in the first cist tomb, the two adults were laid on their backs with their heads oriented NE. SOD-2-1 is dated to calAD (95.4%) 1275-1383 and SOD-2-2 is dated to calAD (95.4%) 1276-1384. Based on dates and identical placement and position, they were interred at the same time as primary burials. The individuals were likely in bundles prior to being placed in the tomb based on their flexed position. Offerings found around the two adult burials include a marine shell, piece of metal, lithics, and polished bone. Below the two adult individuals was another partially articulated juvenile (1-3 years-old) in a flexed upright position, who was not studied for isotopes or genetics. The cist tombs with primary burials represent a very different mortuary style from the *machays* in Sondor Unit 1, which contain the comingled remains of individuals potentially from the same extended kin group or *ayllu*. All contexts are displayed in Figure 8.

Figure 6. Unit 2 after brush was cleared and before excavation.

Figure 7. Unit 2 after excavations were complete, with the two cist tombs visible

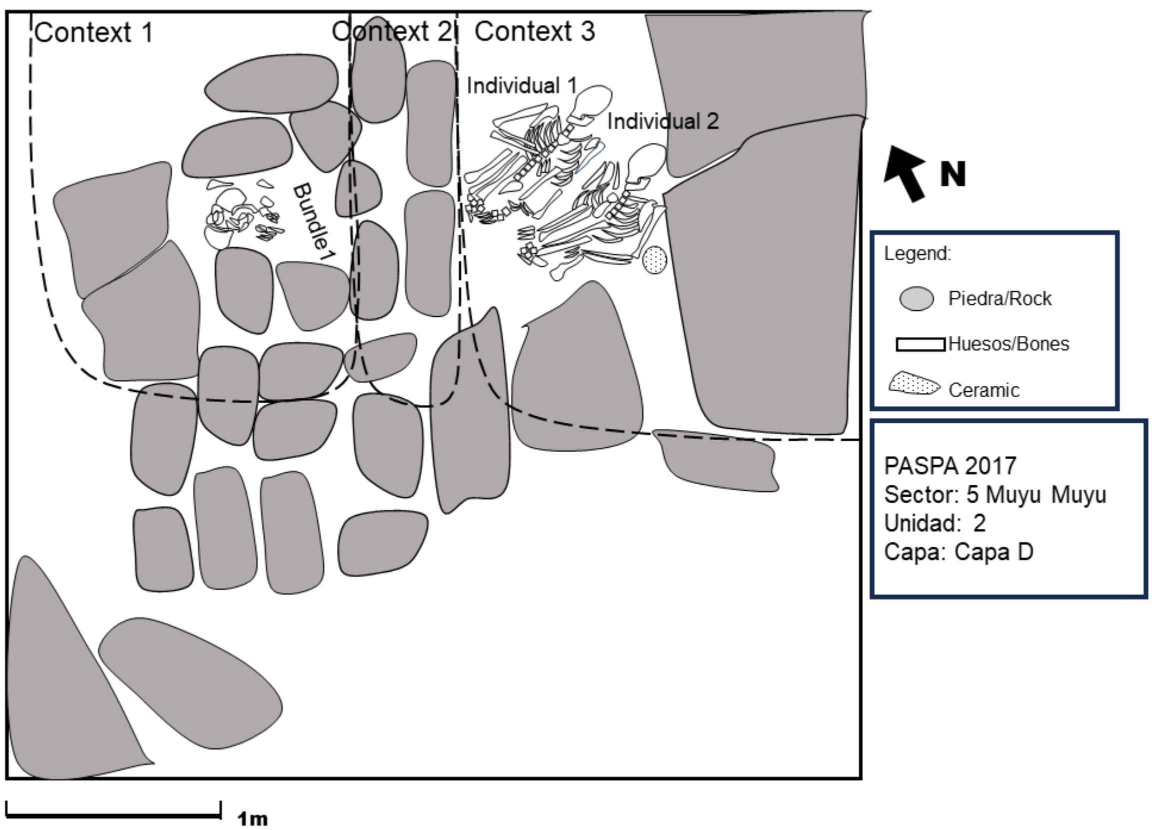

Figure 8. All contexts identified during excavations in Unit 2.

Unit 5 is a hilltop household unit within the habitation sector of *Suyturumi* dated to the late LIP calAD (95.4% prob) 1276-1390 (Figures 9 and 10). Both human remains and an abundance of household related artifacts (e.g., ceramics, manos, batáns, pestles, mortars, animal remains, modified stones, metal objects, and ground stones) were found in association with this residential unit. Five individuals of varying ages were buried beneath the household's floor in upright and flexed positions with rocks placed around them, possibly to keep them in position. Human remains have previously been found within Sondor households. Excavations in 2016 found infants placed upon household floors and one adult individual buried in the habitation sector within a circular enclosure. The infants on the household floors were hypothesized to be related to abandonment rituals (Gómez Choque and Kurin, 2016). Within this study, no dates extend beyond the late LIP with Chanka ceramics present, supporting the evidence of Chanka abandonment of the site. After a few hundred years of negotiations between the Chanka and Inka at Sondor, the Chanka may have been forced to leave. During forced abandonment, the Chanka may have placed their ancestors around the household sector wherever possible, to leave a lasting reminder of their presence at the site. That may explain the variation in burials found in *Suyturumi*, with a child buried in one household, an adult buried in a circular structure separate from a household (Gómez Choque and Kurin, 2016), and then multiple individuals of varying age and sex found in the household from Unit 5. Further excavations at *Suyturumi* may reveal more variation in abandonment rituals. All contexts are displayed in Figure 11.

Figure 9. Unit 5 after brush was cleared and before excavation.

Figure 10. Unit 5 after excavations were complete, with the house structure visible.

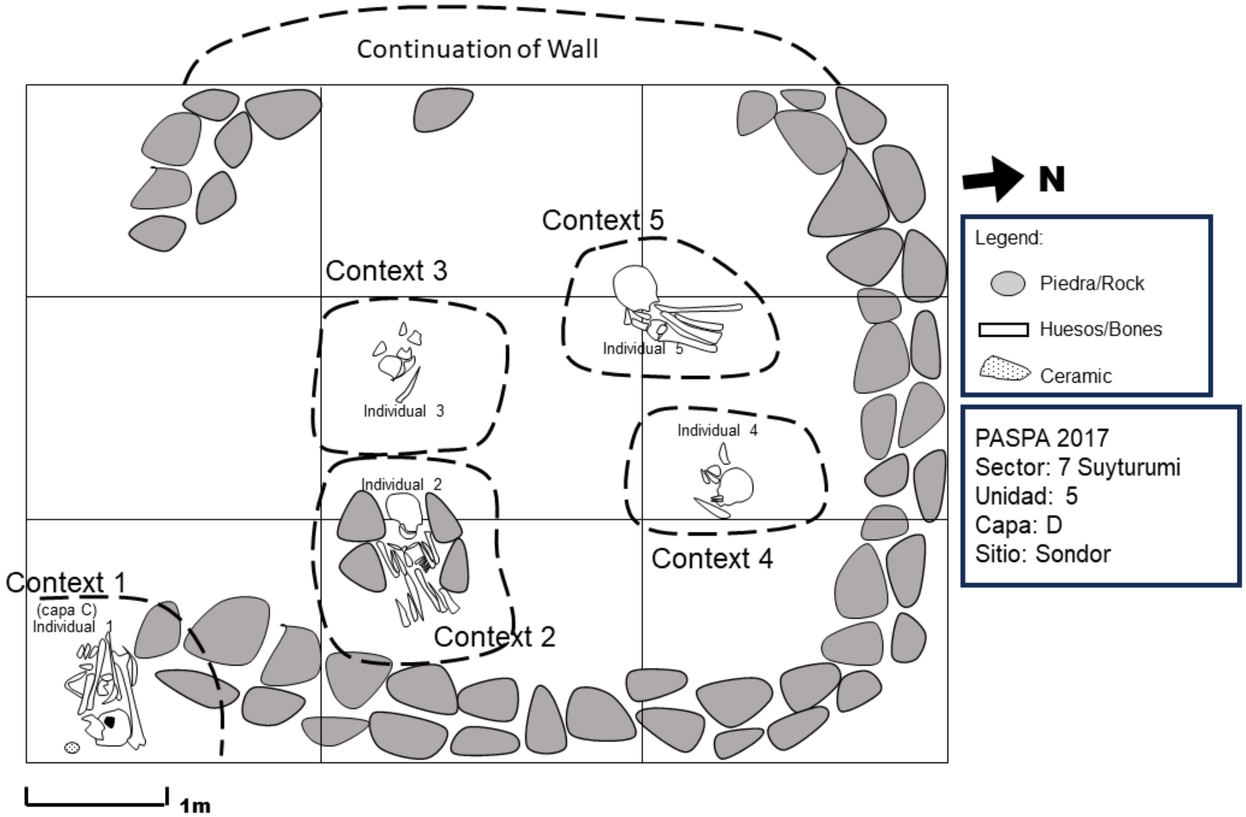

Figure 11. All contexts identified during excavations in Unit 5.

In contrast to the burials found under the floors of residential structures, are two individuals (one adult and one 1-3 year-old child) who were buried outside the residential unit discussed above. The adult was found in a flexed position on their back with the juvenile underneath them. The adult is dated to the late LIP, like the individuals inside the household, but the difference in placement warrants further investigation through isotopic and genetic analysis to identify whether their "outsider" burial status reflects more distant geographic or kinship relationships than those interred within the residential structure.

Excavation of Burial Caves/Rock Shelters (*Machays*)

The excavation methods were only applied for late LIP burial cave contexts of Sondor. This does not include the household unit at Sondor and other sites (Pucullu, Cachi, and Ranracancha) that were previously excavated by Kurin (2012). Excavation methods specifically for *machay* contexts have not been published. In addition, the benefit of these methods is that they can be applied on a small budget while still capturing crucial detailed context information in difficult, unstandardized contexts.

General excavation methods were employed (1/8 inch screens and 10 cm arbitrary levels) with additional alternations for the contexts of burial caves and rock shelters (*machays*) to gather detailed information about the placement of individuals, but also accurately excavate on the side of a hill. The problem with burial caves and rock shelters is that they will include cultural material outside of the cave (ancestral offerings) and excavation into an unknown depth within the cliffside, which also determines is if it a cave burial or rock shelter. Considering previous knowledge about cave burials in the region (Kurin, 2012; 2016), excavation units were set up outside of the machays, spanning beyond the length of the cave opening and extending out to capture ancestral offerings that were left throughout time. For example, Unit 1 had a 2x4m excavation unit set up outside of the large *machay*. The methodology will be presented using the large *machay* in Unit 1 as an example from this point forward.

Since the *machay* is of unknown size and shape, it was defined as a context for Unit 1, but instead of it being within the unit it is mapped and drawn outside of the unit, while still in direct association (Figure 12). The expectation for the *machays* is that they will be disturbed and commingled from ancient ancestral practices or looting, therefore the levels inside and outside the *machay* might not have direct associations. In addition, materials outside and inside the *machay* were mapped separately due to the expected differences in material (human remains versus offerings). Separating the maps also allows for greater detailed drawings of each area.

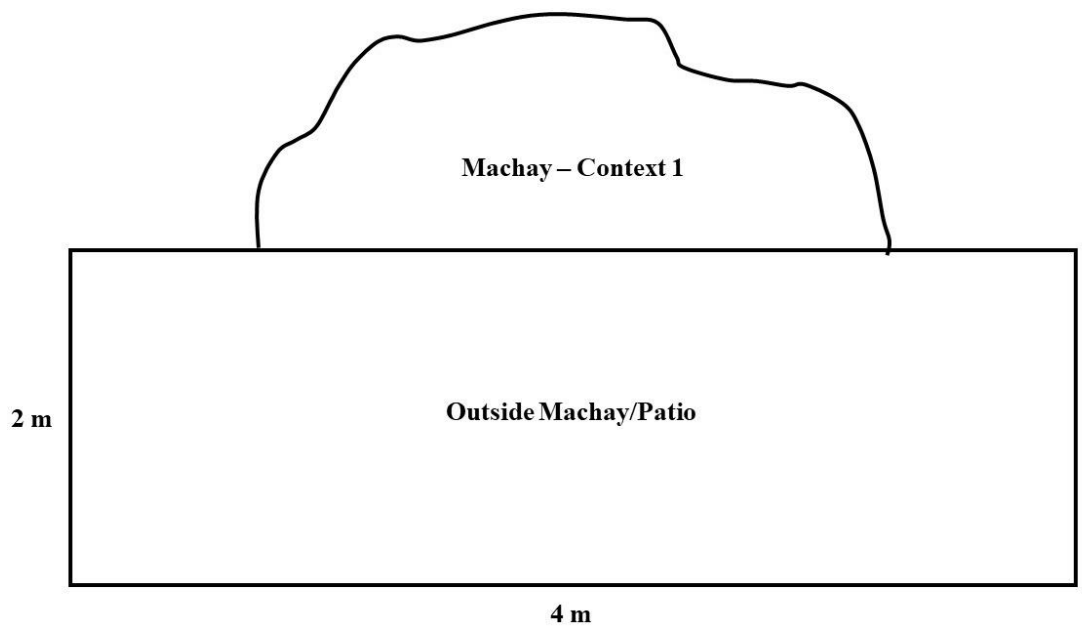

Figure 12. The placement of the *machay* context within the 4x4 unit (Unit 1).

The outside of the *machay* is established using a standard rectangular unit shape while also acknowledging where the *machay* is outside of the unit (Figure 13). The *machay* context (inside) map starts with drawing the boundaries of the cave, with an estimated unit size based on this. For example, Unit 1 showed the extent of the cave boundaries was about 1.75 m x 1.75 m, therefore the map was drawn as a 2x2 m context unit (Figure 14). A depth point is also taken along the boundaries of the cave and the middle.

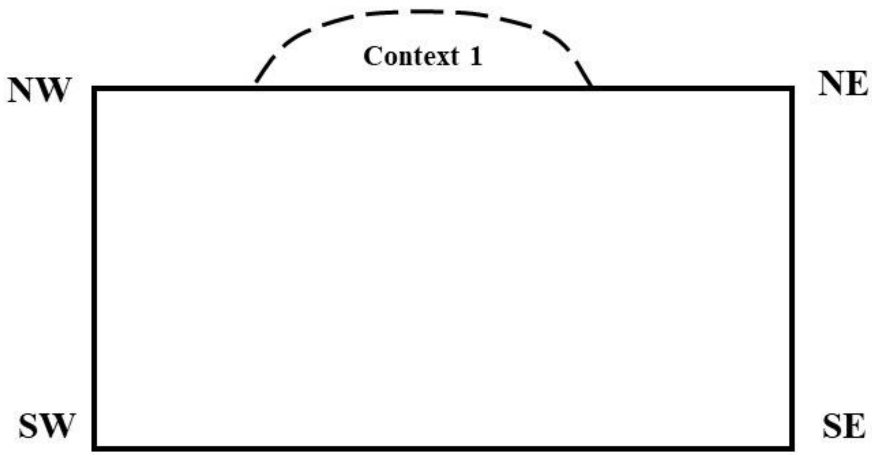

Figure 13. The exterior portion of the excavation for the *machay* in Unit 1.

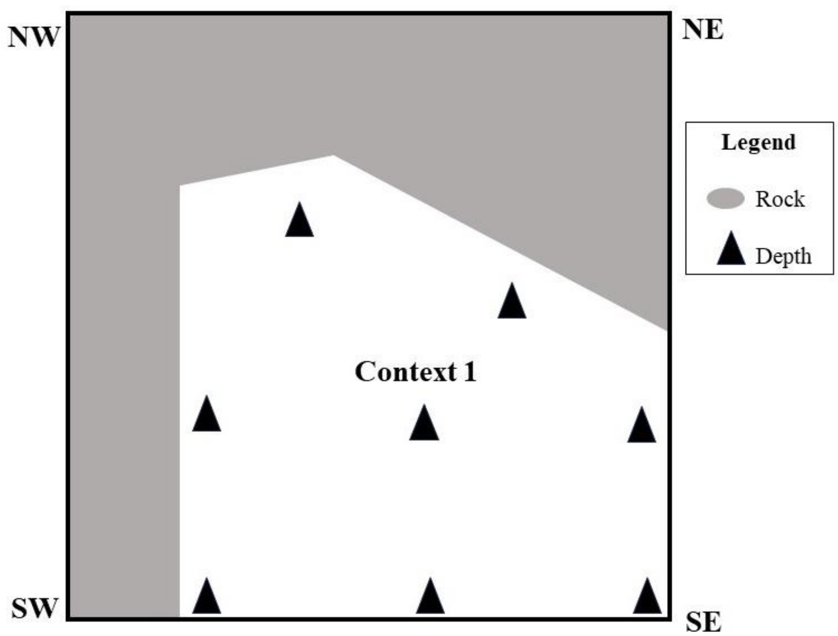

Figure 14. The interior portion of the excavation for the *machay* in Unit 1, with depth markers.

While excavating, the *machay* context and general unit levels are kept the same, so it can easily be recognized if associations are found. It was also important for the levels to follow the natural slope of the hillside to maintain cultural context. However, due to the amount of material (human remains) found within the *machay*, sub-levels were recorded within each general level, each with their own photos and drawings to correctly record each layer of commingled remains before being removed. For each sub-level, a number was provided for each cranium (craneo 1, 2, 3) and articulated remains (articulado 1, 2), and then bagged separately (Figure 15). For photographs, colored strings were placed around each cranium and articulated remains, along with their designated number.

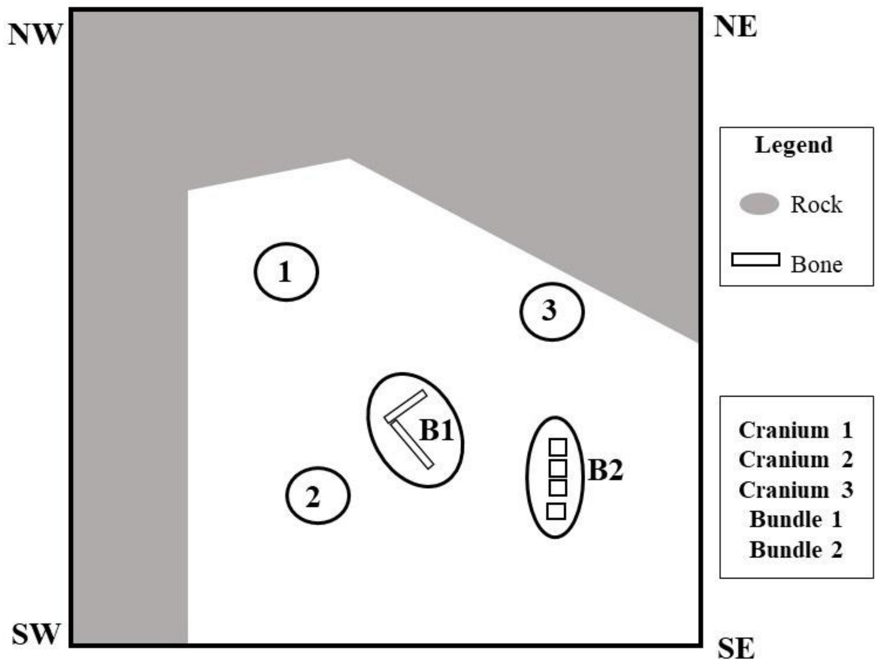

Figure 15. How individuals and bundles were marked while excavating within the *machay*.

Outside of the *machay*, if the unit began to highlight different activity areas, it can be divided into quadrants, and then contexts if necessary. Within Unit 1, the 2x4m unit outside of the cave was separated into 3 quadrants, one for immediately outside the cave with offerings, another for what fell down the hill out of context, and another smaller burial rock shelter identified.

Due to the need to minimize modern human contamination for ancient DNA analyses, all excavators were required to wear disposable gloves and face masks. The excavators were taught to switch gloves if they accidentally touched hair or skin, or if their masks gathered too much moisture.

Osteological Analysis

For the Sondor excavations, every sub-level of human remains was bagged separately so that more precise details could be observed during osteological analysis and connected back to the excavation context, including the separation of crania and articulated remains with their associated map/photo numbers. The same level of context association was not recorded in previous excavations of Cachi, Pucullu, and Ranracancha, but comparable osteological methods were used to analyze the material excavated there (Kurin, 2012; 2016). The crania from these sites were re-analyzed using the methods below when individual values could not be found to make them comparable to Sondor.

Since very few remains within all the LIP sites were articulated, the focus of this dissertation was on the analysis of crania. This prevented redundant sampling of the same individual. Once established as an adult, the age range of each crania was estimated through cranial suture closure (Buikstra & Ubelaker, 1994), dental wear (Mays, 2010), and antemortem tooth loss (Brothwell, 1981; Miles, 1963). Dental eruption and development were recorded on each juvenile crania using Buikstra and Ubelaker (1997) and Ubelaker (1989). The age ranges can be found in Table 3. Sex estimation traits were recorded using the Buikstra & Ubelaker (1994) standards, with a logistic discriminant analysis equation for Native American populations applied to the scores (Walker, 2008):

y = glabella x -0.797 + mastoid x -1.085 + 5.025
score < 0 likely male
score >0 likely female

Table 3. Age estimation ranges (Buikstra & Ubelaker, 1994).

Fetal (<birth)
Infants (birth-3 years)
Children (3-12 years)
Adolescents (12-20 years)
Middle Adult (35-49 years)
Old Adult (50+ years)

Cranial vault modifications (CVM) are the purposeful modification of the cranial vault when the bones are still malleable (Tiesler, 2014) and connected to a variety of societal associations, depending on the region (see Background). The methodology is based on visual observations, starting with determining the broader modification style (e.g., *tabular* versus *annular/circumferential*). *Tabular* is where compression is applied to the front and back of the skull with boards and pads, creating an anteroposterior flattening and bulging of the parietals. *Annular* is when the compression is done by circumferential wraps and bindings, creating expansion of the cranial vault in a tubular fashion, with no parietal expansion (Kurin, 2012; Tiesler, 2014; Torres-Rouff, 2003; Velasco, 2016). Only the *annular* style is observed in the Andahuaylas region. These categories are further divided based on where compression was placed (where the bindings are placed in the *annular* style), creating the subcategories of *circumferential/annular erect* and *oblique*. *Circumferential/annular erect* style is when the wrappings are placed on the lambda and/or inion and the frontal, which creates superior expansion, while *circumferential/annular oblique* is when the bindings are placed on the frontal and below the inion, with an expansion posterosuperior (Figure 16; Kurin, 2012). Another category recently added to this division is *slight*, which is when a cranium cannot be classified as erect or oblique, but deviates from the normal shape, which may not be intentional (Velasco, 2016). The next aspect scored for CVM is the degree of modification on the crania that are either *erect* or *oblique*, which shows the intensity and standardization of the CVM. The scores range from 1 to 4 indicating slight (1), moderate (2), prominent (3), or severe (4) modification. Inter-observer (field assistant) and intra-observer errors were recorded for a random sampling of 10 individuals and I found no significant differences in scores.

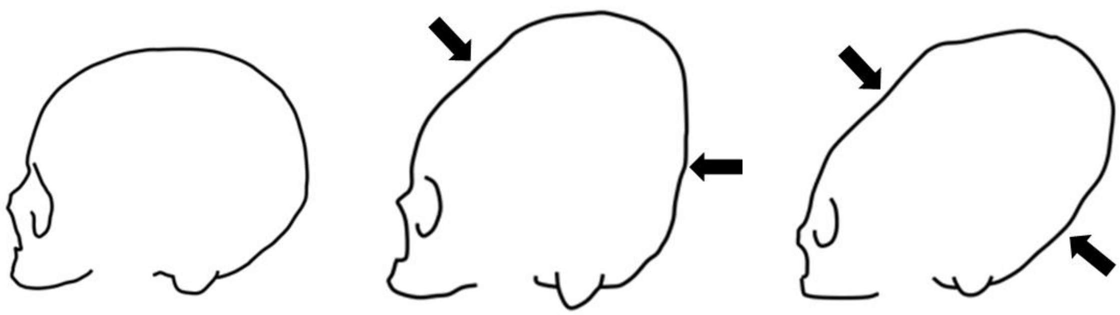

Figure 16. The figures shows an unmodified (left), *annular erect* (center), and *annular oblique* (right) cranium. Image altered from Black (2014).

Trauma was recorded after postmortem damage and taphonomic changes were recorded and ruled out as a cause. First, the type of trauma was identified, with all trauma in Andahuaylas found within the categories of blunt force trauma (BFT) or bone fractures. The degree of trauma was scored as minor, intermediate, or severe, depending on the size and depth of the trauma. Blunt force trauma was also established as antemortem (fully or largely healed), or perimortem (occurring at or around the time of death) (Symes et al., 2012).

Tooth Sample Collection

After photographs were taken and osteological analysis was completed, two teeth were taken (if available) from each cranium. Only maxillary teeth were sampled since mandibles were not always clearly associated with particular crania. This ensured that individuals were not sampled redundantly within the commingled mortuary contexts. Dental sampling was carried out by the author wearing a lab coat, face mask, hair net and nitrile gloves to prevent contamination with modern DNA. Between each sample, gloves were changed and all work surfaces and equipment were sterilized with a diluted bleach solution. Each tooth was placed within a sterile sample bag, weighed, and photographed after extraction.

Strontium and Oxygen Isotope Analysis

Strontium ($^{87}Sr/^{86}Sr$) and oxygen ($\delta^{18}O$) isotope analyses were used to observe human mobility patterns by providing estimates of the number and geographic origins of first-generation migrants. $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values are varied and well-documented throughout the Andes (Dahlstedt et al., 2021; Knudson & Price, 2007; Knudson & Torres-Rouff, 2009; Knudson et al., 2009; Knudson et al., 2012; Knudson et al., 2013; Turner, 2021). The methods are complementary, and when used together, they can provide more robust estimates of the number and geographic origins of first-generation migrants (Balasse et al., 2002; Bentley, 2006; Knudson & Price, 2007; Wright, 2012).

Although $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ can be measured in bone apatite, tooth enamel is the preferred skeletal material to analyze since it is mainly resistant to diagenetic alteration (Budd et al., 2000; Hoppe et al., 2003). Tooth enamel also does not remodel significantly after it is formed, so $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ in teeth reflect local strontium ratios incorporated when the tooth was formed. This allows for identifying individuals who migrated after early childhood (Ericson, 1985). In this study, isotopic analyses were restricted to samples of tooth enamel. When available, second and third molars were sampled to avoid elevated trophic levels for oxygen values from breastfeeding (Wright, 1999; Wright & Schwartz, 1998). However, if other teeth, such as first molars, had to be sampled, then those individuals were checked for elevated $\delta^{18}O$ values, but no adjustments were needed (they all fell well within local range).

International reference standards as well as replicate $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ analyses of human tooth enamel (n=10) were run to establish analytical accuracy and precision. $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values were previously published for some individuals at Cachi, Ranracancha, and Pucullu (Kurin, 2012, 2016; Lofaro et al., 2018). These values are recorded and matched with those sampled for ancient DNA. Additional $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ samples were gathered from individuals without published values to directly match them with ancient DNA results. There are no $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values for Sondor, so all individuals were sampled, when teeth were available, making a total of 74 individuals sampled for isotopes in this dissertation (Table 4).

Table 4. Number of human individuals to be sampled for genetic and isotopic analysis. Genetic and isotopic datasets overlap with both aDNA, Sr, and O isotopes being analyzed from the same 90 individuals

		# of Individuals		
Site	**Context**	**aDNA (this study)**	**$^{87}Sr/^{86}Sr$ & $\delta^{18}O$ (this study)**	**$^{87}Sr/^{86}Sr$ & $\delta^{18}O$ (available data from previous studies)[a]**
Cachi	Mina sector	13	8	5
	Sonhuayo	29	27	2
Pucullu	--	8	4	4
Ranracancha	--	13	7	6
Sondor	Muyu Muyu	23	23	-
	Suyturumi	4	5	-
		90	**74**	**17**

[a] Published data from Kurin (2012) and Lofaro et al. (2018) available for the same individuals being analyzed for aDNA.

To supplement existing sources of local and regional $^{87}Sr/^{86}Sr$ variation (e.g., Knudson et al., 2013; Kurin et al., 2016; Lofaro et al., 2018), I analyzed ten archaeological rodents (mouse, guinea pig) from the site of Sondor. Rodents have limited home ranges and frequently consume discarded human food, so they can serve as a proxy for expected local human values. Expected local ranges for other study sites have been previously established (Kurin et al., 2016; Lofaro et al., 2018). Non-local humans were identified through comparison with expected baseline $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values and "trimmed" datasets (as in Knudson and Tung, 2011; Kootker et al., 2019; Wright, 2005).

Tooth enamel processing, preparation, and pretreatment was done within the WSU Department of Anthropology Stable Isotope Lab (Dr. Erin Thornton, supervisor). Samples were manually cleaned with a toothbrush then mechanically cleaned under 10x magnification with a fine dental drill (170 taper fissure carbide drill bit). After the initial cleaning, samples of 20-30 mg were removed from the crown surface of tooth under magnification with a dental drill and further cleaned with the drill to remove any adhering dentine. To prevent contamination across samples, dental drill bits were changed between samples, and the surface area and drill handle was cleaned with ethanol.

Using the standard protocols described in previous publications (Thornton et al., 2016; Thornton, 2011), the clean enamel pieces were pretreated for 30 minutes in a 5% acetic acid solution to remove post-depositional contaminants and rinsed to neutral with 4x distilled water (Koch et al., 1997; Nielson-Marsh & Hedges, 2000; Price et al., 1992; Sillen & Sealy, 1995). Once dry, the samples were brought to the WSU Radiogenic Isotope and Geochronology Laboratory (RIGL, Dr. Jeff Vervoort, supervisor) for column chemistry and mass spectrometry in a class 1000 clean lab to prevent sample contamination.

The Sr samples were prepped in RIGL via digestion in 8M nitric acid (HNO_3) and then dried in a convection oven. After digestion, samples were loaded into columns containing Eichrom Sr resin. Samples were washed multiple times using 3M HNO_3 until only Sr remained within the columns. To unbind and collect the Sr molecules from the resin, 0.5M HNO_3 was used for elution. Sample $^{87}Sr/^{86}Sr$ was measured using a Thermo Scientific Neptune Plus MC-ICPMS housed in the WSU RIGL. Multiple samples of strontium standard NBS-987 were run to confirm instrument accuracy.

Chemical processing of the $\delta^{18}O$ samples was conducted in the WSU Department of Anthropology Stable Isotope Prep Lab. Each enamel piece was soaked a 2% bleach solution to remove humic acids and organics (Balasse et al., 2022; Bentley et al., 2005; Koch et al., 1997). The samples were then rinsed to neutral before soaking in 0.1M acetic acid to remove diagenetic and secondary carbonates. Samples were again rinsed to neutral with deionized water and then freeze dried to remove excess moisture. Sample $\delta^{18}O$ was analyzed in the WSU Stable Isotope

Core facility (Dr. Dave Evans, supervisor) using a ThermoFinnigan Gasbench II coupled to a DeltaPlus XP Isotope Ratio Mass Spectrometer.

Ancient DNA

Ancient DNA Data Generation

A large issue in ancient DNA work is contamination. To lessen this in the field, excavators used gloves and facemasks. The DNA extractions and the subsequent enrichment and sequencing of 1,240,000 genome-wide Single Nucleotide Polymorphisms (SNPs) relevant for population genomic analyses were split between the Harvard Reich Lab (63 samples) and the UCSC Human Paleogenomics Lab (27 samples) with Dr. Lars Fehren-Schmitz, per the agreement with the funding agency, the the National Geographic Society.

The DNA extractions at the UCSC Human Paleogenomics were done either through a silica-column-based protocol (Dabney et al., 2013) or minimally destructive extraction (Harney et al., 2021). The destructive silica-column-based extraction begins with a pre-digestion of 80mg of tooth powder in a 0.5% sodium hypochlorite solution followed by multiple washes with 1 ml molecular grade H_2O (Boessenkool et al., 2017). Subsequently, the bone powder is demineralized in 1 ml of lysis buffer (980ul of 0.5M EDTA, p.H. 8, and 20ul of 20 mg/ml ProteinaseK) overnight under constant rotation at 37C. The minimally destructive extraction method does not remove any part of the tooth but instead involves wrapping the crown in UV-irradiated parafilm and placing the root in 1 ml of the aforementioned lysis buffer. The silica-column-based lysate purification follows the same steps as the powder samples (Dabney et al., 2013; Harney et al., 2021). Both extraction methods had two negative controls to estimate contamination during clean lab procedures. To reduce potential bias resulting from DNA damage, a partial uracil-DNA-glycosylase (UDG) treatment of the extracts was used to remove all internal damage from the DNA molecules while retaining damaged in the terminal nucleotides (Rohland et al., 2015). Latter allows us to observe if the molecules exhibit damage patterns characteristic of ancient DNA, which serves as authentication criterium.

Dually indexed single-stranded DNA (ssDNA) sequencing libraries were built from the UDG-treated ancient DNA extracts using directional splinted ligation from Illumina's P5 and P7 adapters. This process uses one reaction to combine single-stranded DNA (ssDNA), and heat-denatured double-stranded DNA into sequencing libraries (Kapp et al., 2021). Each batch also had two blanks with libraries built for them. The library building success was tested using a High-Sensitivity DNA Assay on Agilent 2200 TapeStation (Agilent Technologies, Inc.; Santa Clara, CA, USA). After quantifying the DNA concentration for each library using a Qubit 4 fluorometer, the libraries were pooled and sequenced on the Illumina HiSeq 500 sequencer.

At the David Reich Lab (Harvard Medical School), extractions were performed with comparable protocols. Double-stranded DNA (dsDNA) partially-UDG treated sequencing libraries were built from the DNA extracts using the protocol described by Rohland et al. (2015).

Both dsDNA and ssDNA libraries that showed the damage expected from aDNA, and had at least 0.5% of endogenous human DNA, were used for target enrichment. Preservation was high at the sites, with a success rate of 35/42 at Cachi, 8/8 at Pucullu, 13/13 at Ranracancha, and 21/24 at Sondor. At Harvard and UCSC, the successful libraries were subsequently enriched for 1,240k ancestry informative genome-wide SNPs (Fu et al., 2015) using the TWIST Ancient DNA in-solution hybridization assay. The enriched libraries were sequenced on the Illumina HiSeq 4000 (Illumina, Inc., San Diego, CA, USA). The 75 single-end-run cycles were output and de-multiplexed using bcl2fastq version 2.17.1.14 (Illumina conversion Software) and dnaclust version 3.0.0 (Ghodsi et al., 2011).

Ancient DNA Data Analysis

The de-multiplexed sequence reads were processed with the UCSC-PGL computational pipeline (Nakatsuka et al., 2020; https://github.com/mjobin/batpipe, v1, 05/10/2021). Used for all aDNA from UCSC, the process clips adapters, merges paired-end reads (default parameters), maps sequencing reads against a user-specified reference genome, removes duplicate reads, and estimates quality traits. Residual adaptor sequences were trimmed and merged using BC_bin_clip (https://github.com/svohr/bc_bin_clip, v1. 015b4dc, 10/02/2022) and SeqPrep 2 (*64*) (https://github.com/jeizenga/SeqPrep2, v2, 10/02/2022), with a minimum overlap of 11 base pairs needed to merge paired-end reads. Sequencing reads were mapped using the Burrows–Wheeler Aligner (BWA) version 0.7.12 (*65*), disabling seeding (-l 16500, –n 0.01) against UCSC genome browser's human genome reference GRCh37/hg19. Duplicates were removed with DeDup version 0.12.2 (*66*), which removes reads with identical start and end coordinates. A mapping quality filter of 30 was further applied using SAMtools version 1.3.

Authentication

Contamination rates were determined using Contammix (Fu et al., 2013) and ANGSD (Korneliussen et al., 2014). Contammix estimates mitochondrial contamination rates with the recommended parameters (Fu et al., 2013). To estimate contamination for biological males, ANGSD looks at the rate of heterozygosity on the X-chromosome (Korneliussen et al., 2014). The contamination rates of individuals in this study were low (<3% mitochondrial; <1% chromosomal). The rates show that the genomic data is authentic. In addition, the expected patterns of DNA damage were observed using MapDamage2 (Jónsson et al., 2013). The individuals used had damage rates at the read termini at >3%, which is typical for aDNA.

Genetic Relatedness

Establishing pairwise biological relatedness was done by observing identity by descent (IBD) segments within and between burial contexts and sites using Relationship Estimation for Ancient DNA (READ) (Kuhn et al., 2018) and Kinship INference (KIN) (Popli et al., 2023), both good with low coverage DNA. Using the recommended parameters, READ uses pseudo-haploids (randomly sampled allele and SNP site for each individual) to compare normalized rates of non-matching alleles for each pair of individuals, therefore providing the proportion of normalized shard alleles. READ can establish relatedness for first-degree (parent-offspring/sibling) and second-degree (nephew/niece/uncle/aunt) relationships (Kuhn et al., 2018). KIN uses a hidden Markov model (HMM) to estimate relatedness and IBD, while also identifying runs of homozygosity (ROH) and contamination estimates so the results are accurate. KIN makes pairwise comparisons for rates of shared IBD for large genomic windows (10 Mb) and uses likelihood estimates to establish the highest likelihood of relatedness. KIN can estimate relatedness for fifth, fourth, and third-degree (Popli et al., 2023). Therefore, when used together, READ and KIN provides first through fifth-degree relatedness. The degree of parental relatedness will also be analyzed using the frequency of long runs of homozygosity (Ringbauer et al., 2020).

Principal Components Analysis

To explore the broader regional associations, we used a principal components analysis (PCA) with *smartpca* in EIGENSOFT (Version 1.6; Patterson et al., 2006). The parameters were set to default (inbreed: YES; lsqproject: YES; shrinkmode: YES), with the PCA including the populations from the current study and un-admixed South American groups. The PCA allows us to visualize the populations the study sites group with more closely, including populations from the Amazonia, Peru Central Coast, Peru North Coast, Peru South Coast, North Peru Highlands, South Peru Highlands, and Titicaca Basin. Only individuals with at least 20,000 SNPs were included in the PCA plot.

Cluster Analysis Using ADMIXTURE

Cluster analysis was done with the ADMIXTURE algorithm, a model-based unsupervised population cluster analysis. The analysis takes the allele frequencies of all individuals and assigns them a cluster (ancestry). This is based on the number of distinct ancestries (K) you input, such as K=2 dividing the dataset into two populations, K=3 into three, and so on. First, the data has to be placed in the PLINK-Bed format file structure (.bed, .bim, .fam). ADMIXTURE was employed using K=2 through 10 with 5 and 15 repetitions. The ADMIXTURE further broke down the specific mixtures of population associations that were broadly observed in the PCA.

Genetic Homogeneity

We performed four-population (F4) tests to determine the genetic homogeneity within each site or context by looking to see which individuals had associations (admixture) with other populations. F4-tests measure the degree of shared ancestry by looking at correlations of allele frequencies between an individual and another individual from the study compared to a list of more distant populations and an out-group (shared ancestor to all). The qpDstat package in ADMIXTOOLS (Patterson et al., 2012) was used to test admixture. The F4-tests show if the individual has any affinity towards one of the compared populations over the other individual (Patterson et al., 2012). For the F4-statistics of the type f4(Outgoup, X; Ind1, Ind2), we choose (African population) as the outgroup, and X was either of any of the Andean geographic ancestry groups defined by Nakatsuka et al. (2020) – e.g., South Peru Highland, South Peru Coast, Central Peru Coast, North Peru Highland, North Peru Coast, Titicaca Basin, North Chile – or Amazonian groups like Piapoco, and Chane. We further added individuals from England to observe access allele sharing that could indicate contamination. F4-tests were also run for all individuals in each context and site (Ind1, Ind 2). The results of the individual F4-tests were used to separate the sites or contexts into different populations for the rest of the analyses.

F3 Analyses

Three population (F3) tests also measure allele frequency correlations to see if the outgroup population is admixed with two test populations and if there is a shared drift between the two test populations from the outgroup population (Patterson et al., 2012). Overall, F3-tests can be used to explore the relatedness between your test population and other populations to form hypotheses that can be tested in more detail with F4-tests. Outgroup-F3 statistics were employed with 1240K SNP data for ancient and modern Andeans (Barbieri et al., 2019; Lazaridis et al., 2014; Nakatsuka et al., 2020; Skoglund et al., 2015). The statistic was run with Mbuti as the outgroup, with study site populations (determined through the above-mentioned F4-tests) compared to the list of South American populations (Mbuti; Pop1, Pop2). A matrix of outgroup-F3 values between all pairs of populations was converted to distances by creating an inverse of the matrix with one divided by the F3 value (1/F3). The new matrix was placed into the program Past version 4.13 (Hammer et al., 2001) to run a multivariate clustering neighbor-joining (NJ) analysis. A NJ tree was created with the Past 4 outputs using FigTree (http://tree.bio.ed.ac.uk/software/).

The F3-statistics were also run for several modern-day South- and Central American groups using the SNPs overlapping with the Affymetrix Human Origins dataset (~500k SNPs) The resulting F3-values for each genetic group reported in this study were visualized as heatmaps using an R software program (https://github.com/pontussk/point_heatmap, v1, 05/02/2022).

Admixture modeling (F4, qpWave, qpADM)

Similar to the individual-based F4-tests, F4-tests were also run on populations (one established with individual F4-tests) using the qpDstats, qpWave, and qpADM packages in ADMIXTOOLS (Patterson et al., 2006) to look for admixture. First, the study sites were compared to other ancient and present-day populations by using the qpDstat (v970) package in ADMIXTOOLS with f4mode: /yes, and printse: YES parameters. *SEs were computed using a jackknife block size of 0.050.?* The F4-tests here provide the same allele frequency results as the individual F4, just at the population level.

To gain more insight as to whether the populations we created using the individual F4-tests can be established as one ancestry, we used qpWave (v1200) from ADMIXTOOLS (Patterson et al., 2012). Overall, the package determines the minimum number of ancestry sources for each group of individuals using ancient and modern populations. The Reference Groups are basal, or the root to the populations being tested, to see if the populations being tested are consistent with one wave of ancestry ($p>0.5$; rank 0) when compared to other regional Andean ancestry clusters found in Nakatsuka et al. (2020) or non-Andean South Americans. The default settings were used for the qpWave analyses except for allsnps: Yes. The test will show whether the populations within Andahuaylas are all related from one move to the region or if there were other admixture events.

The groups that were found to have more than one wave of ancestry were run through the qpADM package in ADMIXTOOLS (Patterson et al., 2012) to test 2-way and 3-way admixture models. The models will establish how many waves of admixture occurred. This was done using the rotating model approached in qpADM_wrapper (https://github.com/pontussk/qpAdm_wrapper, v1, 03/12/2022) (Skoglund et al., 2017). The rotating approach moves the Source set (our populations) to the Reference populations from Nakatsuka et al. (2020) and other ancient and modern-day populations from the Amazon, Southern Cone, and Central America. There are 120 tested models for each group for the 2-way models. The parameters were set to details: YES, to obtain the customarily distributed Z-score for the best fit.

The materials and methods were selected to answer my questions about community composition and change over time from the individual to regional level. The next chapter begins this process and covering the osteological findings and how that is significant for understanding the context of these communities through time.

CHAPTER 5 - OSTEOLOGICAL ANALYSES

Analysis of human remains can establish mortuary population demographics (e.g., sex, age at death) and rates of pathology and trauma. This informs our understanding of past events (e.g., evidence of warfare, disease, famine or migration), and how archaeological societies chose to group their deceased as material expressions of their social organization and religious beliefs. Antemortem skeletal modifications, such as intentional cranial and dental shaping, can also provide information regarding an individual's status or group identity. Within this dissertation, osteological analyses are combined with isotopic and genetic data to reconstruct aspects of group or social identity and community composition during the LIP in Andahuaylas, Peru. This chapter summarizes the osteological analyses, which will be referenced in later chapters to interpret the isotopic and genetic results.

Cranial Vault Modification and Identity

A distinct form of identity or social association that the Chanka adopted during the LIP was the use of cranial vault modifications (CVM). CVMs may be employed when there is a need to quickly and visually display ethnic or social affiliations due to external pressures, whether they be environmental, political, or both (Tiesler, 2014). Throughout the Andes, CVMs were employed by pre-Hispanic societies to delineate and visually communicate various aspects of identity including status, gender, occupation, kinship, and geographic region (Blom, 2005; Knudson & Blom, 2009; Hoshower et al., 1995; Lozada et al., 2011; Torres-Rouff, 2003, 2008; Velasco, 2018). Changes to rates and styles of CVM within past societies also may be indicative of broader socio-political changes and/or migration. For example, Torres-Rouff (2002, 2003,

2008) asserts that we should observe greater homogeneity in CVM within larger-scale societies, such as empires and expansive state systems, due to more centralized decision-making and broader pan-regional systems of occupational or status-based distinctions. Torres-Rouff tested this in Chile at San Pedro de Atacama, which had interactions with the Tiwanaku polity during the Middle Horizon. In their case study, CVMs showed a higher degree of homogeneity during the Middle Horizon than in the Late Intermediate Period (LIP), when the society broke up into smaller regional groups after the collapse of the Tiwanaku state (Torres-Rouff, 2008; Torres-Rouff et al., 2013). A more recent study done by Velasco (2018) further documents how temporal changes in CVMs reflect periods of social and ethnic identity reorganization during periods of socio-political change. Within the Colca Valley, Peru, there was a shift towards greater homogeneity (standardization) in CVM from the early to late LIP, which corresponds to a period of social reorganization followed by greater consolidation of ethnic boundaries (Velasco, 2016, 2018). These studies emphasize how CVMs in mortuary populations can be used to infer changes to ethnic, status or kinship-based definitions of identity in past populations. When a community begins to solidify their ethnic identity, kinship boundaries, and what is considered as "other," we should expect to see stronger and more standardized signals of these cultural indicators (Barth, 1969; Blom, 1969). Patterns of CVM heterogeneity have also been used to document past migration in Andean societies. At the state capital of Tiwanaku, a diversity of region-specific CVMs observed in the mortuary population indicated possible migration into the capital from outlying regions (Blom, 2005; Knudson & Blom, 2009). Similar observations of CVM diversity were used by Andrushko (2007) to document in-migration into the Inca capital of Cuzco during the Late Horizon. Previous research thus supports the use of CVMs to make inferences regarding migration and the reorganization of communities' ethnic, social or political identities.

The Chanka used the *annular* style of modification. The modifications were not standardized and reveal heterogeneity (Black & Kurin 2021; Kurin 2016), following patterns seen for small-scale societies without modification specialists (Torres-Rouff, 2003). Kurin (2012, 2016) conducted a detailed analysis on trauma and cranial modification styles for early LIP Chanka sites. Kurin found variation in two distinct styles, *annular erect* and *annular oblique*, where head wrapping would have to continually be placed on different regions of the cranium. The distinct styles provide evidence of choices made by the Chanka to display different affiliations (Kurin, 2016). Kurin (2012; 2016) found that unmodified and different types of modifications were mixed within LIP Chanka *machays*, but that the frequencies of modified versus unmodified varied among sites. At the upper moiety site of Cachi, 75% of individuals exhibited CVMs, while at the lower moiety site of Ranracancha, all individuals had cranial modifications. At the site of Pucullu, which was possibly associated with the Quichua *ayllu* or a separate cultural group, only 62% of individuals exhibited CVMs. Kurin argues that the modification styles were attached to the different kin categories of *Piwi* (lower and higher status) and *Wakcha* (non-local and lower status). Overall, the modified individuals had higher rates of trauma than the unmodified individuals, perhaps due their attachment to certain resources, but this cannot be directly connected to specific social groupings or *ayllus* through the archaeological record (Kurin, 2016). However, these patterns are similar to previous studies connecting CVM style to situational social boundaries (e.g., Velasco 2018). The cranial modification styles at the late LIP of Sondor will be included in this dissertation, but a broader study needs to be completed to look at regional changes across time periods.

One difference explored within the Chanka *ayllus* (Hanan and Hurin) is occupation. Studies in other regions show community divisions based on pastoral and agricultural activities in agro-pastoral societies (Capriles and Tripcevich, 2016; Kellett, 2010; Lane, 2006; Masuda et al., 1985; Parsons et al., 1997, 2000). For example, in the Colca Valley, the upper and lower valleys were divided into pastoralists and agriculturalists, with different forms of cranial modifications used between them (Velasco, 2018; Velasco & Tung, 2021). In Andahuaylas, despite the heterogeneity in cranial modification styles within sites, there is a larger percentage of *annular erect* modifications found at the higher elevation sites (upper moiety), while lower elevation (lower moiety) sites have higher rates of *annular oblique* modifications (Kurin, 2016). Upper elevation sites may be connected to herding, while lower are connected to farming. However, a survey in 2019 (Berrocal and Kellett, 2019) did not show any significant differences in architecture (like corrals) or ceramic styles between the upper and lower elevation sites (Bauer et al., 2010; Kellett, 2022). Kellett (2010, 2017, 2022) instead argues that, due to the need of the early LIP individuals to move into high elevation and defensible sites, they developed a community with a mixture of occupations (pastoral and agricultural) so the boundaries could be more easily contained. Termed "situational cooperation," Kellett (2022) did not observe differences in artifacts based on any *ayllu* or moiety association at the early LIP sites of Achanchi and Luisinayoc, and both had camelid corrals near the residential sectors. On the other side of the valley, he found occupations from the valley up to the higher elevations, but the settlements were continuous. He argues the patterns show that they are not fully divided into agriculturalists or pastoralists, but there is a mixture of sites (Kellett, 2022).

Previous Osteological Results from Andahuaylas

Kurin (2012, 2016) conducted the osteological analysis for the early LIP sites of Cachi, Ranracancha, and Pucullu, and the Middle Horizon (MH) site of Turpo. Kurin looked at the transition from the MH to LIP in Andahuaylas. She discovered a high rate of trauma, providing evidence from ethnohistoric texts that the Chanka (and other LIP groups) experienced a high rate of violence during the LIP (Kurin, 2012; 2016). The percentage of wounds at Cachi were 51.9%, Ranracancha 62.1%, and Pucullu 68%, with a large portion at each site being fatal. A more recent study also found high rates of violence for both sexes and stressful lives for individuals at the additional early LIP sites of Qatun Rumi and Achanchi (Jolly and Kurin, Unpublished Manuscript).

The early LIP *machays* excavated and analyzed by Kurin have MNIs of 162 for Cachi, 39 for Ranracancha, and 31 for Pucullu. The *machays* showed a combination of males and females. Cachi had a male to female ratio of 0.9:1, Ranracancha 1.1:1, and Pucullu 1.5:1. The sites also had a combination of ages, with the highest portion of age at death for Young Adults and Middle Adults. A new cultural trait that emerged during the LIP, not seen during the MH, was the adoption of cranial modification. The rate of modification goes from 0% in the MH to 76% of individuals in the LIP (Kurin, 2012). The types of cranial modifications present are *annular erect* and *annular oblique* (Black & Kurin, 2021; Kurin, 2012). Kurin (2012) also found that modified individuals had higher rates of trauma and were perhaps targeted for their visible kinship association marker.

Osteology Results

Although Kurin (2012; 2016) previously reported rates of trauma, age, sex, and cranial modifications for the sites of Cachi, Ranracancha, and Pucullu, individuals from these sites included in this dissertation were scored again by the author to make the results comparable to new data collected for the site of Sondor (i.e., to control for inter-observer variation). The MNI for the newly excavated units at Sondor are provided, along with individual scores for age, sex, cranial modification styles, and trauma for complete or partial crania to compare to the other study sites.

Sondor MNI and Age Distribution

The minimum number of individuals (MNI) was estimated for each unit and context at Sondor from the 2017 excavations (Table 5). The commingled *machay* in Unit 1, Context 1 has the most individuals (N=22), with about half juvenile (10) and half adult (12). The MNI for adults was determined using the left femur and the right humerus for juveniles, based on the largest amount of sided bones available. Unit 1, Context 2, is the Qasawirka Phase *machay* with 6 commingled juvenile remains on top of two partial juvenile individuals with MNI determined using the right humerus. Unit 1, Context 3 had one juvenile bundle with no additional parts. Unit 2 had two cist tombs, 1 with a partial juvenile and the other with 2 adult individuals. Approximately 3 commingled juvenile individuals were estimated on top of the in-context individuals, based on the size (age) of bones present. Unit 6 individuals were articulated and separated into bundles. Two individuals each were found in Context 1 and Context 4, determined using age differences between the individuals.

Table 5. The MNI for each unit excavated at Sondor in 2017.

	Unit 1 (N=31)				
	Context 1	Context 2	Context 3		
Juvenile	10	8	1		
Adult	12	-	-		
	Unit 2 (N=6)				
	Above Contexts	Context 1	Context 3		
Juvenile	3	1	-		
Adult	-	-	2		
	Unit 5 (N=7)				
	Context 1	Context 2	Context 3	Context 4	Context 5
Juvenile	1	-	1	2	-
Adult	1	1	-	-	1

The age distribution for each unit and context is displayed in Table 6. The ages are based on post-cranial remains so the maximum number of age groups could be included. However, only the age category of adult could be determined for adult post-cranial remains.

Table 6. The number of individuals found for each age group for the 2017 excavations.

	Fetal	Birth-1	1-3	4-6	6-8	14-17	Adults
Unit 1, Context 1	-	3	5	1	3	-	12
Unit 1, Context 2	2	3	3	1	1	-	-
Unit 1, Context 3	-	-	1	-	-	-	-
Unit 2	-	-	3	-	1	-	2
Unit 5	1	1	2	-	-	1	3

The differences between contexts and units are expected based on the preliminary results noted during excavations and the differences in mortuary styles. The Unit 1 Context 1 *machay* matches the rates of adults versus juveniles found by Kurin (2012) from the early LIP *machays*. Unit 1 Context 2 *machay* only has juveniles, which does not match the early LIP *machays*, but that is not a LIP cultural difference, and is instead a difference of time since it is dated to the Qasawirka Period. Unit 1 Context 3 only has one articulated juvenile, age 1-3, which is shown to be a common age of offerings when compared to the human offerings/sacrifices found in Unit 2 and Unit 5.

Unit 2 has at least two commingled juveniles ages 1-3 found on top of an articulated older juvenile (6-8 years old) in Context 1 and two adults in Context 2. The two adult males also have a juvenile (1-3 years old) found beneath them in the cist tomb. The mortuary profile and style does not match the early LIP, and it is important to note that the two males had an offering (possible *capacocha*) found beneath them.

Unit 5 shows that the individuals used in the abandonment ritual for the house were of varying age. There is no evidence of the same abandonment rituals done at other early LIP Chanka sites, such as a study done by Kellett (2010) which included excavations of households at Achanchi. When compared to the other excavations done at *Suyturumi*, however, Unit 5 is unique based on the diversity of age ranges buried beneath the floor. Another unique aspect is the mature adult male buried outside of the household with a juvenile (1-3 years old) found beneath him as a possible *capacocha* offering.

Cranial Age and Sex Distribution

The following table only includes individuals from Cachi, Pucullu, Ranracancha, and Sondor that are used for the rest of the osteological analyses (Table 7). Due to the commingled nature of most of the sites and context (except Sondor Unit 1 and 5), crania were chosen to be the prime unit of analysis and comparison because of the amount of information they provide. Juveniles were not scored for Cachi, Ranracancha, or Pucullu because they were not present in storage. Sondor includes juveniles so that there was a larger representative sample of the Sondor population.

Table 7. The number of individuals for each age group at each site, with number of juveniles (J), young adults (YA), mature adults/middle-aged (MA), and old adults (OA).

	J	YA	MA	OA	**Total**
Cachi	*	29	27	9	65
Ranracancha	*	14	6	5	25
Pucullu	*	6	4	2	12
Sondor	10	6	6	-	22

*not scored

Based on the good quality and preservation of the remains at Sondor, the absence of old adjusts may be due to the hardships experienced by individuals at Sondor in the late LIP. The Inca presence is overwhelming, and could have created inequality, or differences in access to food, not apparent in the studies for the early LIP (Kurin, 2012). In contrast to Sondor's unique age distribution, the site is similar to other regional sites according to sex distribution (Table 8). Within sites, previous work by Kurin (2012, 2016), also found that burial caves typically contained an approximately equal distribution of males and females.

Table 8. The sex distribution of the samples included in this study separated by site.

	#Male	#Female	#Indeterminate
Cachi	37	26	2
Ranracancha	15	10	1
Pucullu	8	4	-
Sondor	6	6	-

Cranial Modifications

The number of modified and unmodified crania, style of cranial modification, and degree are presented in Table 9. As expected, the rates of modification found by site matches the results of Kurin (2012; 2016). Cachi (upper moiety) has a higher degree of *annular erect* modification, with *annular oblique* and unmodified present. Ranracancha (lower moiety) has a higher degree of *annular oblique* with *annular erect* present. Pucullu has a slightly higher amount of *annular erect*, with *annular oblique* and unmodified present. In contrast, the majority of the individuals at Sondor are unmodified, with only 4 *annular erect* and 1 *annular oblique* modification present in the mortuary assemblages.

Table 9. Modification style and degree, with age and sex of the individual, for all crania included in this study separate by site.

Site	Mod	Degree	Age	Sex
Cachi	Annular	-	OA	M
Cachi	Annular	-	YA	M
Cachi	Annular	-	YA	F
Cachi	Annular	-	MA	M
Cachi	Annular	-	YA	F
Cachi	Annular Erect	-	YA	F
Cachi	Annular Erect	4	MA	M
Cachi	Annular Erect	-	-	F
Cachi	Annular Erect	3	YA	M
Cachi	Annular Erect	3	MA	M
Cachi	Annular Erect	2	OA	M
Cachi	Annular Erect	4	MA	M
Cachi	Annular Erect	3	OA	M
Cachi	Annular Erect	2	MA	M
Cachi	Annular Erect	4	OA	M
Cachi	Annular Erect	2	-	F
Cachi	Annular Erect	3	OA	F
Cachi	Annular Erect	1	OA	F
Cachi	Annular Erect	2	MA	F

Cachi	Annular Erect	3	MA	F
Cachi	Annular Erect	3	MA	M
Cachi	Annular Erect	2	MA	M
Cachi	Annular Erect	-	YA	F
Cachi	Annular Erect	3	OA	M
Cachi	Annular Erect	4	MA	M
Cachi	Annular Erect	2	YA	M
Cachi	Annular Erect	4	MA	M
Cachi	Annular Erect	3	MA	F
Cachi	Annular Erect	3	MA	F
Cachi	Annular Erect	4	MA	M
Cachi	Annular Erect	-	YA	F
Cachi	Annular Erect	2	YA	F
Cachi	Annular Erect	3	MA	M
Cachi	Annular Erect	2	OA	F
Cachi	Annular Erect	4	YA	M
Cachi	Annular Erect	3	MA	M
Cachi	Annular Erect	4	MA	M
Cachi	Annular Erect	4	YA	F
Cachi	Annular Erect	3	MA	M
Cachi	Annular Erect	3	YA	M
Cachi	Annular Erect	2	MA	F
Cachi	Annular Erect	3	MA	F
Cachi	Annular Erect	3	MA	M
Cachi	Annular Erect	2	OA	M
Cachi	Annular Erect	3	OA	M
Cachi	Annular Erect	2	YA	M
Cachi	Annular Oblique	-	YA	M
Cachi	Annular Oblique	4	OA	F
Cachi	Annular Oblique	2	YA	M
Cachi	Annular Oblique	2	YA	F
Cachi	Annular Oblique	2	YA	M
Cachi	Annular Oblique	3	MA	M
Cachi	Annular Oblique	4	MA	M
Cachi	Annular Slight	1	YA	F
Cachi	Annular Slight	1	YA	M
Cachi	Annular Slight	1	MA	M
Cachi	Unmod	-	MA	M
Cachi	Unmod	-	MA	M
Cachi	Unmod	-	MA	M

Cachi	Unmod	-	YA	M
Cachi	Unmod	-	YA	u
Cachi	Unmod		MA	F
Cachi	Unmod	-	MA	M
Cachi	Unmod	-	YA	F
Cachi	Unmod	-	MA	F
Cachi	Unmod	-	YA	M
Ranracancha	Annular Erect	3	MA	M
Ranracancha	Annular Erect	3	MA	M
Ranracancha	Annular Erect	4	OA	M
Ranracancha	Annular Oblique	3	MA	M
Ranracancha	Annular Oblique	4	YA	F
Ranracancha	Annular Oblique	3	YA	F
Ranracancha	Annular Oblique	4	MA	M
Ranracancha	Annular Oblique	4	YA	F
Ranracancha	Annular Oblique	4	-	F
Ranracancha	Annular Oblique	2	YA	F
Ranracancha	Annular Oblique	2	YA	M
Ranracancha	Annular Oblique	3	YA	M
Ranracancha	Annular Oblique	3	YA	F
Ranracancha	Annular Oblique	4	YA	F
Ranracancha	Annular Oblique	3	YA	F
Ranracancha	Annular Oblique	3	YA	F
Ranracancha	Annular Oblique	4	YA	U
Ranracancha	Annular Oblique	3	OA	F
Ranracancha	Annular Oblique	3	MA	M
Ranracancha	Annular Oblique	3	OA	M
Ranracancha	Annular Oblique	4	MA	M
Ranracancha	Annular Oblique	4	OA	M
Ranracancha	Annular Oblique	4	MA	M
Ranracancha	Annular Oblique	3	YA	M
Ranracancha	Annular Oblique	4	YA	M
Pucullu	Annular Erect	2	MA	M
Pucullu	Annular Erect	2	MA	F
Pucullu	Annular Erect	2	YA	F
Pucullu	Annular Erect	3	OA	M
Pucullu	Annular Erect	3	YA	F
Pucullu	Annular Erect	4	MA	M
Pucullu	Annular Oblique	2	MA	M
Pucullu	Annular Oblique	3	YA	M

Pucullu	Annular Slight	3	YA	M
Pucullu	Unmod	-	YA	F
Pucullu	Unmod	-	YA	M
Pucullu	Unmod	-	OA	M
Sondor	Annular Erect	4	MA	M
Sondor	Annular Erect	4	YA	M
Sondor	Annular Erect	1	MA	M
Sondor	Annular Erect	1	YA	M
Sondor	Annular Oblique	2	YA	F
Sondor	Unmod	-	MA	F
Sondor	Unmod	-	YA	F
Sondor	Unmod	-	MA	F
Sondor	Unmod	-	4-6 years	-
Sondor	Unmod	-	1-3 years	-
Sondor	Unmod	-	MA	F
Sondor	Unmod	-	MA	M
Sondor	Unmod	-	YA	F
Sondor	Unmod	-	YA	M

All of the early LIP sites (Cachi, Ranracancha and Pucullu) show similar rates of modifications between males and females (Table 10). However, at Sondor, although most individuals are unmodified, males and female differ in their CVM style with males (N = 4) having *annular erect* modifications, and females (one individual) having *annular oblique* modifications. The lack of additional females from Sondor with CVM, however, weakens the strength of this observation.

Table 10. The rates of unmodified and modified individuals, with style of modification, separated by context and sex.

Cachi	Sex
5 Annular	3 M, 2 F
41 Annular Erect	25 M, 16 F
7 Annular Oblique	5 M, 2 F
3 Annular Slight	2 M, 1 F
10 Unmod	6 M, 3 F, 1 U
Ranracancha	
3 Annular Erect	3 M
22 Annular Oblique	11 M, 10 F, 1 U
Pucullu	
6 Annular Erect	2 M, 3 F
2 Annular Oblique	2 M
1 Annular Slight	1 M
3 Unmod	2 M, 1 F
Sondor	
4 Annular Erect	4 M
1 Annular Oblique	1 F
9 Unmod	2 M, 5 F, 2 U

Comparing Sondor to the other early LIP sites, there is a decrease in the use of cranial modifications overall. The assessment is supported by the fact that fewer adult individuals are modified, and the fact that no juvenile crania are modified. Not modifying the crania of the next generation may have been a purposeful choice based on the changing social and political landscape of the region in the late LIP. There are also differences in rates of modification based across burial contexts at Sondor. The Unit 1, Context 1 *machay* includes individuals with both *annular erect* (N=2), and *annular oblique* (N=1) modifications, and individuals with unmodified crania (N=6). This a mixture is similar to early LIP sites in the region, but different due to the increase in unmodified individuals present. In Unit 2, the two male adults found in the second cist tomb both have prominent *annular erect* modifications. The style is noteworthy since it is a more common style found at higher elevations in the early LIP, which matches the use of a higher elevation mortuary style. And finally, in Unit 5, none of the individuals have cranial modification. The selection of unmodified individuals to use in the abandonment ritual may have also been purposeful in representing the change of society.

Trauma and Trepanation

The frequency of trauma and trepanations by site is presented in Table 11. All ante- and perimortem trauma was from blunt force trauma (BFT), except for one case (mentioned below). Kurin (2012) found that the majority of the individuals from Cachi, Ranracancha, and Pucullu experienced trauma, whether it be antemortem, perimortem, or both. At Sondor, with a total of 22 individuals scored for trauma, only 4 individuals have antemortem, and 4 have perimortem, showing much lower rates of trauma at Sondor.

One special case of trauma are the two males buried together in the second Unit 2 cist tomb. The mature adult male (SOD-2-1) has perimortem BFT trauma from the right parietal to coronal suture, sharp force trauma posterior of the same area, sharp force trauma on the right mandibular ramus, and BFT on the lower occipital. In addition, this individual has antemortem BFT on the bregma and right parietal. The young adult male (SOD-2-2) has perimortem BFT on the occipital at the lambda. SOD-2-1 lived a violent life, perhaps indicative of being a warrior during the transition from the early to late LIP (dated to calAD 1235-1275), and both died from BFT to the head. The violent death, matching cranial modifications, and unique burial context may have indicated their importance in society making them a target for violence.

Another noteworthy trauma case is the unmodified adult male buried outside of the house structure in Unit 5 (SOD-5-1). This individual also has BFT to the posterior right parietal. The male has a child burial below him, similar to the possible child sacrifice found below the two male individuals in Unit 2. He may have also been a target for violence due to a prominent status near or at the time of abandonment (dated to calAD 1270-1310).

The fourth individual with perimortem BFT trauma is an unmodified mature adult female buried in the Unit 1, Context 1 *machay* (SOD-1-9). The BFT is to the left temporal/parietal. She also has the only case of scraping trepanation found during excavation, which shows evidence of minimal healing. Her violent death warrants her for further investigation with the other methods.

In addition, the use of trepanation drastically decreases when taking into consideration the ratio of individuals with and without it at Sondor (1:22). The drop may correspond to the decreased rate of cranial trauma, which decreases the need for trepanations. The high rates of trauma in the early LIP were determined to be from different groups fighting over resources in Andahuaylas (Kurin, 2012). If the Inca moved large populations out of the area, and began to control the distribution of resources in the region during the late LIP, then less violence would be present between groups.

Table 11. The rate of cranial trauma and trepanations found in each context, including the number of individuals without trauma.

	Cachi	Ranracancha	Pucullu	Sondor
Antemortem BFT	35	6	5	4
Perimortem BFT	7	7	0	4
Trepanation	3	2	2	1
None	22	5	5	4

Osteology Discussion

Each of the 2017 excavated units at Sondor is a snapshot of a different type of event occurring in the late LIP. Unit 1, Context 1 *machay* provides results similar to the early LIP *machays* excavated by Kurin (2012), seen in both mortuary style, number of individuals, and a mixture of age and sex. The Unit 1, Context 2 *machay*, is unique because it is dated to the Qasawirka, but also because only juvenile remains are present, with a variety of juvenile ages. Unit 1, Context 3, is an isolated sacrified juvenile individual (1-3 years old). Units 2 and 5 are not comparable to the early LIP sites excavated by Kurin (2012). In Unit 2, the focus is the two fully articulated adult individuals in the second cist tomb, one middle-aged male and a young adult male, and the juvenile (age 6-8 years old) in the other cist tomb. Above the two cist tombs are commingled remains of at least two juvenile individuals, both 1-3 years old, and one juvenile found underneath the two male adults. Finally, Unit 5 is also unique since the individuals were articulated and placed separately underneath the floor with rocks around them, but are not full cist tombs like Unit 2. The individuals within the household consist of two young adults, one male and one female, and 3 juveniles (1 fetal, 1 birth-1 years old, and 1 between 1-3 years old). From western standards, it appears like a family unit. Outside of the house however, a middle-aged adult male was found, with a 1 to 3-year-old juvenile as an offering underneath him.

Compared to the early LIP, the rate of trauma and use of cranial modifications drops during the late LIP at Sondor. With lower rates of conflict, there is also far less need for trepanations at Sondor. No children found at Sondor have the beginning of cranial modifications being implemented on their crania, showing a shift in the use of this highly visible form of social association and kinship. The mature adult male in the Unit 2 cist tomb has CVM and large amount of antemortem trauma. He is perhaps an example of the shift from the early LIP lifestyle, to the patterns seen for the late LIP with unmodified individuals and less violence. The decrease in violence and use of modifications is likely tied to the Inca exercising some form of social control at Sondor by the late LIP, beginning around 1250-1300 AD. An indicator of potential hardship associated with the shift to Inca influence or control at Sonor is the rate at which children are present in the mortuary record and the lack of old adults. This demographic shift in the mortuary population may indicate that people did not make it to old age. Finally, Unit 5 shows us that eventually, the negotiations and interactions between the Chanka and Inca at Sondor ended with the abandonment of the site.

With the osteological analysis alone, we see that differences arise between communities and through time. The next chapter will incorporate rates and patterns of migration to better explore and understand the complex results of burial unit composition.

CHAPTER 6 - ISOTOPIC ANALYSES

Being able to reconstruct past human migration patterns is important for addressing archaeological questions regarding the interaction of communities and societies and social boundary construction. Strontium ($^{87}Sr/^{86}Sr$) and oxygen ($\delta^{18}O$) isotopes provide estimates of the number and geographic origins of first-generation migrants in the Andes since $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values are varied and well-documented throughout this region (Dahlstedt et al., 2021; Knudson & Price, 2007; Knudson & Torres-Rouff, 2009; Knudson et al., 2009; Knudson et al, 2012; Knudson et al., 2013; Turner, 2021). These two isotopic indicators are commonly used together to obtain more robust results since each suffer from problems of equifinality when potential source regions overlap in $^{87}Sr/^{86}Sr$ or $\delta^{18}O$ due to similar geology or meteoric water conditions, respectively (Balasse et al., 2003; Bentley, 2006; Brown & Brown, 2011; Burton & Price, 2013; Price et al., 2002; White et al., 2004). Multi-isotopic approaches combining both $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ are thus more effective at reconstructing past migration in the South American Andes since regions less frequently overlap to both isotopic proxies. For example, two regions with similar bedrock geology will have similar $^{87}Sr/^{86}Sr$. but may be discriminated according to local $\delta^{18}O$ due to differences in hydrology and elevation or climatic conditions.

Oxygen isotopes ($\delta^{18}O$)

Oxygen isotope ratios ($\delta^{18}O$) recorded in human skeletal tissues can be used to reconstruct past migration because they vary according to a region's latitude, altitude, distance from the coast, and climatic conditions (e.g., temperature and precipitation) (Balasse, 2002; Curtis et al., 1998; Hodell et al., 2005, Sponheimer & Lee-Thorp, 1999). Generally, regions with cooler temperatures and higher elevations tend to have a higher $\delta^{18}O$ in meteoric water sources due to the preferential evaporation of lighter ^{16}O during precipitation. Conversely, regions with warmer climates and lower elevations have lower $\delta^{18}O$. As an animal eats and drinks in a particular area, the oxygen isotope composition of the water they consume, and to a much lesser extent the food they eat, is incorporated into their tooth enamel and bone hydroxyapatite as these skeletal tissues form (Longinelli 1984; Luz et al. 1984).

Within Andean South America, $\delta^{18}O$ in meteoric water sources is typically higher in warmer and/or lower elevation regions, and lower in drier, colder and higher elevation regions (Buzon et al., 2012; Chala-Aldana et al., 2018; Dahlstedt et al., 2021; Horn et al., 2007; Knudson et al., 2009; Knudson & Torres-Rouff, 2009; Marsteller et al., 2016; Milton et al., 2022; Scaffidi & Knudson, 2020; Toyne et al., 2014; Turner et al., 2021). These values range from -1.1 to -22.2 (Milton et al., 2022). Although $\delta^{18}O$ in meteoric water varies broadly with climate and elevation in the Andes, the pattern is complicated by seasonal and annual climatic variation, and the extensive movement of water across elevational zones in this steep, alpine region (Knudson 2009; Scaffidi & Knudson, 2020). This means that even nearby communities may have different $\delta^{18}O$ depending on their water source and elevation (Dahlstedt et al., 2021). Drinking water can also be affected by human beverage storage and preparation behaviors such as boiling, brewing, or the retention of water in reservoirs (Brettell et al., 2012; Daux et al., 2008, Gagnon 2015). Due to these complicating factors, combining oxygen with other isotopes such as strontium, is often essential to understanding past migration patterns (Dahlstead et al., 2021).

Strontium isotopes (87Sr/86Sr)

Strontium isotope ratios ($^{87}Sr/^{86}Sr$) typically used in human paleomobility studies vary across the landscape based on the underlying geology. Ratios of these heavy isotopes in human skeletal tissues thus reflect the local geological signature, rather than local climatic conditions. $^{87}Sr/^{86}Sr$ in skeletal tissues is also largely derived from food sources (Bentley, 2006; Burton & Price, 2013) in contrast to $\delta^{18}O$, which is primarily derived from drinking water. As an animal feeds and drinks, the $^{87}Sr/^{86}Sr$ of what they consume is recorded in their skeletal tissues when strontium (Sr) substitutes for calcium (Ca) during bone and tooth mineralization (Graustein, 1989; Likins et al., 1960). Unlike light stable isotope ratios (e.g., $\delta^{13}C$, $\delta^{15}N$ and $\delta^{18}O$), heavy strontium isotope ratios ($^{87}Sr/^{86}Sr$) are incorporated into skeletal tissues without significant fractionation (Price et al., 2002).

Strontium has four naturally occurring stable isotopes (^{84}Sr, ^{86}Sr, ^{87}Sr, ^{88}Sr), one of which is radiogenic (^{87}Sr), and can form from the decay of ^{87}Rb over extremely long timescales (^{87}Rb half-life = 48.8 billion years). In geological materials, the relative abundance of ^{87}Sr in comparison to ^{86}Sr thus varies according to a rock's age and original $^{87}Rb/^{87}Sr$ composition (Bentley, 2006; Dasch, 1969; Elderfield, 1986; Graustein 1989). Therefore, the older the geological structures, the higher the Rb/Sr and thus, higher $^{87}Sr/^{86}Sr$ (Bentley, 2006; Burton & Price, 2013).

The Andes have varied geology, so it is an ideal location for strontium isotope analyses (Andrushko et al., 2009; Knudson et al., 2013). $^{87}Sr/^{86}Sr$ isoscapes follow geological formations moving from north to south and east to west from the highlands to the coast, but the complexity of Andean geology precludes simple highland vs. coastal and north vs. south distinctions.

Instead, paleomobility studies are informed by expanding baseline research and isoscapes generated for this geologically complex region (see Scaffidi & Knudson, 2020, Scaffidi et al., 2020). Past dietary patterns also need to be considered since extensive consumption of non-local foods such as sea salt or marine fish in non-coastal communities could also affect the observed $^{87}Sr/^{86}Sr$ in human skeletal tissues (Dahlsted et al., 2021).

LIP and LH Patterns of Mobility and Interaction

Previous isotopic research suggests that the rise and fall of Andean state systems had variable effects on human migration and interaction. In some cases, major sociopolitical transitions were accompanied by extensive population movements (e.g., Knudson et al., 2004; Knudson et al., 2015; Torres-Rouff et al., 2015), while other transitions resulted in relative population stability (e.g., Buzon et al., 2012; Conlee et al., 2009; Knudson & Tung, 2011). Within Andahuaylas, the combined $\delta^{18}O$ and $^{87}Sr/^{86}Sr$ datasets thus provide critical comparative information regarding how the major sociopolitical perturbations of the Late Intermediate Period (LIP) and Late Horizon (LH) affected regional population composition and in-migration.

The early LIP is characterized as an unstable time with heightened levels of migration following the Wari collapse. Despite this, previous osteological studies in Andahuaylas do not support widespread population movement or replacement (Kurin, 2016; Lofaro et al. 2018; Pink, 2013). The current study more than doubles the number of individuals from Andahuaylas analyzed for $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ as a means of identifying first generation migrants and determining whether certain segments of the population (e.g., males versus females) were more likely to be non-local. If the early LIP population is primarily local, the cultural transitions occurring in Andahuaylas reflect rapid social reconfiguration by local populations following the Wari collapse. In contrast, if a large segment of the population is non-local, the early LIP social changes may be partially attributed to the introduction of outside influences and individuals. Determining which segments of the population are non-local will further indicate whether mass migrations occurred, or whether non-local individuals entered the region primarily through marriage (e.g., if non-local individuals are primarily female).

Towards the end of the LIP and into the Late Horizon, the Andahuaylas region was impacted by the emerging and rapidly expanding Inca state. Evidence of external Inca influence during the late LIP has been observed at Sondor (Bauer et al., 2010; Tenorio, 2021), but the extent to which observed shifts in material culture correlate to population continuity or replacement at Sondor has not yet been explored through isotopic analyses. Mortuary populations from late LIP contexts at Sondor will thus be analyzed for $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ to compare rates and patterns of migration between the early and late LIP in Andahuaylas. Evidence of greater in-migration at Sondor, in comparison to early LIP regional sites, would indicate that late LIP changes in material culture at Sondor were due to population movements associated with the changing socio-political landscape. In contrast, if rates and patterns of in-migration at Sondor are similar to the early LIP sites analyzed in this study, shifting material culture and burial styles instead reflect adoption of new cultural influences by local populations. This assessment provides insight regarding whether late LIP cultural shifts in Andahuaylas were due to direct or indirect cultural influences. The isotopic data from Sondor will also provide crucial information regarding early Inca use of population relocations for labor organization and sociopolitical control (D'Altroy, 2002). Previous isotopic studies have documented population movements associated with the Inca state (Andrushko et al., 2009; Turner et al., 2009; Turner, 2021), including the potential targeted relocation of females for gender-specific labor tasks (e.g., textile production) or specialized occupations such as *mamaconas* (female ritual specialists) (Andruhsko et al., 2009). However, the degree of population movement associated with the rise of the Inca empire varies across sites (Turner, 2021). More information is needed to determine the temporal and regional variability of Inca-associated population movement and control.

Regional Isotopic Variation: Defining Local and Non-local Ranges

Previous isotopic analyses in Andahuaylas have established preliminary local $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ baseline that can be used to interpret additional values measured in human skeletons (Kurin et al., 2016; Lofaro et al., 2018) (Table 12). This baseline data comes from a limited number of archaeological faunal samples and trimmed human isotopic datasets (as in Knudson and Tung 2011; Kootker et al. 2019; Wright 2005). The currently available baseline data for my study sites largely conforms to predicted human $\delta^{18}O$ (-10.5 to -8.1‰) and $^{87}Sr/^{86}Sr$ (0.70771 - 0.70839) for the Andahuaylas region based on geological maps, environmental zones and isoscape modelling (Chala-Aldana et al., 2018; Juengst, 2017; Mader et al., 2018; Mader et al., 2023; Marsteller et al., 2017; Milton et al., 2022; Scaffidi & Knudson, 2020; Scaffidi et al., 2020; Slovak et al., 2018; Standen et al., 2018; Standen et al., 2020; Takigami et al., 2020; Thornton et al., 2011) (Figures 17 and 18). However, $^{87}Sr/^{86}Sr$ values are slightly lower at the current study sites (when outliers are removed) (Table 12**;** .7068-0.7083) than predicted by isoscape maps, which emphasizes the need for more local isotopic sampling.

Table 12. Estimated local $\delta^{18}O$ and $^{87}Sr/^{86}Sr$ based on previous work by Kurin et al. (2016) and Lofaro et al. (2018) and Sondor faunal samples reported in the current study.

		$^{87}Sr/^{86}Sr$		$\delta^{18}O_{VPDB}$(‰)	
Site	**Count**	**Range**	**Avg**	**Range**	**Avg**
Cachi (human)[a]	9	0.7069 to 0.7078	0.7073	-10.8 to -9.1	-9.8
Cachi (fauna)[bc]	3	0.7068 to 0.7070	0.7069	-	-
Cachi (rock salt)	1	0.7078	-	-	-
Ranracancha (human)[a]	8	0.7074 to 0.7083	0.7079	-11.3 to -9.1	-9.9
Pucullu (human)[a]	8	0.7071 to 0.7077	0.7074	-10.3 to -8.5	-9.7
Sondor (fauna)[cd]	10	0.7065 - 0.7078	0.7075	-	-

[a] human means and ranges calculated with outliers removed;
[b] archaeological fauna include 1 camelid and 2 canids;
[c] $\delta^{18}O$ for fauna are not reported since dietary and metabolic differences between humans and other animals results in differential fractionation of oxygen isotopes. Faunal $\delta^{18}O$ is thus not directly comparable to humans (Sponheimer, 1999);
[d] all Sondor fauna are small-bodied, archaeological rodents

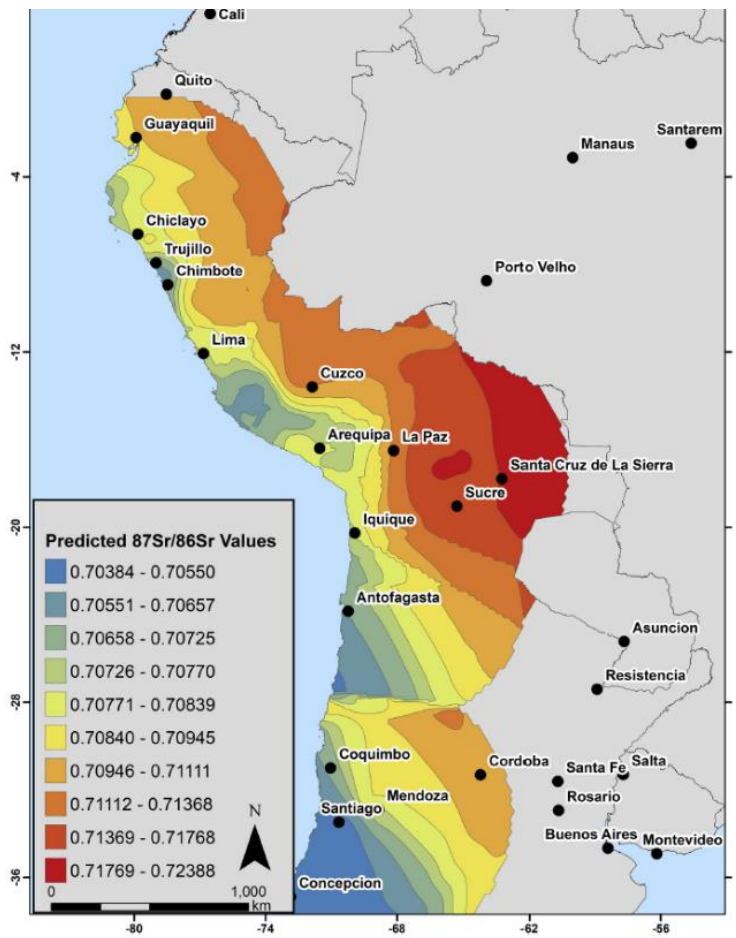

Figure 17. A predictive $^{87}Sr/^{86}Sr$ isoscape of the Andes and associated regions, taken from Scaffidi & Knudson (2020).

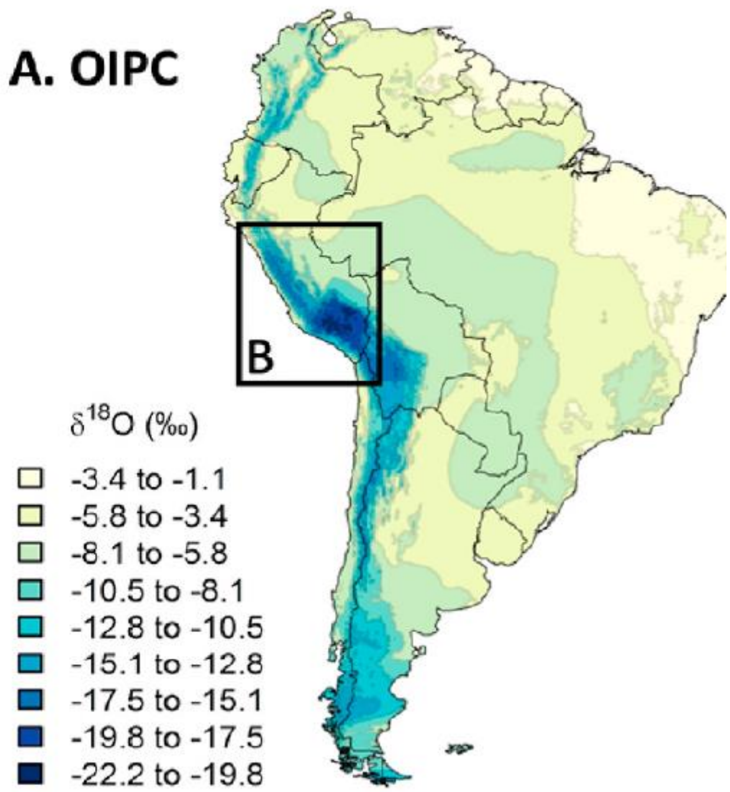

Figure 18. A precipitation map for South America with $\delta^{18}O$ values, taken from Milton et al., 2022.

Within Andahuaylas, most of the study sites are located at similar elevations and in similar environmental zones, but there is potential for inter-site variation based on the use of different water sources. Previously analyzed human skeletons (Kurin et al., 2016; Lofaro et al., 2018) provide expected local $\delta^{18}O$ for the sites of Cachi (mean $\delta^{18}O$ = -9.8‰), Ranracancha (mean $\delta^{18}O$ = -9.9‰) and Pucullu (mean $\delta^{18}O$ = -9.7‰) based on a trimmed datasets with outliers (i.e., likely migrants) removed from the sample (Table 13). The site of Sondor was not studied previously, but both Pucullu and Sondor surround a large lake called Laguna Pacucha and may reflect similar $\delta^{18}O$ values (Bauer et al., 2010). A variation that could be seen temporally for $\delta^{18}O$ is based on a sediment core taken from Laguna Pacucha, adjacent to both Pucullu and Sondor, that shows there was a severe drought that peaked ~AD 1200 during the

LIP, which would cause higher $\delta^{18}O$ values (Hillyer et al., 2009). The drought occurred directly in the middle of the LIP, so if the late LIP populations show that all individuals have an increase in $\delta^{18}O$ values, it may only be due to the drought and not migration.

Slight differences in $^{87}Sr/^{86}Sr$ across Chanka sites reflect local geological variation. Ranracancha is on a basement composed of volcanic rock and clastics from the Mitu group dated to the Late Paleozoic and Early Triassic (Marocco, 1978; Lofaro et al., 2018). Cachi and Pucullu share a similar geological formation composed of marine sedimentary rock from the Mesozoic and early Cenozoic (Lofaro, 2017; Marocco, 1978). However, Cachi is close to a rock salt formation and Pucullu overlaps with an alluvial formation from the early Holocene (Lofaro et al. 2018; Peru Carta Geológica Nacional). Sondor is expected to have $^{87}Sr/^{86}Sr$ values similar to the neighboring site of Pucullu, but its proximity to an Early Paleozoic formation from the Copacahana group and an intrusive granodiorite layer, could result in greater than expected variation between the two sites (Peru Carta Geológica Nacional).

To date, only three baseline archaeological faunal samples (2 camelid and 2 canids) have been analyzed for strontium isotopes from the site of Cachi due to a lack of available zooarchaeological samples (Kurin et al. 2016) (Table 12). Although the sampled taxa (camelids and canids) have potential for human-controlled mobility, the three baseline fauna samples have a narrow $^{87}Sr/^{86}Sr$ range of 0.7068-0.7070. This overlaps with but is slightly lower than the expected local range based on bedrock geology and previously reported human values (Kurin et al. 2016; Lofaro et al. 2018) (Table 12). Due to very narrow $^{87}Sr/^{86}Sr$ range overserved in the small number of available baseline samples, expected local $^{87}Sr/^{86}Sr$ at the study sites is based primarily on previously analyzed human skeletons from the sites of Cachi, Ranracancha and Pucullu (Kurin, 2012, 2016; Lofaro et al., 2018). Human values from the region are similar to the archaeological fauna from Cachi but have slightly broader ranges, which better approximate local bioavailable $^{87}Sr/^{86}Sr$ (Table 12). Since $^{87}Sr/^{86}Sr$ values do not yet exist for the site of Sondor, I analyzed $^{87}Sr/^{86}Sr$ in tooth enamel from ten archaeological rodents recovered from the site. Rodents have limited home ranges and frequently consume discarded human food so they can serve as a proxy for expected local human values (Bentley et al., 2004; Evans and Tatham, 2004; Price et al., 2002). Archaeological rodents at Sondor have $^{87}Sr/^{86}Sr$ ranges that overlap with other regional study sites ($^{87}Sr/^{86}Sr$: mean = 0.7075; range = 0.7065-0.7078) (Table 12).

Although the study sites vary somewhat in their isotopic means and ranges, there is broad overlap in their $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values. Isotopic analyses of archaeological humans from the study sites are thus of limited value for identifying individuals that moved between nearby communities in Andahuaylas. However, combined $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ should identify individuals who migrated into the region from more distant locales. In this regard, the current study is fairly conservative in its use of isotopic proxies to identify past human migration.

Results and Discussion

Novel $\delta^{18}O$ and $^{87}Sr/^{86}Sr$ results for 70 individuals from four Andahuaylas archaeological sites are presented in Table 13. These results are compared to previous isotopic data from three of these sites (Pucullu, Ranracancha, Cachi) (Kurin 2012; Kurin et al. 2016; Lofaro et al. 2018) to present an expanded isotopic dataset for these communities to document patterns of in-migration. Non-local individuals (i.e., isotopic outliers) are identified based on comparison with existing baseline $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ data (Table 12), and on trimmed human $^{87}Sr/^{86}Sr$ datasets following methods outlined in Wright (2005). Using descriptive statistical analysis (i.e., "trimmed datasets") of the human data is appropriate based on the limited availability of local baseline samples (i.e., floral, faunal, geological and hydrological samples) from the study sites. The presence of non-local individuals at each site skews the distribution of the isotopic values. Outliers are thus identified and removed, resulting in a trimmed dataset that more closely conforms to a normal distribution (Wright 2005:206) (Table 14). Human $\delta^{18}O$ and $^{87}Sr/^{86}Sr$ from previous studies (Kurin, 2012, Kurin et al. 2016; Lofaro et al., 2018) were pooled with my own data to calculate descriptive statistics and trimmed datasets for each site to increase the sample size available for each site. This inclusion adds 35 individuals from Cachi, 7 from Ranracancha, and 8 from Pucullu.

Table 13. Individuals sampled for $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ in this dissertation with individual values, context, sex, and CVM.

	Site	Sector	Unit/Cave	Sex	CVM	$^{87}Sr/^{86}Sr$	$\delta^{18}O$ (‰)$_{VPDB}$
MCH.01.03.11	Cachi	Mina	-	M	-	0.707405	-8.81
MPM.01.01.01	Cachi	Mina	-	F	Annular Erect	0.70744	-8.79
MPM.01.03	Cachi	Mina	-	M	Annular Erect	0.707812	-8.58
MPM.01.07	Cachi	Mina	-	F	Annular Slight	0.707534	-9.97
MPM.01.12	Cachi	Mina	-	M	Unmod	0.707027	-8.11
MPM.01.16	Cachi	Mina	-	M	Unmod	0.707064	-9.62
MPM.01.17	Cachi	Mina	-	M	Annular Oblique	0.707674	-8.66
MPM.01.18	Cachi	Mina	-	F	Annular Erect	0.707339	-8.29
SON.01.01.01	Cachi	Sonhua yo	1	F	Annular Erect	0.707207	-8.47
SON.01.01.03	Cachi	Sonhua yo	1	F	Annular Erect	0.707292	-8.35
SON.01.01.04	Cachi	Sonhua yo	1	M	Annular Erect	0.707401	-9.28
SON.01.01.05	Cachi	Sonhua yo	1	M	Annular Erect	0.707304	-9.19
SON.01.01.11	Cachi	Sonhua yo	1	F	Annular Erect	0.707318	-8.08

SON.02.02.01	Cachi	Sonhuayo	2	M	Annular Oblique	0.708017	-9.65
SON.02.02.03	Cachi	Sonhuayo	2	M	Annular Erect	0.707558	-9.20
SON.02.02.04	Cachi	Sonhuayo	2	M	Annular Erect	0.707394	-8.50
SON.02.02.10	Cachi	Sonhuayo	2	M	Annular Erect	0.707571	-11.59
SON.02.02.11	Cachi	Sonhuayo	2	M	Annular Oblique	0.707551	-8.76
SON.02.02.12	Cachi	Sonhuayo	2	F	Annular Erect	0.707157	-8.59
SON.02.03.25	Cachi	Sonhuayo	2	M	Unmod	0.709552	-8.53
SON.02.03.26	Cachi	Sonhuayo	2	F	Annular Erect	0.707433	-8.47
SON.02.03.29	Cachi	Sonhuayo	2	M	Annular Erect	0.709297	-10.64
SON.02.03.30A	Cachi	Sonhuayo	2	F	Annular Erect	0.70701	-6.93
SON.02.03.31	Cachi	Sonhuayo	2	F	Annular Erect	0.707309	-7.75
SON.02.04-1.55	Cachi	Sonhuayo	2	-	-	0.707037	-9.82
SON.02.04.2.p.58	Cachi	Sonhuayo	2	F	Annular Erect	0.707063	-9.63
SON.02.04.1.69	Cachi	Sonhuayo	2	M	Annular Oblique	0.707324	-9.51
SON.02.04.1.70	Cachi	Sonhuayo	2	M	Annular Erect	0.707288	-8.22
SON.02.04.1.71	Cachi	Sonhuayo	2	F	-	0.707245	-8.08
SON.03.01.03	Cachi	Sonhuayo	3	F	Unmod	0.706948	-
SON.03.01.06	Cachi	Sonhuayo	3	F	Annular	0.70734	-7.46
SON.05.01.05	Cachi	Sonhuayo	5	F	-	0.707615	-9.10
SON.05.01.06	Cachi	Sonhuayo	5	M	Unmod	0.707573	-9.45
SON.05.01.07	Cachi	Sonhuayo	5	M	Annular Erect	0.706932	-8.56
RCC.01.01.15	Ranracancha	-	-	F	Annular Oblique	0.70747	-9.93
RCC.01.01.19	Ranracancha	-	-	M	Annular Oblique	0.707359	-10.28
RCC.01.01.21	Ranracancha	-	-	M	Annular Oblique	0.707467	-9.86

RCC.01.01.28	Ranracancha	-	-	F	Annular Oblique	0.70749	-8.72
RCC.01.01.35	Ranracancha	-	-	F	Annular Oblique	0.707627	-9.10
RCC.01.01.39	Ranracancha	-	-	F	Annular Oblique	0.707359	-9.73
RCC.01.01.42	Ranracancha	-	-	M	Annular Oblique	0.707461	-9.84
PCU.01.01.10	Pucullu	-	-	F	Annular Erect	0.707254	-9.57
PCU.01.01.11	Pucullu	-	-	F	Annular Erect	0.707311	-8.15
PCU.01.01.12	Pucullu	-	-	M	Annular Erect	0.707636	-9.63
PCU.01.01.18	Pucullu	-	-	F	Annular Erect	0.70747	-10.16
SOD_1_C3	Sondor	Muyu Muyu	1	-	Unmod	0.708078	-9.66
SOD_1_1	Sondor	Muyu Muyu	1	F	Unmod	0.70502	-3.39
SOD_1_I1	Sondor	Muyu Muyu	1	-	-	0.707497	-8.07
SOD_1_2	Sondor	Muyu Muyu	1	F	Unmod	0.705346	-2.76
SOD_1_3	Sondor	Muyu Muyu	1	F	Unmod	0.707974	-8.47
SOD_1_I2	Sondor	Muyu Muyu	1	-	-	0.708025	-8.82
SOD_1_I3	Sondor	Muyu Muyu	1	-	-	0.706469	-8.95
SOD_1_I4	Sondor	Muyu Muyu	1	-	-	0.706309	-7.52
SOD_1_6	Sondor	Muyu Muyu	1	M	Annular Erect	0.707315	-7.98
SOD_1_C2	Sondor	Muyu Muyu	1	-	-	0.707279	-8.50
SOD_1_10	Sondor	Muyu Muyu	1	F	Annular Oblique	0.707073	-7.65
SOD_1_9	Sondor	Muyu Muyu	1	F	Unmod	0.705157	-3.26
SOD_1_7	Sondor	Muyu Muyu	1	-	Unmod	0.707316	-8.76
SOD_1_11	Sondor	Muyu Muyu	1	M	Annular Erect	0.707347	-8.97
SOD_2_I1	Sondor	Muyu Muyu	2	-	-	0.708465	-9.14
SOD_2_I2	Sondor	Muyu Muyu	2	-	-	0.706927	-8.62

SOD_2_I4	Sondor	Muyu Muyu	2	-	-	0.706584	-8.94
SOD_2_I3	Sondor	Muyu Muyu	2	-	-	0.707358	-
SOD_2_1	Sondor	Muyu Muyu	2	M	Annular Erect	0.70686	-8.86
SOD_2_2	Sondor	Muyu Muyu	2	M	Annular Erect	0.707174	-8.24
SOD_5_1	Sondor	Suyturu mi	5	M	Unmod	0.719028	-9.17
SOD_5_3	Sondor	Suyturu mi	5	F	Unmod	0.707272	-9.44
SOD_5_5	Sondor	Suyturu mi	5	-	-	0.707296	-7.80
SOD_5_7	Sondor	Suyturu mi	5	M	Unmod	0.707388	-9.15

Table 14. Calculations for $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ separated by context for the untrimmed and trimmed groups.

		Untrimmed		**Trimmed**	
Cachi		$^{87/86}Sr$ (N=43)	O18 (N= 42)	$^{87/86}Sr$ (N=40)	O18 (N= 38)
	Avg	0.7074	-9.05	0.7073	-8.89
	2 SD	0.001151	1.81	0.000536	1.3
	Range	0.7057 to 0.7096	-11.59 to -6.93	0.7068 to 0.708	-9.97 to -7.46
	Range Diff	0.0039	-4.66	0.00121	2.51
	Skewness	1.589	-0.328	0.3847	0.182
	Kurtosis	7.527	-0.774	-0.119	-0.795
Ranracancha		$^{87/86}Sr$ (N=16)	O18 (N=16)	$^{87/86}Sr$ (N=15)	O18 (N=15)
	Avg	0.7077	-9.45	0.7076	-9.31
	2 SD	0.001028	1.44	0.000485	-1.0803
	Range	0.7073 to 0.7092	-11.3 to -8.6	0.7076 to 0.7083	-10.28 to -8.6
	Range Diff	0.0018	2.7	0.0007	1.68
	Skewness	2.538	-9.44	1.479	-0.254
	Kurtosis	7.304	1.509	2.482	-1.289
Pucullu		$^{87/86}Sr$ (N=14)	O18 (N=14)	$^{87/86}Sr$ (N=12)	O18 (N=12)
	Avg	0.7078	-9.55	0.7074	-9.75
	2 SD	0.00219	1.192	0.000365	0.6266
	Range	0.7071 to 0.7100	-10.16 to -8.5	0.7074 to 0.7076	-10.16 to -9.18
	Range Diff	0.0036	2.01	0.0002	0.98
	Skewness	2.244	1.353	-0.69	0.311
	Kurtosis	3.97	1.402	-0.581	-0.82
Sondor		$^{87/86}Sr$ (N=25)	O18 (N=24)	$^{87/86}Sr$ (N=20)	O18 (N=20)
	Avg	0.7074	-7.758	0.7073	-8.63

	2 SD	0.005277	4.169	0.001084	1.195
	Range	0.7050 to 0.7190	-9.658 to -2.756	0.7063 to 0.7084	-9.658 to -7.515
	Range Diff	0.01401	6.902	0.0021	2.144
	Skewness	3.901	1.67	0.248	0.368
	Kurtosis	17.707	1.421	0.1906	-0.658

Cachi

Previous isotopic analysis (Kurin et al. 2016; Lofaro et al. 2018) of individuals from the site of Cachi identified a single non-local individual with $^{87}Sr/^{86}Sr$ (0.7057) falling below the expected local range (Figure 21). The current study identified two additional isotopic outliers with $^{87}Sr/^{86}Sr$ that fall well above the local range (SON020325 = 0.70956; SON020329 = 0.70929) (Figure 19). Together, the strontium isotope results suggest migration into Cachi from at least two different regions even if the rate of immigration was fairly limited (3 of 43 sampled individuals).

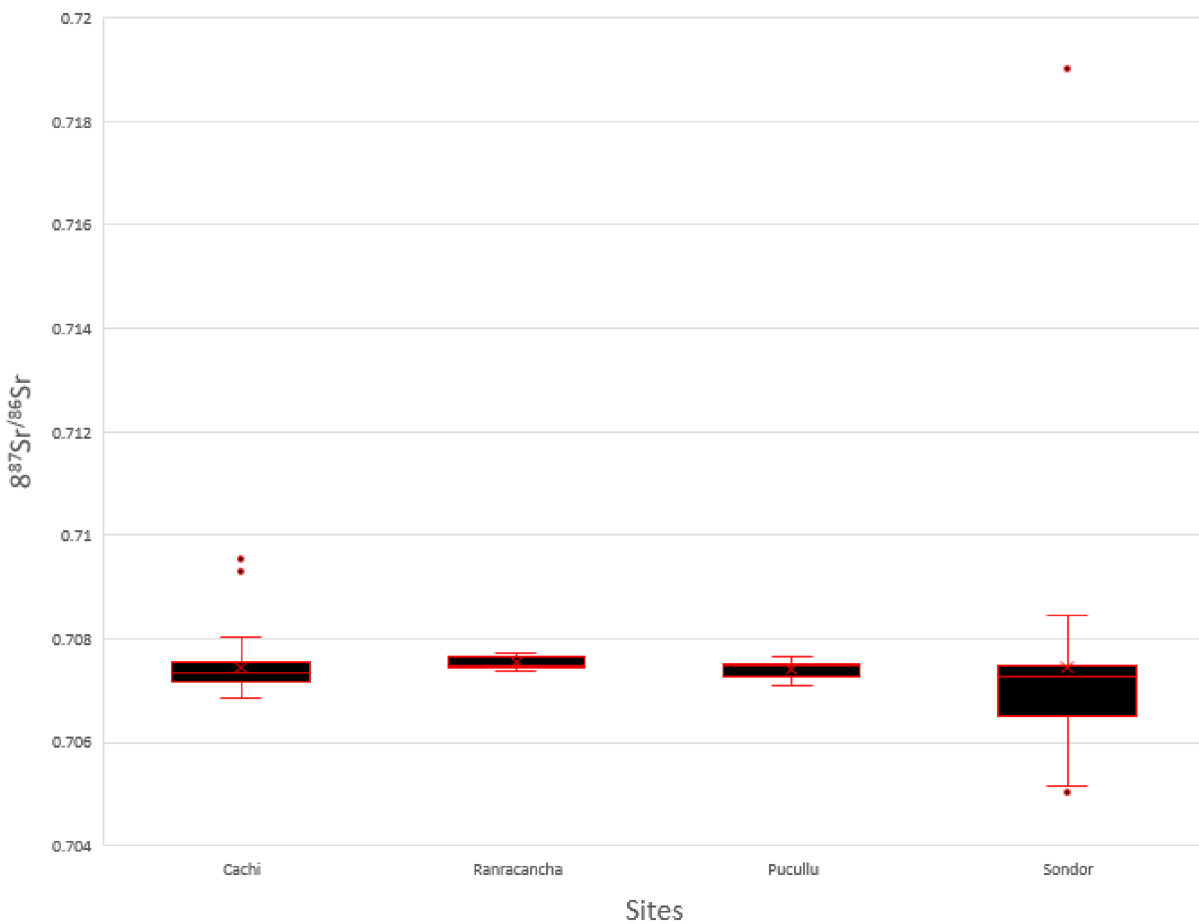

Figure 19. $^{87}Sr/^{86}Sr$ by site for human enamel samples analyzed in this study.

The oxygen isotope results only identify a single outlier (SON020210 = -11.59‰) who has an $^{87}Sr/^{86}Sr$ value (0.70758) within the local range (Figure 20, Table 14). This individual may have migrated into the site from higher elevations in the region, but it is not possible to determine where due to a lack of $\delta^{18}O$ values from the surrounding region. When combined with the strontium isotope data, additional non-locals may be identified and discussed in terms of potential source region.

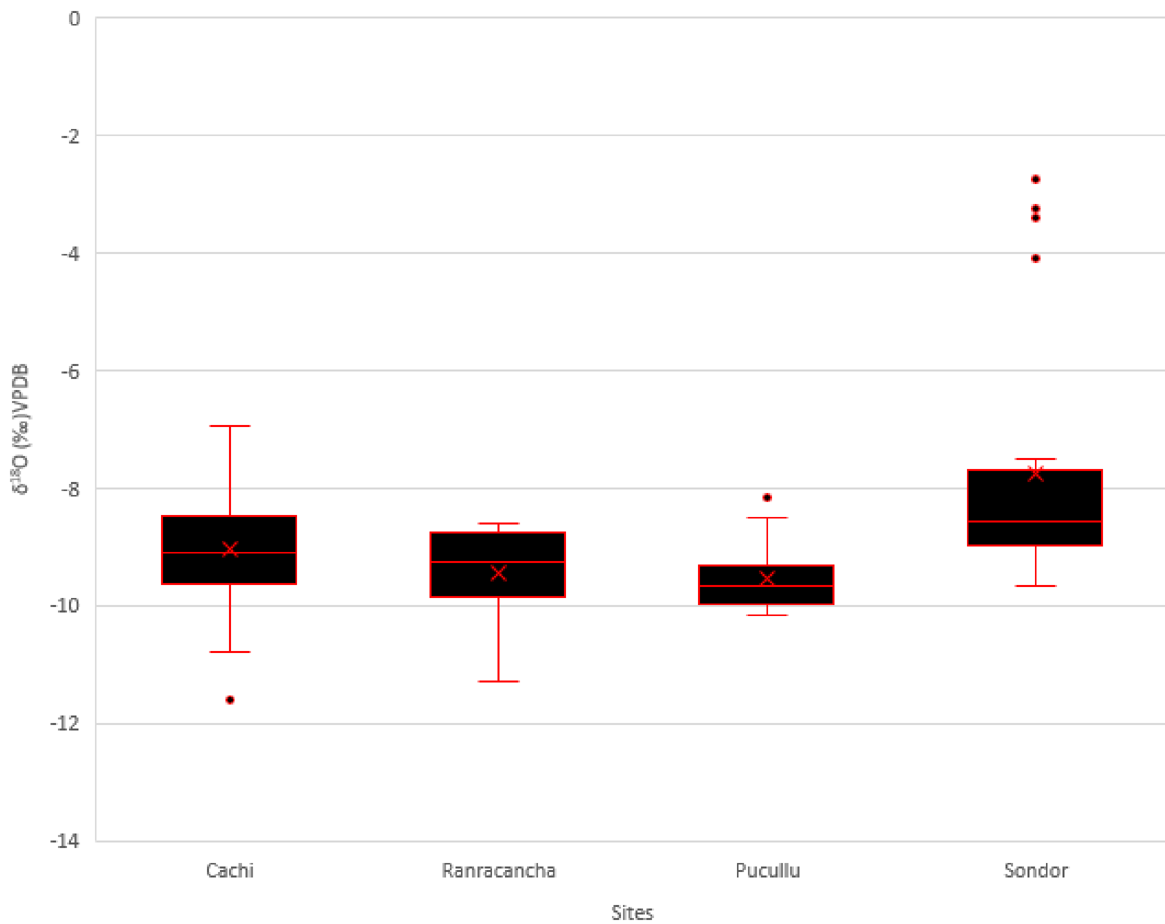

Figure 20. $\delta^{18}O$ by site for human enamel samples analyzed in this study.

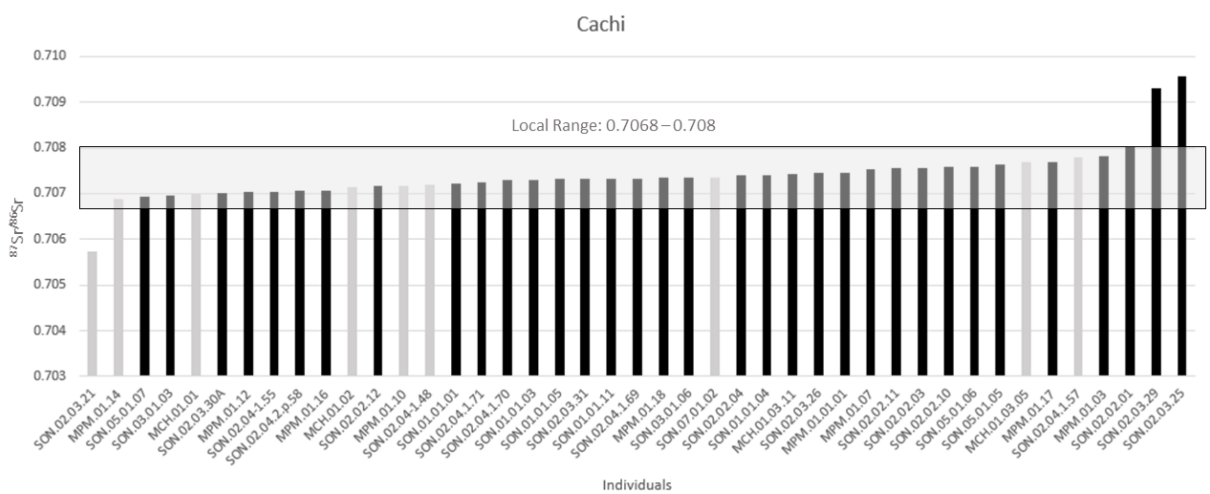

Figure 21. Individual $^{87}Sr/^{86}Sr$ values at Cachi. Grey bars are comparative individuals reported in Kurin (2012) and/or Lofaro et al. (2018), and the black bars are individuals sampled as part of this study. The grey horizontal box denotes the estimated local $^{87}Sr/^{86}Sr$ range. Individuals falling outside this box are interpreted as non-local.

When both isotopic proxies are considered, five individuals fall outside the cluster of local values (Figure 22). The two individuals with elevated $^{87}Sr/^{86}Sr$ (>0.7090) have variable $\delta^{18}O$ indicating they may have migrated from different regions or elevations with similar $^{87}Sr/^{86}Sr$. According to their $^{87}Sr/^{86}Sr$ values, these individuals likely originated from further east or south than Andahuaylas since similar $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values are found in the SW Highlands of Peru (e.g., near Machu Picchu), NE Chile, NW Argentina, and NW Bolivia (Barberena et al. 2020; Knudson & Price, 2007; Scaffidi & Knudson, 2020; Turner et al., 2009; Turner et al. 2021) (Figures 17 and 18). Individual SON.02.03.25 ($\delta^{18}O$ = -8.53‰) is a middle-aged adult male, without cranial modification, whereas individual SON.02.03.29 ($\delta^{18}O$ = -10.64‰) is middle-aged adult male with a highly modified (Degree =4) *annular erect* cranial vault modification (CVM) with multiple incidents of blunt force trauma (BFT). It is also important to note that individual SON.02.02.10, who is the only $\delta^{18}O$ outlier (-11.59 ‰), is also a middle-aged male with a highly modified (Degree = 4) *annular erect* CVM and evidence of cranial BFT. This individual likely comes from a higher elevation region with similar geology, which can be found to the east and south of Andahuaylas. All three of these non-local men were buried in the same *machay* (Cave 2) suggesting some sort of kinship or identify-based association among them.

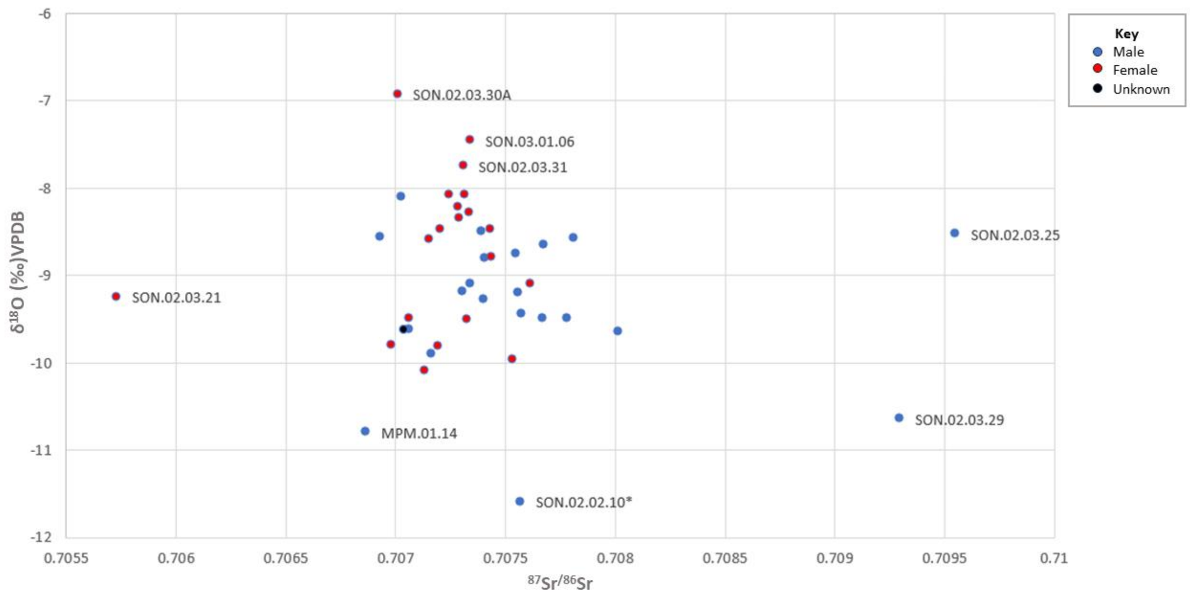

Figure 22. Combined $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ for all individuals from Cachi. Males are in blue, females are in red, and individuals of indeterminate sex are in black. Outliers and other individuals of interest are labeled with their osteological sample numbers.

In contrast, the individual (SON.02.03.21) established by Kurin (2012; 2016) and Lofaro et al. (2018) with the lowest $^{87}Sr/^{86}Sr$ value (0.7057) may originate west or south of Andahuaylas where similar $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values have been identified (Scaffidi & Knudson, 2020) (Figures 16 and 17). Although her $^{87}Sr/^{86}Sr$ could indicate an origin near the Pacific Coast, her lower $\delta^{18}O$ (-9.24‰) is more indicative of a mid or upper-valley origin. This individual is a young adult female without cranial vault modification. She is the only definite non-local female found in the early LIP sites and Kurin (2012; 2016) hypothesizes that she was part of the practice of female capture during early LIP warfare. However, additional samples run in this study identified three additional females (SON.03.01.06, SON.02.03.30A, SON.02.03.31) that cluster slightly above the local $\delta^{18}O$ range (Figure 21), and could indicate their origins from lower elevations. Two of the women (SON.02.03.30A and SON.02.03.31) have *annular erect* (Degree

= 3 and 2) CVM and were buried in the same *machay* (Cave 2). The other young adult woman (SON.03.01.06) has an *annular* CVM and was buried in a different *machay* (Cave 3).

Overall, the majority of the mortuary population at Cachi appears to have been born locally (38 of 43 sampled individuals), or somewhere within the broader region, but there is also evidence of in-migration from several different locales. The additional samples run in this study identified a much wider range of non-locals. While it is unlikely the non-locals came from distant regions, the small differences in values reveals patterns of movement that may be tied to kinship or relationships between communities. The results show that certain males migrated from the E/SE or higher elevations than Andahuaylas, while females migrated from the W/SW or lower elevations than Andahuaylas. The movement of males and females differ, and may be due to different agreements or kin relations with certain communities.

Ranracancha

The site of Ranracancha has one individual identified as an $^{87}Sr/^{86}Sr$ outlier and therefore likely non-local (Figure 23). Individual RCC.01.01.07 $^{87}Sr/^{86}Sr$ value (0.70918) falls above the local range. There is also a possible $^{87}Sr/^{86}Sr$ outlier (RCC.01.01.24, $^{87}Sr/^{86}Sr$ = 0.70826). Both individuals were reported in previous publications (Kurin et al. 2016; Lofaro et al. 2018). The remining 14 individuals from Ranracancha show little variation in their $^{87}Sr/^{86}Sr$ values which range from 0.7074 to 0.7079. The oxygen isotope results identify one outlier that falls outside of the 2 SD $\delta^{18}O$ range (RCC.01.01.14 = -11.3‰), but not identified within the boxplot, and has an $^{87}Sr/^{86}Sr$ value (0.70744) within the local range (Figure 24, Table 14). This individual may have migrated from a higher elevation in the region.

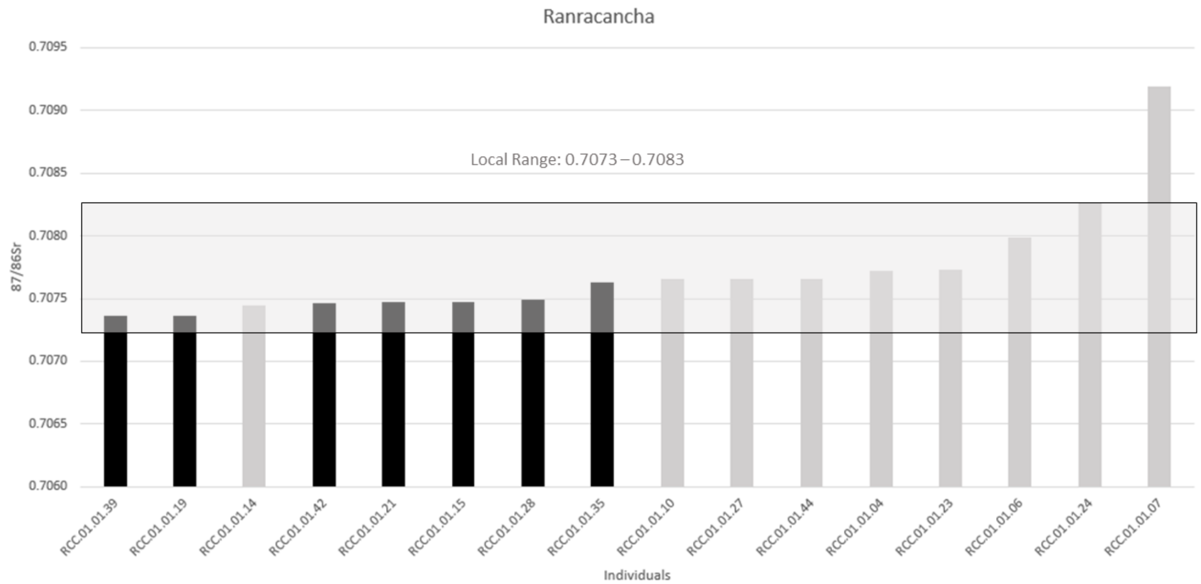

Figure 23. Individual $^{87}Sr/^{86}Sr$ values at Ranracancha. Grey bars are comparative individuals reported in Kurin (2012) and/or Lofaro et al. (2018), and the black bars are individuals sampled as part of this study. The grey horizontal box denotes the estimated local $^{87}Sr/^{86}Sr$ range. Individuals falling outside this box are interpreted as non-local.

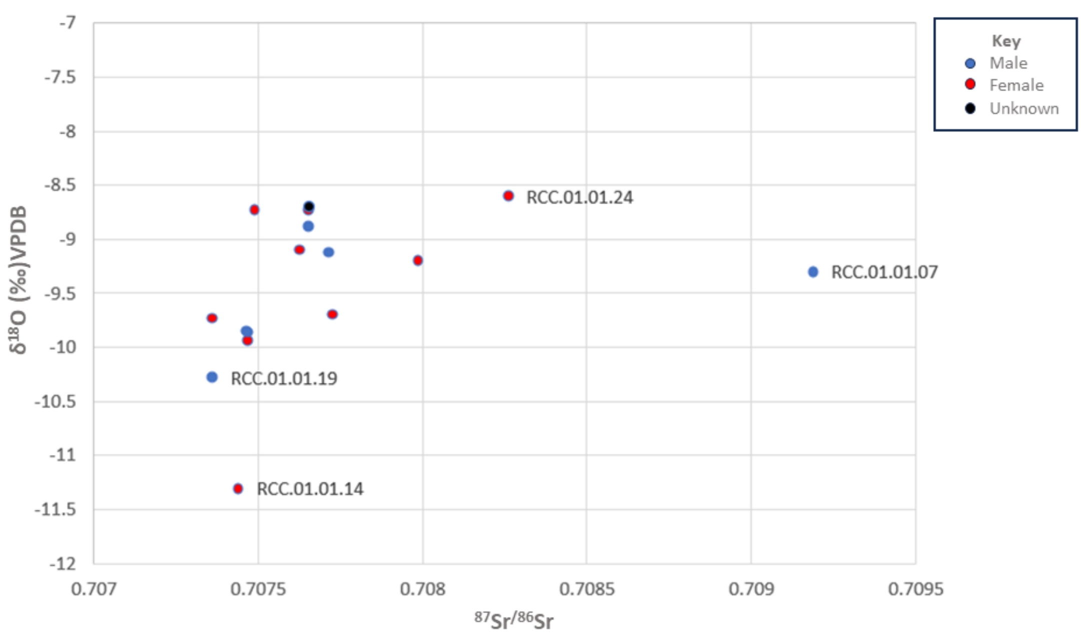

Figure 24. Combined $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ for all individuals from Ranracancha. Males are in blue, females are in red, and individuals of indeterminate sex are in black. Outliers and other individuals of interest are labeled with their osteological sample numbers.

The individual RCC.01.01.07 with the elevated $^{87}Sr/^{86}Sr$ (>0.7090) was identified as a young-adult female by Kurin (2012) with an *annular oblique* CVM. The analysis was paired with the non-local female at Cachi as evidence for female capture during warfare (Kurin, 2012, 2016; Lofaro et al., 2018). However, the DNA results (presented in the next chapter) determined this individual to be a young adult male. Similar to the non-local males at Cachi, this individual may have migrated from E/SE of Andahuaylas (e.g., from near Machu Picchu, NE Chile, NW Argentina, or NW Bolivia) based on their combined $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ (Figure 25) (Barberena et al. 2020; Knudson & Price, 2007; Scaffidi & Knudson, 2020; Turner et al., 2009; Turner et al. 2021; Figures 17 and 18). In contrast to the results found at Cachi, the rest of the non-locals do not follow the male/female migration trend established at Cachi. The outlier for oxygen (RCC.01.01.14) is a young-adult female with *annular oblique* CVM who has a lower $\delta^{18}O$ value (-11.3‰), indicative of migration from a higher elevation. The possible female $^{87}Sr/^{86}Sr$ outlier (RCC.01.01.24) has an elevated value ($^{87}Sr/^{86}Sr$ = 0.70826) indicating migration from a region further E/SE of Andahuaylas, also supported by their $\delta^{18}O$ value (Figure 24). This contrasts with Cachi, where only male migrants came from the E/SE and higher elevations.

The majority of the mortuary population at Ranracancha (13 of 16 sampled individuals) appears to have been born locally or somewhere within Andahuaylas. However, there is evidence of in-migration from the E/SE and higher elevations. The additional samples completed for this study identified a broader range of local $^{87}Sr/^{86}Sr$, adding to the lower end of values (Figure 22). Migration patterns at Ranracancha differ from Cachi, showing that both males and females migrated from the E/SE and from higher elevations. Ranracancha is said to be the Chanka lower moiety and is located in an isolated and difficult to reach area, so it is not surprising that the movement of people and kin relations may differ.

Pucullu

The $^{87}Sr/^{86}Sr$ analysis of four additional individuals from the site of Pucullu did not identify any new outliers, but did serve to further define the local site $^{87}Sr/^{86}Sr$ range (Figure 25). The $^{87}Sr/^{86}Sr$ outliers (>0.710), and therefore non-locals, at Pucullu (PCU.01.01.08 and PCU.01.01.25) were identified previously by Kurin (2012) and were determined to be males with modified crania. According to my own osteological analyses, individual PCU.01.01.08 is a middle-aged adult male with healed BFT on the right mid-frontal and an *annular erect* CVM. Individual PCU.01.01.25 is an unmodified old adult male with healing BFT to the right parietal. The combined $^{87}Sr/^{86}Sr$ and the $\delta^{18}O$ of these individuals (Figure 26) indicates that these males may have come from E, SE, or NE of Andahuaylas including areas such as the Titicaca Basin, Cusco Valley, and the Northern Peruvian Andes (Andrushko et al., 2009; Knudson & Price, 2007; Scaffidi & Knudson, 2020; Slovak et al., 2018) (Figures 17 and 18).

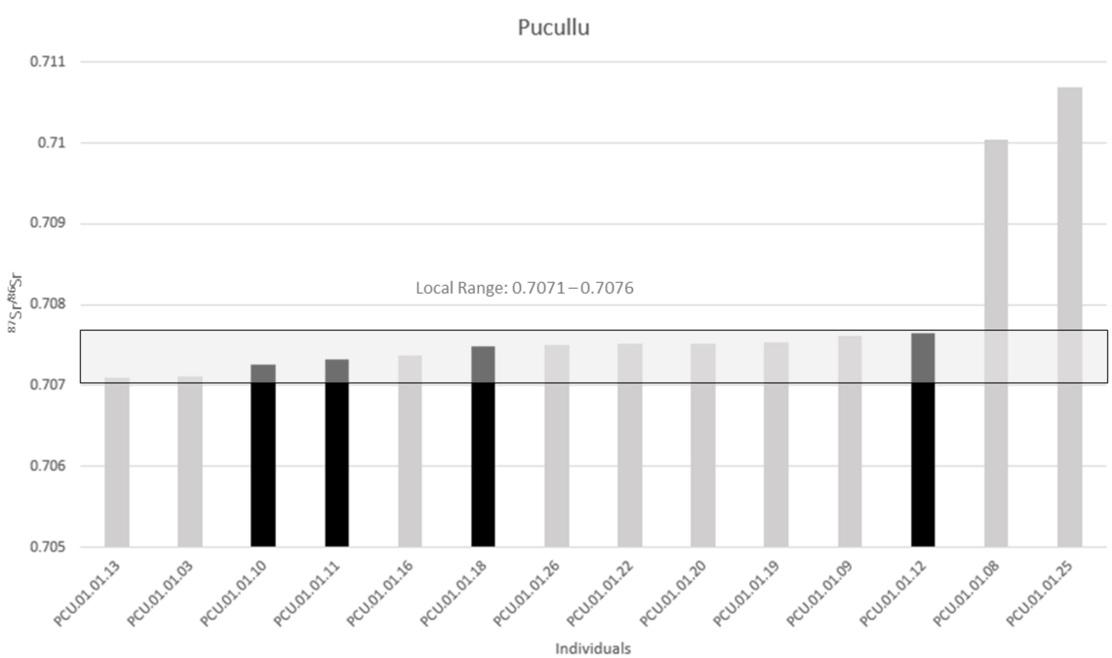

Figure 25. Individual $^{87}Sr/^{86}Sr$ values at Pucullu. Grey bars are comparative individuals reported in Kurin (2012) and/or Lofaro et al. (2018), and the black bars are individuals sampled as part of this study. The grey horizontal box denotes the estimated local $^{87}Sr/^{86}Sr$ range. Individuals falling outside this box are interpreted as non-local.

New samples contributed as part of this study identified one additional outlier (i.e., non-local) (PCU.01.01.11) based on their $\delta^{18}O$ value (-8.15‰) (Figure 20). This individual appears local based on their $^{87}Sr/^{86}Sr$ (0.70731), but their higher $\delta^{18}O$ (-8.15‰) indicate that they are from a lower elevation region that is geologically similar to Andahuaylas (Figure 26). PCU.01.01.11 is a female with an *annular erect* CVM (Degree = 2) and no evidence of trauma.

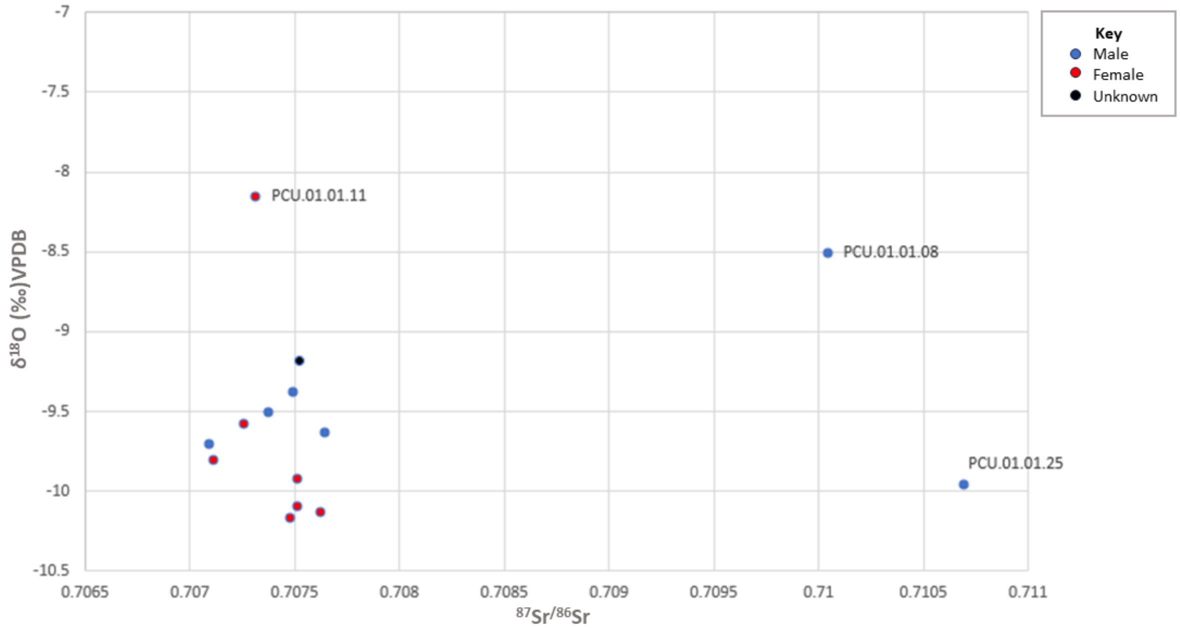

Figure 26. Combined $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ for all individuals from Pucullu. Males are in blue, females are in red, and individuals of indeterminate sex are in black. Outliers are labeled with their osteological sample numbers.

Similar to Cachi, Pucullu only has males migrating from the E/SE, however, another option due to the higher $^{87}Sr/^{86}Sr$ value is that they came from farther north. Also, similar to Cachi, is that the one non-local female migrated into the region from a lower altitude/elevation. The values for the males and females differ from what is found at Cachi though, indicating that Pucullu differed from Cachi in its kinship or community-based relationships.

Sondor

At the site of Sondor, four individuals were identified as $^{87}Sr/^{86}Sr$ outliers, with three of those same individuals also identified as $\delta^{18}O$ outliers, making it likely they are all non-local (Figures 27 and 28**)**. The three outliers (SOD_1_1, SOD_1_2, SOD_1_9) for both isotopic proxies fall well below the local isotopic ranges (outliers: $^{87}Sr/^{86}Sr$ = 0.7050 to 0.7053; $\delta^{18}O$ = -2.76 to -3.39‰) and may originate from the same region or community (Figure 28). These three individuals are all from the same *machay* context dated to the late LIP (Unit 1, Context 1), and they were interred alongside individuals exhibiting local isotopic values. All three of the non-local individuals are adult females (two middle-aged and one young adult) who lack cranial vault modification. SOD_1_9 stands out due to perimortem BFT trauma to the left temporal/parietal and a scraping trepanation with minimal healing. The trepanation is the only one seen at Sondor from these excavations. The $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ for these women indicate they are from lower elevations or altitudes to the W/SW/NW of Andahuaylas (Milton et al., 2022; Scaffidi & Knudson, 2020) with similar values found in the Peruvian Coast Chao Valley (Bethard et al., 2008) (Figures 16 and 17).

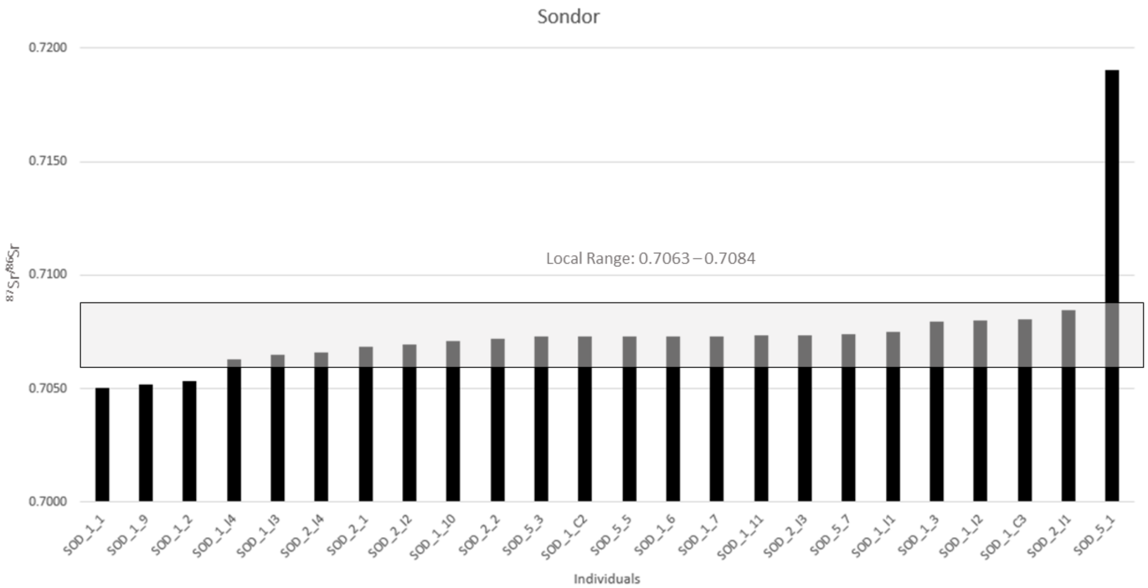

Figure 27. Individual $^{87}Sr/^{86}Sr$ values at Sondor. The grey horizontal box denotes the estimated local $^{87}Sr/^{86}Sr$ range. Individuals falling outside this box are interpreted as non-local.

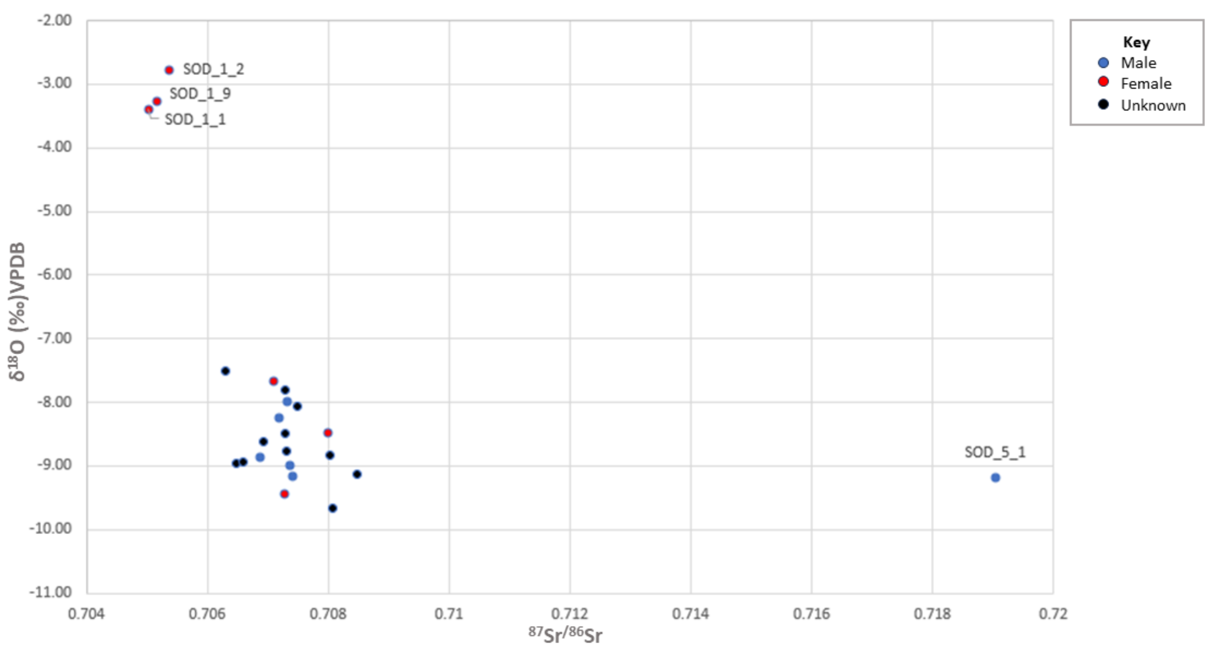

Figure 28. Combined $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ for all individuals from Sondor. Males are in blue, females are in red, and individuals of indeterminate sex are in black. Outliers are labeled with their osteological sample numbers.

The fourth isotopic outlier (SOD_5_1) identified at Sondor has a non-local $^{87}Sr/^{86}Sr$ value well above the local range (0.71902), and a highland $\delta^{18}O$ value within the local range of the Andahuaylas region (Figures 27 and 28). This individual is distinct from the three women found in Unit 1. Individual SOD_5_1 is a middle-aged male without CVM dated to the late LIP and found buried outside the household in Unit 5. He has perimortem BFT to the posterior right parietal. He is the only individual buried outside the house and the only individual with a higher status *capacocha* offering beneath him. With a highland $\delta^{18}O$ value and $^{87}Sr/^{86}Sr$ of 0.71902, it is likely this individual migrated from further E/SE (Milton et al., 2022; Scaffidi & Knudson, 2020), with similar values found in the Inca Sacred Valley and Central Bolivia (Lucas, 2012; Lucas et al., 2023; Turner et al., 2021). He thus migrated from a different region than the three non-local females identified at Sondor. He is also distinct from the individuals buried inside the house (Unit 5) as part of an abandonment ritual (Gomez Choque & Kurin, 2016; Lizarraga & Kurin, 2017) who all have local Sondor isotopic values.

The remaining individuals at Sondor all have isotopic values identifying them as likely local to the site and/or Andahuaylas region. The local population at Sondor includes two male individuals found buried together with a *capacocha* offering in a cist tomb in Unit 2. It was hypothesized in the excavation section that they may have been from a higher elevation region where cist tombs are more common (Bauer et al., 2010; Kellett, 2022). Based on their local isotopic values, burial of these two individuals may instead be indicative of their high status, or their less direct connection to higher elevation regions.

In comparison to other study sites in Andahuaylas, the site of Sondor has a broader isotopic range for individuals identified as "locals", even in comparison to the nearby site of Pucullu which shares a primary water source with Sondor (Table 14; Figures 19, 27, 28). The larger overall range of isotopic values may indicate that people from the region at large were living at Sondor during the late LIP. With evidence from surveys (Bauer et al., 2010) and excavations (Kurin, 2012), combined with the radiocarbon dates in this project, there is evidence of a population reduction at the site of Cachi and site abandonment at Ranracancha. It is possible that some of the Chanka migrated to Sondor, thus establishing the larger range of local values. In addition, the evidence for the three females and one male non-locals indicate individuals were immigrating to Sondor from much further away than what was recorded in the early LIP. Together, the isotopic evidence demonstrates a significance degree of change in migration and mobility during the late LIP.

Duplicates were run on the same 10 individuals for both $^{87}Sr/^{86}Sr$ and $\delta^{18}O$, with the results presented in Table 15. The value differences are minimal showing the results are reliable and robust.

Table 15. The duplicate $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values compared to the original values.

	$^{87}Sr/^{86}Sr$			**$\delta^{18}O(‰)_{VPDB}$**		
	1st	**2nd**	**Difference**	**1st**	**2nd**	**Difference**
RCC010115	0.707470	0.707479	0.000008	-9.93	-9.97	0.04
RCC010142	0.707461	0.707475	0.000014	-9.84	-9.84	0
MPM0117	0.707674	0.707660	0.000013	-8.66	-8.08	0.58
SON010105	0.707304	0.707304	0	-9.19	-8.59	0.6
SON020211	0.707551	0.707523	0.000028	-8.76	-8.58	0.18
SON0204155	0.707037	0.707148	0.000111	-9.63	-9.5	0.13
SOD060069	0.705020	0.705180	0.000159	-3.39	-3.22	0.17
SOD160052	0.706927	0.706967	0.000410	-8.62	-8.76	0.14
SOD2500392	0.719028	0.718923	0.000105	-9.17	-8.99	0.18

Based on context information, there is no evidence of the consumption of *chica* or marine food sources. Deciduous teeth were sampled at Sondor, but were altered based on trophic enrichment of ~3-4 ‰ and fell well within the local values of the region.

Conclusions

The use of $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ was able to reveal a complex landscape of movement and interactions during the LIP into the Late Horizon within Andahuaylas. The primarily early LIP sites of Cachi, Ranracancha, and Pucullu were composed of mostly local individuals, but had varying rates and patterns of migration. Cachi showed a pattern of males immigrating from the E/SE or higher elevations and females from the W/SW or lower elevations, with all individuals buried in *machays* with locals. With the exception of one individual, three out of the four non-local or possible non-local males had highly modified *annular erect* crania. These patterns of migration may reflect exogamy agreements with communities outside of Andahuaylas for marriages across moieties within the same regional *ayllu* (Isbell, 1997), with men being selected due to status from birth that is reflected in their cranial modifications. Pucullu showed similar patterns of immigration as Cachi, except that where individuals were immigrating from differed, indicating exogamy and relations with different communities.

Ranracancha showed a mixture of males and females immigrating from the E/SE or higher elevations, with no distinct patterns pertaining to CVM due to majority of individuals at Ranracancha having an *annular oblique* modification. During times of stress, the *ayllu* can become flexible and ambilocality may occur. It may be that Ranracancha, based on its isolation and the degree of violence in the region, exchanged marriage partners with other communities based on where a husband or wife could safely gain land or resources (Skar, 1982).

The Sondor individuals in this study date to the late LIP (with the individual dated to the EIP/MH not included in analysis). The patterns of migration change from the early to late LIP, based on inclusion of individuals from further distances and the larger range of isotopic values found at Sondor. Colonial texts state that non-local workers were brought to Sondor during the Late Horizon (Carabajal 1974 [1586], Julien, 2002, Markham, 1872; Ramos Gavilan 1988 [1621], and the broader range of values may fit these descriptions. The Inca showed a presence earlier in Andahuaylas than previously thought (late LIP instead of LH), and their presence occurred before they their state/empire achieved its full height of power. Early Inca activities in Andahuaylas may have involved moving individuals to Sondor from nearby regions or from within Andahuaylas. In addition, the movement of women for specialized tasks was a common practice within the Inca state (Andrushko et al., 2009) and a colonial text states that women workers specifically were moved to Sondor (Julien, 2002). The presence of non-local females from the W/SW/NW and lower elevations may be an indication of this practice occurring at Sondor prior to the Late Horizon. Alternatively, since the females were found within the same *machay* with locals, the in-migration of females for exogamy purposes may have expanded during the late LIP with the presence and kin agreements with the Inca. The presence of the male with a possible *capacocha* offering in Unit 5, with a strontium value that overlaps with the Inca Sacred Valley, might be direct evidence of an Inca individual within Sondor, but more research would have to be done to confirm this hypothesis.

Overall, a multi-isotopic approach combined with mortuary and osteological assessments was able to establish patterns of community composition and interaction. Between the early and late LIP, the majority of the individuals at Cachi, Ranracancha, Pucullu, and Sondor were local. However, there are distinct differences of migrations between the early and late LIP. During the early LIP, the variation of male versus female immigrations may be based on differing *ayllu* exogamy agreements between the local sites and communities outside of the local ranges, or based on necessity due to increased stress during the early LIP. Whereas the late LIP saw a broader range of values and individuals immigrating from much further distances. In the following chapter, the isotopic work will be integrated with genetic analyses to further explore LIP shifts in community composition and interaction and patterns of migration.

CHAPTER 7 – ANCIENT DNA ANALYSIS

Ancient DNA provides the opportunity to discover who is living within Andahuaylas and how they were related to each other. By incorporating degrees of relatedness within and between burial contexts, we can begin to unravel whether non-locals were related or kin with locals, and who was buried together. Establishing these patterns can aid in the analysis of change through time and how socio-political factors, such as the Inca presence in the region, impacted kinship. Taking the small-scale understanding grounded in Andahuaylas, and placing it within a broader genetic context of South America, can also help us identify patterns through time

Ancient DNA Problems and Solutions

DNA degrades over time making it difficult to extract, but recent extraction and sequencing methods have vastly improved what questions can be asked about the past. Next Generation Sequencing (NGS) has been more successful in retrieving highly degraded aDNA. Although Polymerase Chain Reaction (PCR) was revolutionary when it first hit the DNA scene in the 1980s, NGS has proven able to circumvent most of the complications that came with using PCR for degraded samples. Degradation begins when an organism dies and the environment acts on DNA to break it down in ways that mimic mutations and DNA damage in living organisms. And no matter how well DNA preserves, bacteria, fungi, and insects will feed on the degraded DNA molecules causing a tremendous loss in the abundance of DNA present in the sample (Pääbo et al., 2004). There are certain conditions in which DNA is more likely to preserve, though, such as rapid desiccation and low temperatures, but it does not prevent all degradation (Llamas et al., 2017). With a small amount of endogenous DNA preserved and the endogenous

DNA that is present becoming degraded, aDNA studies become a tricky endeavor, especially for researchers in warm and humid climates.

DNA is composed of nucleotides made from sugar, phosphate, and nitrogen bases. The nitrogen bases attach (Adenine with Thymine and Guanine with Cytosine), forming a polynucleotide strand (double-stranded ladder) (Stoneking, 2016). The most common form of degradation breaks apart this structure through hydrolysis (Pääbo et al., 2004). The process does not cause the polynucleotide strand to break apart right away but instead leaves nicks on one side of the double strand. Enough of these nicks and the polynucleotide strand will fragment (Brown & Brown, 2011). These abasic sites are blocking lesions, which are any modifications to polynucleotide strands that prevent DNA polymerase from moving along the strand and accumulate after death without repair mechanisms. Another blocking lesion is the oxidation of purine and pyrimidine bases of ribose sugar caused by free radicals (O_2, H_2O_2, OH). The last blocking lesion is called the Maillard reaction, which is when polynucleotides are linked together and commonly occurs during decomposition (Brown & Brown, 2011; Pääbo et al., 2004).

The errors listed above cause fragmentation, but another major issue we run into with degraded DNA is miscoding lesions or modifications to the sequence. The most common is the hydraulic loss of an amino group from the cytosine base, causing cytosine to form uracil, which is called deamination (Brown & Brown, 2011; Pääbo et al., 2004). Another deamination involves the 5-methylcytosine base, which usually pairs with guanine, but instead forms thymine (Brown & Brown, 2011; Pääbo et al., 2004). These can cause errors in sequencing DNA.

The most problematic issue we run into with aDNA is contamination. Contamination can occur through substances that copurify with the DNA that can cause inhibition, environmental DNA (eDNA), and contamination from modern human DNA (Llamas et al., 2017; Stoneking

2016). There are tests for inhibition so approaches can be employed to alleviate the issue, such as dilution (Stoneking, 2016). The second issue is that eDNA from microbes, fungi, and other organisms will overwhelm aDNA in the sample since only 1-5% of the DNA in sample is endogenous (Llamas et al., 2017; Stoneking 2016). And finally, there can be contamination from modern humans. This can occur from any contact the sample has with a human in the field or lab (Llamas et al., 2017; Stoneking 2016). In the field, researchers should take precautionary measures such as wearing protective gear (masks, gloves, whole body suits), sampling in the field with sterile bags, and/or storing samples in a cool and dry location. Contamination can also occur in an aDNA lab, so clean lab precautions are always in place such as lab members wearing protective gear, ultraviolent radiation to sterilize tools and surfaces, controlled and filtered air, and more (Llamas et al., 2017). No matter the precautions taken, aDNA is usually still contaminated to some degree or another, but there are ways to deal with this using NGS.

New methods of extraction and sequencing provide the ability to target small regions of DNA that have been fragmentated from degradation and avoid longer strands from contamination. In addition, the miscoded regions are problematic but also important for identifying that a sample is ancient; without the miscoding, you cannot confidently say you are not sequencing contamination. NGS (also known as high-throughput sequencing, HTS) methods of extraction can be used to target and sequence a large number of DNA molecules. Hybridization capture is designed for complex DNA mixtures since it targets and enriches specific biomarkers (based on the research question) and is better at targeting short fragments than PCR (Gasc et al., 2016; Hofreiter et al., 2014). For the methods used in this dissertation, see the Materials and Methods chapter.

With more DNA being obtained with each sample, more complex questions about past individuals can be explored. Before methods improved, most researchers could only ask questions related to the uniparental marker of mitochondrial DNA. Uniparental markers refer to the genetic information you get from one parent, either the maternal or paternal side. Mitochondrial DNA (mtDNA) comes from the maternal side and is located outside the nucleus in the mitochondria ("powerhouse of the cell"). The molecule is circular and compact, with only 16,500 base-pairs (BPs) (Stoneking, 2016). The best feature about mtDNA, especially for aDNA research, is that there are hundreds to thousands of mitochondria within a cell, and each mitochondrion has 5-10 mtDNA genomes. This means there is a much higher chance of mtDNA preserving in ancient specimens. And since mtDNA is maternally inherited, they are haploid with no recombination (if it occurs, it is only swapping from identical loci), which means it is useful for inferring the maternal population history. Population history can be partially observed through haplotypes, which are segments of mtDNA found in the hypervariable region (HVR, specifically HV1). The variations are representative of populations but can also be traced back through time to one common ancestor following the founder effect and mutation trends out of Africa and across the world. One issue with mtDNA is that it is strongly influenced by the forces of evolution (especially drift), which becomes problematic when trying to trace changes due to socio-political forces (Stoneking, 2016).

The other uniparental marker is the Y-chromosome, found in the nucleus along with the X-chromosome and autosomal DNA. The Y-chromosome is only present in males, so it can only give insights into the paternal population history (Jota et al. 2011; Stoneking, 2016). There are only a dozen genes on the Y-chromosome, and it is haploid like mtDNA. Some regions end up recombining with the X-chromosome, but the nonrecombining Y chromosome region (NRY) is used for population studies. NRY is like mtDNA in that the variations can be population-specific and pertain to haplogroups, which means it is subject to the forces of evolution (Stoneking, 2016). Combining the use of mtDNA and Y-chromosome (NRY) can reveal sex differences in the movement of people, such as marriage practices (Mesa et al., 2000; Stoneking, 2016).

The X-chromosome complicates studies for population history since males are haploid and females are diploid. There are reasons to study the X-chromosome, but that will not be covered here. The rest of the nuclear DNA is composed of diploid autosomal DNA, a copy from each parent. Autosomes hold a tremendous amount of information, providing highly discriminatory power for tracing population history (Stoneking, 2016). Even though autosomal DNA is subject to the forces of evolution, averaging across a vast number of loci minimizes the effects of selection and drift on the results. A major difference between uni-parental inherited and autosomal DNA is that uni-parental DNA undergoes recombination. Recombination is a process that occurs during meiosis, which exchanges the genetic material on homologous chromosome pairs to provide a unique combination of genetic information for the offspring inherited from their parents. Within this process, some genetic information is more likely to be inherited together because of their distance on the chromosomes. Therefore, recombination is useful for population studies because of linkage disequilibrium (LD), which is when closely linked SNPs create nonrandom associations, are important when focused around population diagnostic mutations. The stretches of sequence that contain associated alleles will start large but shrink through generations due to recombination (Stoneking, 2016). The length and amount of recombination around the mutations are attached to demographic history, so it is used to trace admixture, how much occurred, and when it occurred (admixture blocks) (Barbieri et al., 2019; Stoneking, 2016).

Peopling of South America

Precontact South America has seen a lot of movement of people through time, starting with the first inhabitants ~15,000 years ago and continuing until today (Reich et al., 2012; Posth et al., 2018). The population history of South America is a combination of differences in movement between the eastern and western parts of South America and socio-political influences of ancient cultures. Tracing population history using modern human DNA samples gives you part of the story for past genetic diversity, but ancient DNA (aDNA) can provide a snapshot for a time and place.

Looking at the peopling of the Americas, mtDNA has been the most common marker used in aDNA studies up until recently since it is so abundant. Native Americas originate from Asian founders that went over Beringia, but modern mtDNA shows there was a standstill where new mutations accumulated before the founder populations quickly spread out into the Americas (Tamm et al., 2007). The founding mtDNA haplogroups for the Americas are A2, B2, C1c, C1d, and D1, with a sixth haplogroup, X, only found in North America, and others discovered later. The coalescence average of the founding populations is about 19,000 years ago, with evidence of a secondary migration into the Americas shown by haplogroup A2 (Achilli et al., 2008).

The addition of aDNA can reveal further details since recent migrations and admixtures can mask ancient signals. Llamas et al. (2016) looked at 92 genomes from pre-Columbian South Americans and found that a population entered the Americas around 16,000 years ago, after isolation in Beringia for 2,400-9,000 years (confirming the Tamm et al., 2007, findings), and that there were five founding haplogroups. The population migrated quickly to South America with limited gene flow after separation. None of the 83 haplotypes in the study exist in modern mtDNA diversity, showing a bottleneck (likely due to colonization), emphasizing the importance of incorporating aDNA (Llamas et al., 2016). The Y-chromosome haplogroups in the Americas are C3, Q1a, Q1a3, and Q1a3a, and these studies confirm the mtDNA trends on founding migrations (Jota et al., 2011). Using thousands of SNPs from all regions of the genome, Reich et al. (2012) found three flows into the Americas, with most modern people descending from the first ~15k years ago, and Skoglund and Reich (2016) later adding another stream of migration.

The main area of interest is South America. Using mtDNA and 1.2 million SNPs from ancient and modern individuals, Posth et al., (2018) found that the founding populations entered South America ~17,500-14,600 BP (14,750 years ago found by Lindo et al., 2018), and that the founding population does not contribute to most of South American ancestry today (multiple lineages). There is also evidence of migrations between North and South America ~4,200 BP (Posth et al., 2018). Once in South America, mtDNA and >360K autosomal SNPs from modern populations showed a split between the east and west. Eastern populations stayed in smaller groups throughout time with lower gene flow. In contrast western populations (particularly the Andes) had larger populations with higher gene flow (Gómex-Carballa et al., 2018). Most studies, whether using SNPs or STRs, uniparental or biparental markers, modern or aDNA, agree there was population growth ~9,000 years ago with genetic continuity beginning ~4-6,000 years ago in the Andes (Barbieri et al., 2019; Cabana et al., 2015; Fuselli et al., 2003; Gómez-Carballa et al., 2018; Jota et al., 2011; Lewis et al., 2007; Perez, 2017; Posth et al., 2018).

The founder effect out of Africa puts South America at the end of the line, therefore with the least genetic diversity, even with new mutations. Combining that with genetic continuity throughout the times of major sociopolitical change makes it very difficult to explore archaeological questions (Lewis et al., 2007; Lewis et al., 2009) using aDNA. Uniparental markers are especially limiting since they have less discriminatory power and subject to frequency changes from genetic drift. Using mtDNA, differing frequencies of haplogroups and haplotypes (with haplogroup B being the most common in the Andes) fall within genetic continuity models, despite archaeological evidence showing significant social changes (Fehren-Schmitz et al., 2014; Kemp et al., 2009; Lewis, 2009; Lewis et al., 2004; Lewis et al., 2007). The addition of the Y-chromosome (Fehren-Schmitz et al., 2015; Fehren-Schmitz et al., 2011) and autosomal DNA (Baca et al. 2014) also found continuity. Using genetic analysis alone, it is difficult to identify movement and interaction of people except for when they are moving from distant populations, such as the coast (Fehren-Schmitz et al., 2010; Shinoda et al., 2006; Valverde et al., 2016) and Argentina (Mendisco et al. 2014; Russo et al., 2016; Russo et al., 2018).

Population Substructure

Aside from the larger-scale changes and movements across South America and genetic continuity, autosomal DNA has provided the opportunity to recognize even more substructure within South American populations. For example, Posth et al. (2018) found that a Clovis-associated genome from ~12,800 BP shares ancestry with the oldest Chilean, Brazilian, and Belizean individuals. However, later South American ancestry lacks this connection to Clovis, supporting multiple migrations into South America, instead of one founding population. Posth et al. (2020) also found that individuals from the California Channel Islands show evidence of gene sharing with the Central Andes around 4,200 BP. There is no evidence of cultural exchange between these regions at the time, but it could be the ancestry carried over from an earlier exchange in a population not yet identified (Posth et al., 2018). Nakatsuka et al. (2020) found evidence of the North and Central Peru coasts sharing more gene flow with Amazonian groups than the Highlands, which may be due to gene flow in low mountain ranges around 1,000-1,500 years ago. In addition, gene flow was found between the Argentine Pampas and South-Central Andes starting around 1,600 BP (Nakatsuka et al., 2020).

Despite these advances, it is still difficult to reach a discriminatory level that identifies and reflects socio-political changes of populations that are in close proximity to each other, even with the archaeology identifying large regional changes. Nakatsuka et al. (2020) identified changes through the introduction of heterogeneity within the Titicaca Basin during the Tiwanaku polity and in Cusco during the Inca Empire. Bongers et al. (2020) used a multi-disciplinary approach and found that non-local individuals were moved to the Chincha Valley likely due to Inca resettlement, with the genetics supporting a Late Horizon move to the area since individuals were unadmixed (Bongers et al., 2020).

Another approach that can be used in combination with broader-based population genetic studies is the degree of genetic relatedness within and between archaeological sites. The study of relatedness and kinship is where we run into biasing issues, so we must take care to avoid assumptions about past familial relationships and organization based solely on colonial texts and western standards (Johnson & Paul, 2016). One study used uni- and biparental markers to look at kinship burial patterns at a Peruvian LH site. They found close maternal relationships and patrilocality, with the degree of relatedness from autosomal DNA showing the closest relations within burial locations. By using multiple markers, they also found that one burial plot showed females were more closely related, introducing more variation than previously believed based on ethnohistoric texts (Baca et al., 2012). One study in Argentina during the Late Formative period found patrilocal organization with highest relatedness between males (Russo et al., 2016), but another site in Argentina at the same time showed patterns of matrilocal practices (Mendisco et al., 2018). Similar results have been found in studies across the globe (Drosou et al., 2018; Kennett et al. 2017), showing the usefulness of relatedness studies for questions about ancient kinship.

Uniparental markers can be useful here by revealing sex-biased social practices that influence genetic variation by comparing the Y-chromosome and mtDNA frequencies within groups and populations with the genetic distances for these markers. If patrilocality is practiced, there will be smaller genetic differences between populations for mtDNA since the women move around each generation (Stoneking, 2016). These patterns can be observed without Y-chromosome data if autosomal and mtDNA are captured, such as a study that found directional mating in Native Americans with 30% autosomal and 90% mtDNA similarities (males did not move around) (Mesa et al., 2000). Patrilocality is expected for the Chanka based on ethnographic texts and the general patterns of marriage in the Andes (Skar, 1982).

Within Andahuaylas, due to the close proximity to the Inca heartland of Cusco, population genetic studies alone will not reveal the social substructure needed to answer the research questions. Heterogeneity along with degrees of relatedness will aid in identifying kinship and how communities interacted with each other in a small region. The early LIP individuals separated themselves into highly defensible sites and high degrees of trauma found within burial contexts. Whether individuals are closely related between the sites can point to social interactions, or the opposite if they are not. We also expect to see the introduction of heterogeneity within the region during the late LIP because of Inca resettlement, but the archaeology also says the Chanka were still there, and this may be reflected if they group with the earlier sites. For more information on how data was gathered for this analysis, refer to Chapter 4- Materials and Methods.

Broader Placement of the LIP/LH Population in Andahuaylas

The first step is to place the populations at Cachi, Ranracancha, Pucullu, and Sondor within the broader context of South America. To do this, the genomic data obtained from the individuals from those sites was merged with published genomes of past and present-day individuals from South America. A principal components analysis (PCA) of genome-wide SNP data was used to visualize the ancient Andahuaylas sites with populations from Amazonia, Peru Central Coast, Peru North Coast, Peru South Coast, North Peru Highlands, South Peru Highlands, and the Titicaca Basin (Figure 29; PC1 5%, PC2 4%). The Andahuaylas sites cluster with individuals throughout the South Peru Highlands. The populations from Cachi, Ranracancha, Pucullu, and Sondor match expectations for the region and cluster more closely with each other than other populations, establishing a consistent population throughout the LIP. However, site specific compositions need to be explored to see what ancestries contribute to the whole regional population and to see if this reflects socio-political activities occurring during the LIP.

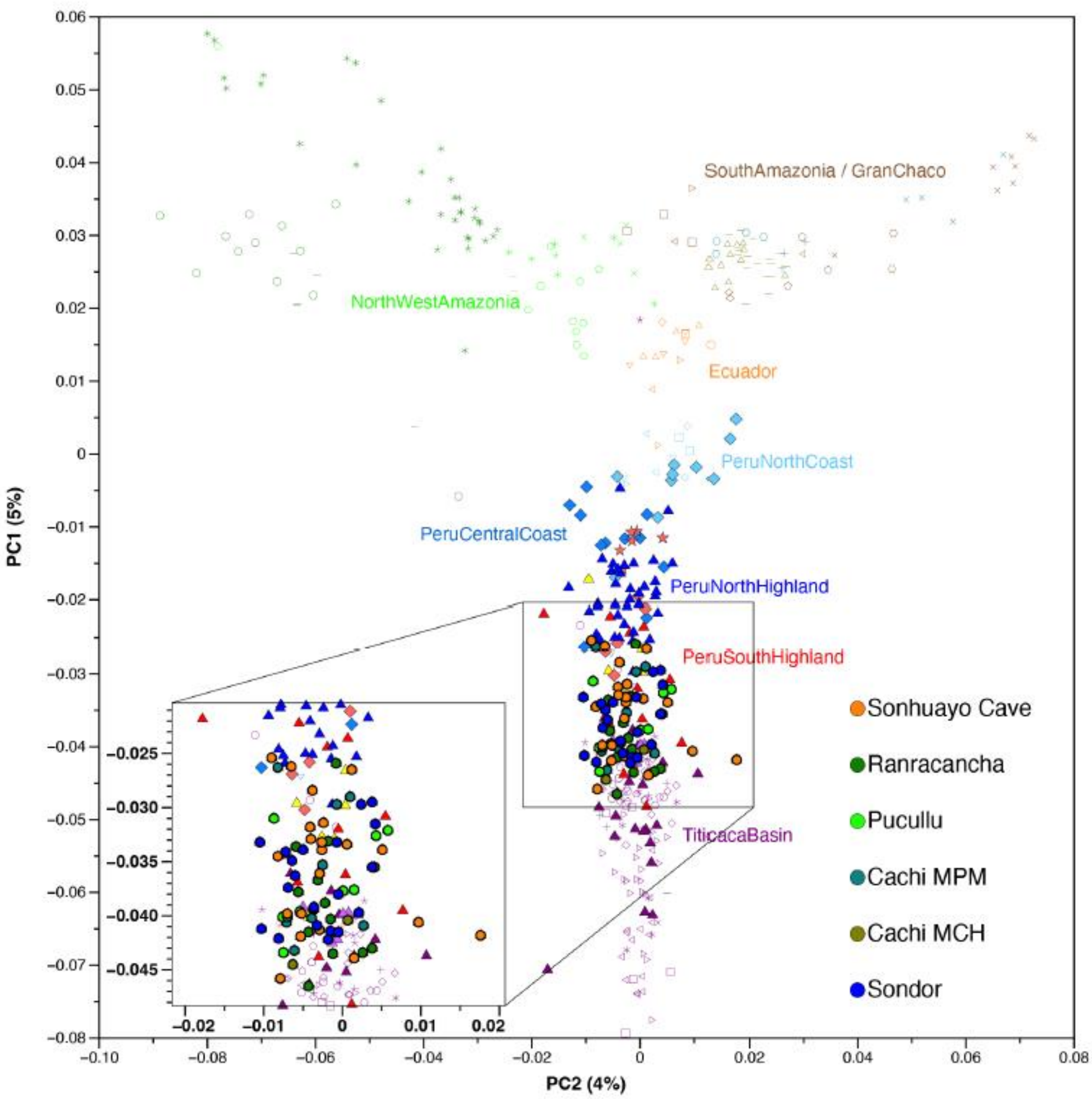

Figure 29. PCA plot of the populations of Cachi, Ranracancha, Pucullu, and Sondor with other published genomes.

Population Substructure at Cachi, Ranracancha, Pucullu, and Sondor

The goal here was to determine what the Chanka population structure was within Andahuaylas during the early LIP and whether Inca presence in Andahuaylas disrupted and changed that. Intra-group genetic homogeneity was explored using F4-tests, which tests whether individuals from various contexts can be grouped together as sharing a common ancestry. The results separated Cachi (MCH, MPM, SON) into 13 groups, Ranracancha (RCC) into 3, Pucullu (PCU) into 3, and Sondor (SOD) into 3 (Table 16). The differences seen within the early LIP contexts created the need for further radiocarbon tests to determine if the differences are based on changes through time, since most individuals at Cachi, Ranracancha, and Pucullu were dated based on association with Chanka ceramics (Kurin, 2012).

Table 16. Groupings of Individuals at Cachi, Ranracancha, Pucullu, and Sondor.

Cachi

MCH	MCH11
	MCH12
	MCH125
	MCH13112
MPM1	MPM111
	MPM172
	MPM110
	MPM112
	MPM114
	MPM1161
	MPM117
MPM2	MPM13
MPM3	MPM118
SONCave1-1	SON1111
	SON113
	SON11112
SONCave1-2	SON115
SONCave2-1	SON22121
	SON2325

	SON2326
	SON2329
	SON2330A
	SON24169
	SON24170
SONCave2-2	SON2211
	SON2331
SONCave2-3	SON24148
	SON24171
SONCave2-4	SON2212
	SON242p58
SONCave3	SON313
	SON316
SONCave5	SON515
SONCave7	SON712
Ranracancha	
RCC1	RCC116
	RCC1172
	RCC1114
	RCC1115
	RCC1119
	RCC1128
	RCC1135
	RCC1139
	RCC1142
	RCC1144
RCC2	RCC11241
RCC3	RCC1121
	RCC1123
Pucullu	
PCU1	PCU113
	PCU118
	PCU1111
	PCU1112
	PCU1116
	PCU1118
PCU1	PCU1113
PCU3	PCU1110
Sondor	

SOD1	SOD_1_10
	SOD_1_9
	SOD_1_11
	SOD_2_I4
	SOD_2_I3
	SOD_2_1
	SOD_2_2
	SOD_1_C3
	SOD_2_I1
	SOD_2_I5
	SOD_2_I2
	SOD_1_1
	SOD_1_I1
	SOD_1_2
	SOD_1_2
	SOD_1_I3
	SOD_1_I4
	SOD_5_7
SOD2	SOD_1_I2
	SOD_1_7
SOD3	SOD_1_3

As mentioned in the radiocarbon results section, some of the individuals that were distinct within Cachi, Pucullu, and Ranracancha show temporal patterns. Ranracancha dates to the early LIP, so differences within this population may be due to social factors. Pucullu had dates from the early and late LIP, indicating the population structure is not temporally based. Similar patterns were seen for MPM and Caves 1 and 2 at Cachi in the early LIP, however, the distinct groups of MCH and Caves 3, 5, and 7 were all dated to the late LIP. The initial F4-tests spurred further investigation, and with a greater understanding of time-frame and context, the following analyses are more well-founded.

Based on the new groupings, the investigation continues to explore population structure using F3-tests, which allow to determine the degree of shared genetic drift between two populations in relation to an outgroup population (Patternson, 2012). This estimate of genetic similarity can be translated into a genetic distance matrix between several pairs of populations throughout the Andes and South America, and be visualized in the form of a phylogenetic tree. In this F3 derived tree, the Andahuaylas groups cluster with other South Peru Highland populations such as the Laramate Highlands, Mesayocpata, Charangochayoc, and Campanayuq (Nakatsuka et al., 2020; Figure 30). PCU2 clusters with Bolivia_Totocachi_LIP, which was previously found to have issues in analyses with North Chile and the Highlands, and should be explored further in future research, but this is outside the scope of this project (Popovic et al., 2021). Ollantaytambo_LIP was also found to be a closely associated population, which is to the east of Anduahuaylas towards Cusco (Salazar et al., 2023), while the South Peru Highland populations (more specifically Laramate) are to the west of Andahuaylas (Nakatsuka et al., 2020). To explore these associations further and determine the degree of contribution for these regions, a combination of statistical tests f4(Mbuti, X, Pop1, Pop2), qpWave, and qpADM modeling were performed (Patterson et al., 2006; Patterson et al., 2012).

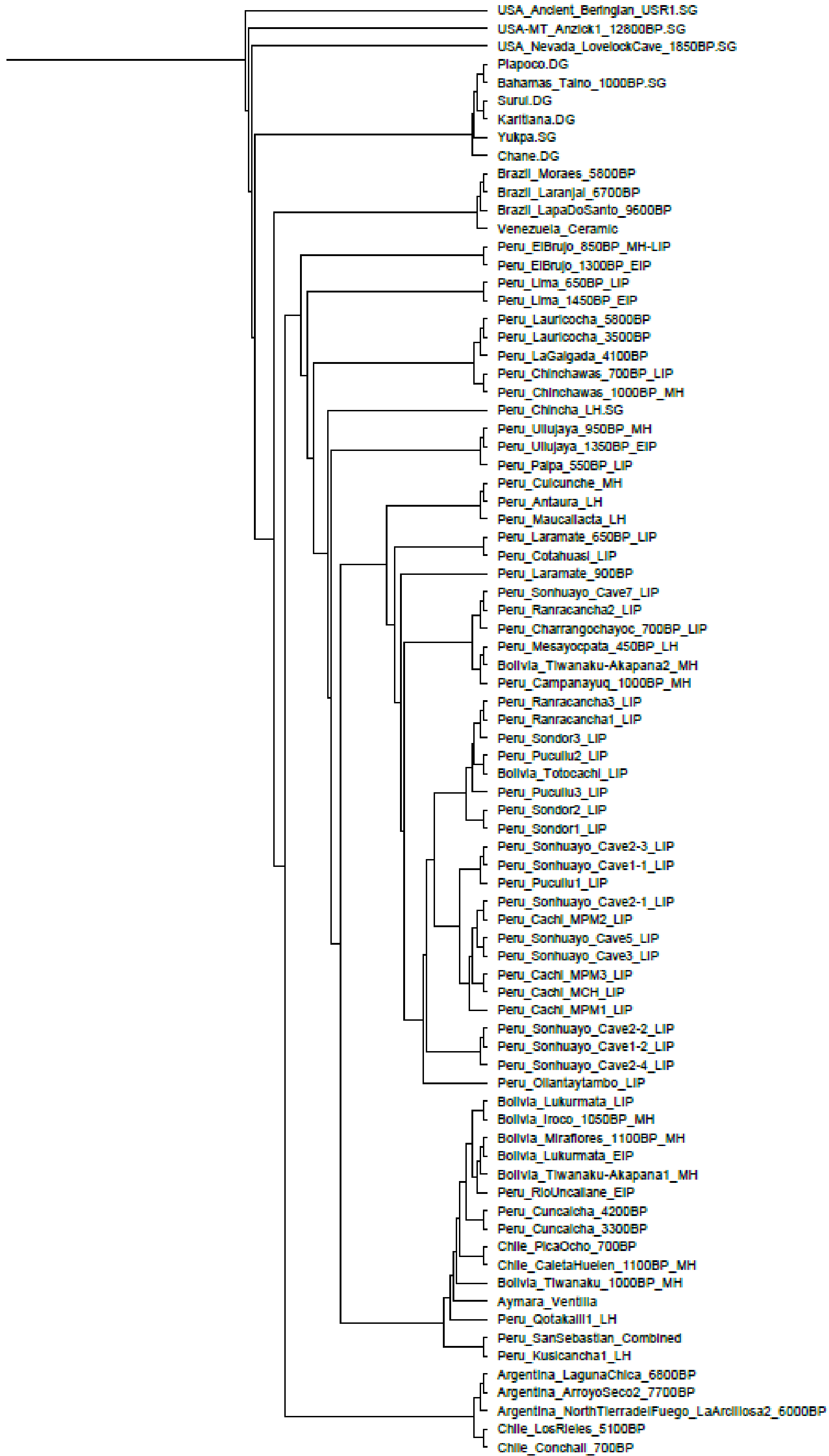

Figure 30. Tree generated from the F3-test (using 1/F3 to translate genetic similarity to genetic distance) using all Andahuaylas groups from this study and other populations in the Americas with a focus on South America.

The f4(Mbuti, X, Pop1, Pop2) test, where Pop1 and Pop2 are each one of the previously determined Andahuaylas groups, and X is any ancient or modern-day population from the Americas (emphasizing the Andean ancestry clusters determined by Nakatsuka et al 2020) was conducted to see if the groups established in the individual f4-tests form clades with other Andean populations, and match the results of the F3-tests. While the PCA and F3 tests revealed that the individuals studied here largely share the same regional genetic ancestry, the results of the F4 tests indicate internal genetic structure in the collective of sites and contexts with subtle contributions of different sources of ancestry contributing to the ancient Andahuaylas gene-pool (Table 17). The genetic homogeneity observed with PCA and F3-statistics in combination with the subtle genetic differentiation observed with the F4-statistics suggests that for most individuals these differences are not due to recent gene-flow processes, but rather due to structured mating within the group's gene-pool. QpWave was used to determine if some of these populations exhibit admixture with any ancestries outside of the South Highland cluster from Nakatsuka et al., (2020) and Salazar et al. (2023).

Table 17. F4-test match and nonmatch results for population groups at all sites in the study. The light green shows nonmatch on the negative end and the dark green on the positive end.

	Cachi_MCH	Cachi_MPM1	Cachi_MPM2	Cachi_MPM3	Pucullu1	Pucullu2	Pucullu3	Ranracancha1	Ranracancha2	Ranracancha3	Sonhuayo Cave1-1	Sonhuayo Cave1-2	Sonhuayo Cave2-1	Sonhuayo Cave2-2	Sonhuayo Cave2-3	Sonhuayo Cave2-4	Sonhuayo Cave3	Sonhuayo Cave5	Sonhuayo Cave7	Sondor1	Sondor2	Sondor3
Cachi_MCH		match	match	match	nonmatch	match	match	match	nonmatch	match	match	nonmatch	match	nonmatch	nonmatch	match	match	match	match	match	nonmatch	nonmatch
Cachi_MPM1	match		nonmatch	match	match	match	match	nonmatch	nonmatch	nonmatch	match	nonmatch	match	match	nonmatch	match	match	nonmatch	match	match	nonmatch	nonmatch
Cachi_MPM2	match	nonmatch		match	nonmatch	nonmatch	nonmatch	match	nonmatch	match	nonmatch	nonmatch	match	nonmatch	nonmatch	nonmatch	match	match	match	nonmatch	match	nonmatch

Sonhuayo_ Cave5	Sonhuayo_ Cave3	Sonhuayo Cave2-4	Sonhuayo_ Cave2-3	Sonhuayo_ Cave2-2	Sonhuayo Cave2-1	Sonhuayo_ Cave1-2	Sonhuayo_ Cave1-1	Ranracancha3	Ranracancha2	Ranracancha1	Pucullu3	Pucullu2	Pucullu1	Cachi_M PM3
match	match	match	nonmatch	nonmatch	match	nonmatch	match	match	nonmatch	match	match	match	nonmatch	match
nonmatch	match	match	nonmatch	match	match	nonmatch	match	nonmatch	nonmatch	nonmatch	match	match	match	match
match	match	nonmatch	nonmatch	nonmatch	match	nonmatch	nonmatch	match	nonmatch	match	nonmatch	nonmatch	nonmatch	match
match	match	match	match	match	match	match	match	nonmatch	nonmatch	nonmatch	match	match	match	
nonmatch	match	match	nonmatch	match	match	nonmatch	match	nonmatch	nonmatch	nonmatch	match	nonmatch		match
match	match	match	nonmatch	match	match	match	match	match	nonmatch	match	match		nonmatch	match
match	match	match	nonmatch	match	nonmatch	match	nonmatch	nonmatch	match	nonmatch		match	match	match
nonmatch	match	match	nonmatch	nonmatch	match	nonmatch	match	nonmatch	nonmatch		nonmatch	match	nonmatch	nonmatch
match	nonmatch	nonmatch	nonmatch	match	nonmatch	nonmatch	nonmatch	nonmatch		nonmatch	match	nonmatch	nonmatch	nonmatch
match	match	match	nonmatch	nonmatch	match	nonmatch	match		nonmatch	nonmatch	nonmatch	match	nonmatch	nonmatch
nonmatch	match	match	nonmatch	match	match	nonmatch		match	nonmatch	nonmatch	nonmatch	match	match	match
nonmatch	match	match	nonmatch	match	nonmatch		nonmatch	nonmatch	nonmatch	nonmatch	match	match	nonmatch	match
match	match	match	nonmatch	nonmatch		match	match	match	nonmatch	match	match	match	match	match
nonmatch	match	match	match		nonmatch	match	match	nonmatch	match	nonmatch	match	match	match	match
match	nonmatch	nonmatch		match	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	match
match	match		nonmatch	match	match	match	match	match	nonmatch	match	match	match	match	match
nonmatch		match	nonmatch	match	match	match	match	match	nonmatch	match	match	match	match	match
	nonmatch	match	match	nonmatch	match	nonmatch	nonmatch	match	match	nonmatch	match	match	nonmatch	match
match	match	match	match	match	match	nonmatch	match	nonmatch	match	nonmatch	match	match	match	match
match	match	nonmatch	nonmatch	nonmatch	match	match	match	match	nonmatch	nonmatch	match	nonmatch	match	match
match	match	match	match	match	nonmatch	nonmatch	nonmatch	nonmatch	match	nonmatch	nonmatch	nonmatch	nonmatch	match
nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	match	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch	nonmatch

Sondor3	Sondor2	Sondor1	Sonhuayo_ Cave7
nonmatch	nonmatch	nonmatch	match
nonmatch	nonmatch	match	match
nonmatch	match	nonmatch	match
nonmatch	match	match	match
nonmatch	nonmatch	match	match
nonmatch	nonmatch	nonmatch	match
nonmatch	nonmatch	match	match
match	nonmatch	nonmatch	nonmatch
nonmatch	match	nonmatch	match
match	nonmatch	nonmatch	nonmatch
nonmatch	nonmatch	match	match
nonmatch	nonmatch	match	nonmatch
nonmatch	nonmatch	match	match
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nonmatch	match	nonmatch	match
nonmatch	match	nonmatch	match
nonmatch	match	match	match
nonmatch	match	nonmatch	match
nonmatch	match	match	
nonmatch	nonmatch		match
nonmatch		nonmatch	match
	nonmatch	nonmatch	nonmatch

QpWave pairs two or more target populations to test if they are genetically homogenous (can be explained by one wave of genetic ancestry) in relation to a number of outgroups. The qpWave tested each of the Andahuaylas groups against a set of ancestry clusters from throughout South America (Piapoco, MachuPicchu_Amazon, Karitiana, Chane, NorthPeruCoast, CentralPeruCoast, TiticacaBasin, NorthChile, SouthPeruCoast, SouthPeruHighland, and PeruOllantaytamboLIP). Here, Ollantaytambo is east of Andahuaylas, and SouthPeruHighlands represents west of Andahuaylas. Based on p-values >0.05, MCH, PCU1, PCU2, RCC3, SONCave2-1, SONCave2-4, SONCave3, SONCave7, and SOD1 share ancestry with Ollantaytambo. SONCave1-2 shares ancestry with SouthPeruHighland (p-value >0.05). SONCave2-3 and SONCave5 share ancestry (p-value >0.05) with both Ollantaytambo and SouthPeruHighland. For the remaining groups, MPM1, MPM2, MPM3, PCU3, RCC1, RCC2, SONCave1-1, SONCave2-2, and SOD2 and 3, no singular population match could be determined, suggesting that they might be admixed between two or more ancestries. To explore potential admixture models we used qpADM, which both allows to test for feasible combinations of ancestry sources explaining the ancestry observed for an individual / group, and to quantify each of those ancestry contributions (Patterson et al., 2006; Patterson et al., 2012). A summary of all tested models can be found in Table 18. Overall, most confirmed admixture models suggest an admixture between ancestry deriving from the South Central Peruvian Andes (PeruSouthHighland and/or Ollantaytambo) with either Amazonian-, Coastal-, or North Chile associated ancestry. For most groups we find several competing admixture models, indicating that the actual source of ancestry cannot be identified, or that the admixture process happened many generations ago, before the contemporary genetic structure was established. Most models have in common that the South Highland associated ancestry component is always dominant (ranging from 60% to 95%). RCC1 and Sondor 3 do not fit a one-way or two-wave model, and cluster together in the F3 tree, therefore they may share an ancestry not yet known or not sampled for this study. Overall, RCC1 and Sondor 3 still fit within the broader range of the South Peru Highland populations within the other analyses.

Table 18. Summary results of the qpADM and qpWave tests.

	qp-Wave	**p-value**
MCH	Peru_Ollantaytambo_LIP	0.112234125
PCU1	Peru_Ollantaytambo_LIP	0.201249373
PCU2	Peru_Ollantaytambo_LIP	0.45107946
RCC3	Peru_Ollantaytambo_LIP	0.255843464
SONCave2-1	Peru_Ollantaytambo_LIP	0.395031005
SONCave2-4	Peru_Ollantaytambo_LIP	0.382865317
SONCave3	Peru_Ollantaytambo_LIP	0.421844112
SONCave7	Peru_Ollantaytambo_LIP	0.046247314
SOD1	Peru_Ollantaytambo_LIP	0.112351956
SONCave1-2	SouthPeruHighland	0.260766507
SONCave2-3	Peru_Ollantaytambo_LIP	0.664203468
	SouthPeruHighland	0.251569703
SONCave5	Peru_Ollantaytambo_LIP	0.940113688
	SouthPeruHighland	0.856778257

	qp-ADM	**% Contribution**
MPM1	Ollantaytambo vs. Amazon	~92-97 % Ollantaytambo, ~3-8% Amazon

	Ollantaytambo vs. NorthPeruCoast	83.9% Ollantaytambo, 17.1% NorthPeruCoast
	Ollantaytambo vs. NorthChile	85.3% Ollantaytambo, 14.7% NorthChile
PCU3	Ollantaytambo vs. Amazon	~84-92% Ollantaytambo, ~8-16% Amazon
	Ollantaytambo vs. CentralPeruCoast	72.1% Ollantaytambo, 27.9% CentralPeruCoast
	Ollantaytambo vs. NorthPeruCoast	69.3% Ollantaytambo, 30.7% NorthPeruCoast
	SouthPeruHighlands vs. Amazon	86% SouthPeruHighlands, 14% Amazon
RCC2	SouthPeruHighland vs. Amazon	~73-85% SouthPeruHighland, ~14-26%
	SouthPeruHighland vs. NorthPeruCoast	62.7% SouthPeru Highland, 37.3% NorthPeruCoast
	SouthPeruHighland vs. CentralPeruCoast	67.9% SouthPeruHighland, 32.1% CentralPeruCoast
	SouthPeruHighland vs. TiticacaBasin	62.4% SouthPeruHighland, 37.6% TiticacaBasin
	SouthPeruHighland vs. NorthChile	61.4% SouthPeruHighland, 38.6% NorthChile
	Ollantaytambo vs. Amazon	~76-85% Ollantaytambo, ~15-24% Amazon
	Ollantaytambo vs. NorthPeruCoast	51.3% Ollantaytambo, 48.7% NorthPeruCoast
	Ollantaytambo vs. CentralPeruCoast	59.9% Ollantaytambo, 40.1% CentralPeruCoast
	Ollantaytambo vs. NorthChile	53.6% Ollantaytambo, 53.6% NorthChile
SONCave1-1	Ollantaytambo vs. Amazon	~84-94% Ollantaytambo, ~6-16% Amazon
SONCave2-2	SouthPeruHighland vs. Amazon	~81-90% SouthPeruHighland, ~10-19% Amazon
	SouthPeruHighland vs. NorthPeruCoast	76.4% SouthPeruHighland, 23.6% NorthPeruCoast
	SouthPeruHighland vs. CentralPeruCoast	70.9% SouthPeruHighland, 29.8% CentralPeruCoast
	SouthPeruHighland vs. TiticacaBasin	676% SouthPeruHighland, 32.4% TiticacaBasin
	SouthPeruHighland vs. NorthChile	69.5% SouthPeruHighland, 30.5% NorthChile
	Ollantaytambo vs. Amazon	~82-86 Ollantaytambo, ~14-18% Amazon
	Ollantaytambo vs. NorthPeruCoast	68% Ollantaytambo, 32% NorthPeruCoast

	Ollantaytambo vs. CentralPeruCoast	60.3% Ollantaytambo, 39.7% CentralPeruCoast
	Ollantaytambo vs. NorthChile	60.9% Ollantaytambo, 39.1% CentralPeruCoast
SOD1	Ollantaytambo vs. NorthPeruCoast	80% Ollantaytambo, 20% NorthPeruCoast
	Ollantaytambo vs. CentralPeruCoast	86% Ollantaytambo, 14% CentralPeruCoast
	Ollantaytambo vs. SouthPeruCoast	81% Ollantaytambo, 19% SouthPeruCoast

The early LIP samples at Cachi, Ranrancancha, and Pucullu show that individuals with different ancestry groupings were found within the same sites and burial caves. The mixture may be due to the exogamy practices hypothesized in the isotopes section, introducing structure into the populations, or connections further back in time. RCC1 holds the majority of individuals at Ranracancha and is distinct, which may match the hypothesis established from the isotopic analyses that different behaviors were occurring at this site due to isolation and increased stress.

The genetic diversity in these sites does not appear to be from recent admixture, and instead matches the isotopic findings that the populations at Cachi, Ranracancha, Pucullu, and Sondor are individuals from within the general region in or around Andahuaylas. The associations with populations east and west of Andahuaylas in the isotopes are also seen in the genetic analyses, which may indicate continued gene flow through time between the regions or that the original migrants to Andahuaylas came from these regions. The same population mixtures were present in the late LIP at Cachi and Pucullu. Although population size declined during the late LIP, the same populations appear to still be present at these sites without the introduction of further diversity between the early LIP and late LIP, when the Inca were present.

Relatedness and Kinship Results and Discussion

The population structure for Cachi, Ranracancha, Pucullu, and Sondor show a general cluster of local individuals within the region matching the expectations of the South Peru Highlands. However, diversity estimates can establish if the diversity within the region was evenly spread within all contexts and sites. The contexts of Pucullu, MPM, Sondor, and Sonhuayo match the diversity estimates (>0.20) seen at other sites such as Ollantaytambo and Laramate (Table 19**)**. The MCH context within Cachi and Ranracancha both have lower diversity estimates. The lower diversity estimates can be explained through the Runs of Homozygosity (ROH) estimates (Figure 31) (Ringbauer et al., 2021). At MCH, there are a large number of shorter runs of ROHs, indicating a limited population or small gene pool over time (Fernandes et al 2021), therefore creating less diversity in the context. RCC shows a large number of long runs of ROHs, an indicator of inbreeding within the population, which would also create a lower degree of diversity in the population (Ringbauer et al., 2020, 2021). In addition to relatedness values, these estimates can contribute to how we assess the kinship and connections between communities and contexts in Andahuaylas.

Table 19. Conditional heterozygosity (CH) found at the Andahuaylas populations compared to other sites in South America.

Population	CH	SD	Z
Pucullu	0.202692	0.00092868	218.2584
Ranracancha	**0.192551**	0.00091015	211.5586
MCH	**0.177775**	0.00113745	156.2934
MPM	0.200626	0.00091359	219.6025
Sonhuayo_Cave1	0.203714	0.0011668	174.5926
Sonhuayo_Cave2	0.204738	0.00094772	216.0321
Sonhuayo_Cave3	0.200125	0.00193869	103.2266
Sondor	0.202132	0.00086905	232.5894
Ollantaytambo	0.200587	0.00097269	206.2176
Laramate_650BP	0.205245	0.00112287	182.7856
Laramate_900BP	0.203545	0.00109255	186.3028
Peru_Lima_LIP	0.203688	0.00109476	186.0578
Peru_ElBrujo_MH-LIP	0.20829	0.00113268	183.8907
Bolivia_Lukurmata_LIP	0.207472	0.00127056	163.2923
Bolivia_Miraflores_LIP	0.204994	0.00110338	185.787
Peru_Chinchawas_LIP	0.198203	0.00120021	165.1411
Peru_Palpa_LIP	0.208632	0.00143611	145.2754

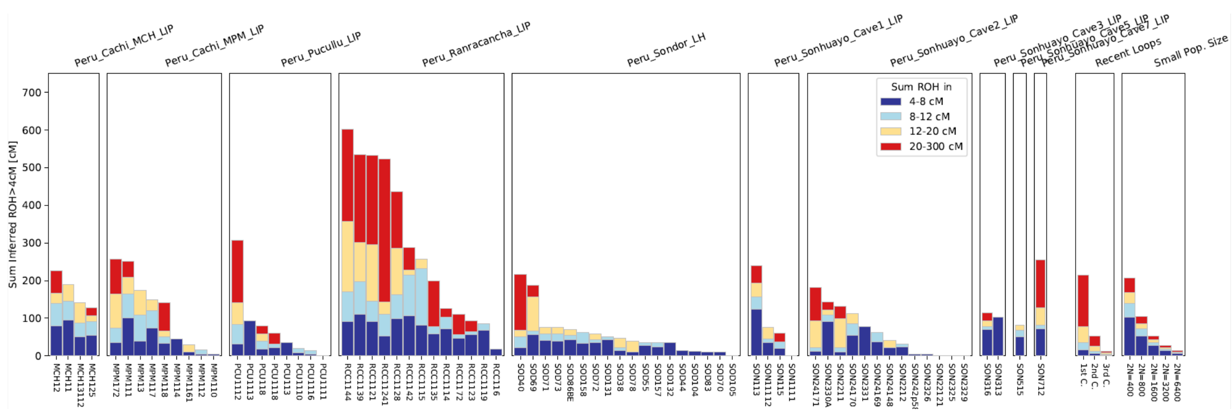

Figure 31. The figure shows the ROHs for individuals within each context. The last two boxes show the expectation of ROH if an individual's parents had a specific degree of relatedness, or if there was a limited population size.

Cachi Early LIP

The two sectors of Cachi included in this study are Mina and Sonhuayo. Beginning with Mina, two caves were included in the study: MCH and MPM. The MCH individuals dating to the MH were not sampled; only individuals associated with the late LIP dates were sampled.

Additional dates may be needed to fully understand the context, but based on current information, MCH will be assessed as a late LIP group in the next section. The MPM cave at Mina dates to the early LIP and shows *annular erect, annular oblique*, unmodified, males, and females all buried together in one context. Nine individuals from MPM were included for isotopic and genetic analyses, all local, with a summary of relatedness found in Table 20**.** We observe a group of 4 individuals who are either second- or third-degree relatives, with both styles of cranial modification and unmodified individuals present among these relatives. Although complete kinship cannot be assessed, it shows more distant relatives are buried in the same cave with more closely related individuals (first-degree) possibly marrying into other kin groups. To support this, we also saw that MPM does not show long runs of ROH and falls within the expected diversity estimates, indicating a large gene pool. These results match the expectation for the early LIP of exogamous marriages within *ayllu* groups (Isbell, 1997; Skar, 1982).

Table 20. Relatedness results for the Cachi MPM context.

Individual	Age	CVM	Sex	Degree of Relatedness
MPM.01.01.01	YA	Annular Erect	F	Second: MPM117, 13
MPM.01.17	J/YA	Annular Oblique	M	Second: MPM111
MPM.1.10	MA	Unmod	M	Third: MPM112
MPM.1.12	MA	Unmod	M	Third: MPM110
MPM.1.3	YA/MA	Annular Erect	M	None
MPM.1.7	YA	Annular Slight	F	None
MPM.1.14	YA/MA	Unmod	M	None
MPM.1.16	YA	Unmod	M	None
MPM.01.18	-	Annular Erect	F	None

The Sonhuayo early LIP sample includes Caves 1 and 2. These caves are the largest seen at the site of Cachi, and interesting patterns of kinship emerge. Both caves have diversity estimates and ROH results showing a larger gene pool, which matches the assessment that they are not marrying with close kin and instead were performing exogamy. The degrees of relatedness indicates that these two caves share a first- and second-, possibly third-degree relatives between them, indicating they are part of the same kin group. The summary of relatedness can be found in Table 21. The most interesting finding is that there is a sister and brother found in different caves, with the sister (SON.01.01.11) in Cave 1 found to be local, while the brother (SON.02.03.25) found in Cave 2 is non-local. In addition, a female in Cave 1 (SON.01.01.03), with possible second-degree relatedness with SON.01.01.11, has a second-degree relation to SON.02.03.29, another non-local male found in Cave 2, with other relatives in Cave 2. There could be endless reasons why these two males have non-local values, while clearly their family is based in Cachi. Due to the flexible nature of the *ayllu*, and the tendency of individuals to move where resources are available during tough times, it may be that these two individuals were born before movement to Cachi, with the other relatives born later. Another possibility is that these two men were moved during childhood for labor purposes to *ayllu*-related communities in need of extra help, but moved back in adulthood. One individual, SON.02.02.12, is a second-degree relative to an individual in Cave 5, SON.05.01.07, which is dated to the late LIP. The connections between these individuals are discussed in the late LIP section.

Table 21. Relatedness results for the Cachi Sohuayo Cave 1 and 2. Non-local individuals are in bold.

Individual	Age	CVM	Sex	Degree of Relatedness
SON.01.01.11	YA	Annular Erect	F	First: Siblings, SON2325 Possible Second: SON113
SON.01.01.03	MA	Annular Erect	F	Second: SON2329; Possible Second: SON1111
SON.01.01.05	MA	Annular Erect	M	Possible Second: SON020329
SON.02.03.25	**MA**	**Unmod**	**M**	**First: SON1111, Siblings** **Possible Second: SON2329**
SON.02.03.29	**MA**	**Annular Erect**	**M**	**Second: SON020212, SON2330A, SON113** **Possible Second: SON2325**
SON.02.02.12	MA	Annular Erect	F	Second: SON020329, SON517 Possible Third: SON115
SON.02.03.30A	MA	Annular Erect	F	Second: SON2329
SON.02.02.01	MA	Annular Erect	M	None
SON.02.02.11	YA	Annular Oblique	M	None
SON.02.03.26	J/YA	Annular Erect	F	None
SON.02.03.31	YA	Annular Erect	F	None
SON.02.04.1.69	YA	Annular Oblique	F	None
SON.02.04.1.70	MA	Annular Erect	M	None
SON.02.04.1.71	MA	-	F	None
SON.02.04.2.p.58	OA	Annular Erect	F	None
SON.02.04-1.48	YA	Annular	F	None

Individual	Age	CVM	Sex	Degree of Relatedness
SON.01.01.11	YA	Annular Erect	F	First: Siblings, SON2325 Possible Second: SON113
SON.01.01.03	MA	Annular Erect	F	Second: SON2329; Possible Second: SON1111

SON.01.01.05	MA	Annular Erect	M	Possible Second: SON020329
SON.02.03.25	MA	Unmod	M	First: SON1111, Siblings Possible Second: SON2329
SON.02.03.29	MA	Annular Erect	M	Second: SON020212, SON2330A, SON113 Possible Second: SON2325
SON.02.02.12	MA	Annular Erect	F	Second: SON020329, SON517 Possible Third: SON115
SON.02.03.30A	MA	Annular Erect	F	Second: SON2329
SON.02.02.01	MA	Annular Erect	M	None
SON.02.02.11	YA	Annular Oblique	M	None
SON.02.03.26	J/YA	Annular Erect	F	None
SON.02.03.31	YA	Annular Erect	F	None
SON.02.04.1.69	YA	Annular Oblique	F	None
SON.02.04.1.70	MA	Annular Erect	M	None
SON.02.04.1.71	MA	-	F	None
SON.02.04.2.p.58	OA	Annular Erect	F	None
SON.02.04-1.48	YA	Annular	F	None

SON.02.03.29 is distinct since he has a highly modified *annular erect* modification, with *annular erect* seen in all the other relatives at lesser modification degrees, except for SON.02.03.25, who is unmodified. SON.02.03.29, with the most relatives in the caves, may have been the head of the kin group or a main contributor to the gene pool. The highly modified CVM is distinct and purposeful, and the other male relative did not have a modification while his sister does, could point to lineage or status choices in modification style.

The early LIP Chanka contexts of MPM and Sonhuayo Caves 1 and 2, who together have the largest number of individuals at the site, show patterns of first-degree kin being buried in separate contexts. At Sonhuayo Cave 1 and 2, we have the opportunity to see that this may be based on sex, with a male and female sibling pairing being buried in separate caves. In addition, the study reveals that the non-local males, previously assessed in the isotopes section as possibly being brought in for marriage purposes, are found to have relatives (even first-degree) within Cachi. While the gene pool holds diversity, the contribution may not be due to marriage arrangements with communities outside the region of Andahuaylas, but instead the original movement of people to the area after the MH holding this diversity. And there may be more diversity present due to the larger mortuary population sizes found in these contexts. Since these caves only hold a few generations of individuals, the patterns may indicate marriage between kin groups within the site itself, instead of with outside groups. The early LIP was a violent and competitive time, and once groups split into their separate communities, they may have had to hold control of their limited resources and therefore did not marry outside of the immediate area.

Ranracancha

The same need to keep local resources within a close-knit kin group is also observed at Ranracancha, but to a higher degree. The physical location of Ranracancha is isolated, which may have been purposeful for extra protection from external competition. The diversity estimates for Ranracancha are low, and in combination with long runs of ROHs, the population at Ranracancha had a small gene pool of closely related individuals (inbreeding). Unlike Cachi, degrees of relatedness between individuals in Ranracancha show first-, second-, and third-degree relatives all buried together. RCC.01.01.42 based on age-at-death and estimate of parent offspring relationship, is the father of RCC.01.01.14 and RCC.01.01.15. In support of this, RCC.01.01.14 and RCC.01.01.15 are also determined to be siblings (sisters). As seen in Table

22, the majority of individuals buried in the cave are related and share the same *annular oblique* cranial modification. Osteological analysis does show a few individuals buried in the cave that have *annular erect* modifications, but unfortunately, they were not part of this genetic study. Although some individuals with *annular oblique* are not closely related in the cave, the majority are, and this could point to a kin basis for cranial modification at Ranracancha. Similar to Cachi, a young adult male (RCC.01.01.07) is non-local but related to other individuals in the *machay*. RCC.01.01.07 may have been moved for labor purposes as a child in another community, but all other indicators point to an isolated population groups/gene pool, making it more likely the individual was part of the founding migrants to the site. The diversity estimates, long runs of ROHs, and closely related individuals all show evidence of the isolation of Ranracancha from other groups in the area during the early LIP. The need to keep resources within their kin group may have driven the people of Ranracancha to these extreme circumstances.

Table 22. Relatedness results for the Ranracancha. Non-local individuals are in bold.

Individual	Age	CVM	Sex	Degree of Relatedness
RCC.01.01.42	MA	Annular Oblique	M	Children: RCC1115, RCC1114 Second: RCC1121
RCC.01.01.14	YA	Annular Oblique	F	Father: RCC1142, Sibling: RCC1115 Second: RCC1121
RCC.01.01.15	YA	Annular Oblique	F	Father: RCC1142, Sibling: RCC1114 Second: RCC1121
RCC.01.01.21	MA	Annular Oblique	M	Second: RCC1114, RCC1115, RCC1142, RCC1144 Second or Third: RCC1119, 1107, RCC116

RCC.01.01.44	YA	Annular Oblique	F	Second: RCC1121, 1128, 1139, 1142
RCC. 01.01.28	-	Annular Oblique	F	Second: RCC1139, 1142, 1144, 1121
RCC.01.01.39	J/YA	Annular Oblique	F	Second: RCC1128, 1142, 1144, 1121 Third: RCC1114, 1115
RCC.01.01.19	YA	Annular Oblique	M	Second or Third: RCC1121 Third: RCC1142, 22121
RCC.01.01.07	**J/YA**	**Annular Oblique**	**M**	**Second or Third: RCC1121**
RCC.01.01.06	YA	Annular Oblique	F	None
RCC.01.01.23	YA	Annular Oblique	F	None
RCC.01.01.24	YA	Annular Oblique	F	None
RCC.01.01.35	J/YA	Annular Oblique	F	None

Pucullu

While Pucullu fits into the broader population expectation for the region with genetic diversity and typical runs of ROH, no individuals were found to have close degrees of relatedness within Pucullu. The lack of related individuals is likely due to sampling error. However, following the same logic used at Cachi, the non-local males within this sample may have been first generation migrants to the area, but additional radiocarbon dates are needed to confirm this.

Cachi Late LIP to LH

The study began with the expectation that majority of the population at Cachi was from the early LIP, however additional radiocarbon dates found that the caves of MCH and Sonhuayo Caves 3, 5, and 7 dated to the late LIP. As mentioned, all of these caves are smaller compared to the early LIP samples at Cachi, indicating a possible population decline, but evidence that the Chanka were still in the area, even with Inca presence. With the addition of genetic analyses, there is more support for this hypothesis.

Caves 3, 5, and 7 show longer runs of ROHs, which are indicators of a small gene pool/breeding population. If the population size was greatly reduced in and around Cachi during the late LIP into the LH, there may have been less options for partners (a smaller-scale bottleneck event). However, other than the samples for the late LIP matching the broader expectations for the region, we see a relative pairing between Cave 2 and Cave 5. Individual SON.02.02.12 and SON.05.01.07 are second-degree relatives. Individual SON.02.02.12 is radiocarbon dated to the early LIP (calAD 95.4% prob 1162-1267), while SON.05.01.07 is associated with an individual dating to the LH/colonial period (SON.05.01.05). Even though SON.05.01.05 is dated later than the late LIP, there is evidence of a connection to late LIP individuals and the Chanka. SON.05.01.05 is the young-adult daughter of a middle-aged woman in Cave 3 (SON.03.01.03), and Cave 3 is associated with a late LIP date. To put this all together, individual SON.05.01.07 is likely the grandson of individual female SON.02.02.12, both of whom have an *annular erect* modification. In addition, unmodified individual SON.03.01.03 is the mother of *annular erect* young-adult woman SON.05.01.05. These individuals show the continuation of the Chanka from the early to late LIP into the LH/colonial period. It is also important to note that cranial modifications continue to be seen in these later periods, holding onto that identity even with massive socio-political changes occurring around them. A summary of relatedness for the late LIP Cachi can be found in Table 23.

Table 23. Relatedness results for the Cachi Sohuayo Cave 3, 5, and 7.

Individual	Age	CVM	Sex	Degree of Relatedness
SON.03.01.03	MA	Unmod	F	First: SON515, mother-daughter
SON.03.01.06	YA	Annular	F	None
SON.05.01.05	YA	Annular Erect	F	First: SON313, mother-daughter
SON.05.01.07	YA	Annular Erect	M	Second: SON020212
SON.07.01.02	MA	Annular Slight	M	None

The MCH cave is a unique case. A previous study (Kurin, 2012) found dates in the MH, with one date in the late LIP. Excluding individuals associated with the MH dates, the current study provided one additional radiocarbon date, also found within the late LIP (1279-1384, calAD 95.4% prob). Without any evidence of use during the early LIP, the cave may have been used again during the late LIP after population decline in the region. Based on kin patterns determined from the early LIP Cachi contexts, particularly MPM found in the same sector, differences are observed in this possible late LIP context. Diversity estimates at MCH show much less diversity than the early LIP MPM, with short runs of ROH indicating a small gene pool. The patterns for degrees of relatedness also differ, with a male (MCH.01.03.05; labeled MCH125 within the genetic studies) and female (MCH.01.01) siblings found buried together (Table 24), whereas the early LIP Cachi contexts had first-degree relatives separated into different caves. All individuals in this study, except MCH.01.01, have the *annular erect* modification, another indicator of a close kin group. The pattern here might be similar to

Ranracancha, where a now depleted population taking up desperate means to keep kin and resources together, such as burying all kin together in one cave.

Table 24. Relatedness results for the Cachi MCH.

Individual	Age	CVM	Sex	Degree of Relatedness
MCH.01.01	MA	Unmod	F	First: sibling MCH125(135) Second: MCH13112
MCH.01.03.05	YA	Annular Erect	M	First: sibling MCH11 Second: MCH13112
MCH.01.03.11	YA	Annular Erect	M	Second: MCH11, 125
MCH.01.02	-	Annular Erect	F	

Late LIP Sondor

The above section establishes that the Chanka are still present at the site of Cachi during the late LIP, with late LIP dates also found at Pucullu. The samples from Sondor in the current study are all dated to the late LIP, but very different behaviors are seen at Sondor compared to the Cachi, Ranracancha, and Pucullu populations. Overall, Sondor matches the genetic expectations for the region with normal diversity estimates and ROHs. What this establishes is that at this point in time, or in this region, the Inca were not moving distant populations to Sondor. However, the larger range from the isotopes compared to the early LIP sites, indicates while although they are from the same broader genetic groupings, the individuals at Sondor moved from different sites within Andahuaylas or from areas nearby Andahuaylas. People from a variety of elevations in the general region would explain why the genetics do not introduce new variation, but the isotopes indicate a wider range, even showing values from low elevations ($\delta^{18}O$ around -3).

The Unit 1 *machay* has individuals SOD_1_9, SOD_1_1, and SOD_1_2, who were all identified as non-locals from lower elevations in the isotopic section, but the genetics shows they are not outliers for the region. These results indicate that these individuals, instead of being from somewhere such as the coast, are from a lower elevation close to Andahuaylas. Based on findings by Kellett (2022) and Skar (1982), a combination of ethnographic and archaeological research, the Chanka *ayllus* were made up of communities from valley floors to the highest peaks to take advantage of different resources. If individuals were forcefully being moved to Sondor by the Inca, or choosing to move to Sondor based on changing sociopolitical situations in the region, then having genetically similar individuals from lower elevations is feasible.

These non-local individuals found a home at Sondor though. The Unit 1 *machay* shows non-locals SOD_1_9 and SOD_1_1 have local relatives (Table 25). SOD_1_9, a middle-aged female who originally stood out based on her perimortem BFT, scraping trepanation, and non-local isotopic values, also stands out because of the number of relatives she has in the Unit 1 *machay*. The SOD_1_1 female, with a similar isotopic signature, is a first-degree relative of SOD_1_9, while a local juvenile (SOD_1_I4, isolated tooth) is also a first-degree relative to SOD_1_9 and second-degree relative to SOD_1_1. Based on these results, it is likely that SOD_1_9 is the mother to juvenile SOD_1_I4, with SOD_1_1 being the sister and aunt. SOD_1_2, the third non-local female, has a second-degree relation to juvenile SOD_2_I3, found commingled on top of the two articulated males in Unit 2. Unit 1 is above Unit 2 on the hillside of *Muyu Muyu*, and since the juvenile isolated tooth SOD_2_I3 was found at or near the surface, it should be acknowledged that the tooth might have fallen from Unit 1. The alternative is individuals from Unit 1 were possible offerings or buried above the two males in Unit 2. Either way, the non-local females have local relatives buried with them in Unit 1, including one local offspring, indicating incorporation of these females into a local kin group, or they were the first generation of migrants for the kin group found in Unit 1. It should be noted that all adult individuals related in Unit 1 are female, even though local males are buried in the *machay*. Taking into account sampling error, the current patterns point to this kin unit being female kin focused, possibly due to arriving from the same region together.

Table 25. Relatedness results for Sondor.

Individual	Age	CVM	Sex	Degree of Relatedness
SOD_1_9	MA	Unmod	F	First: SOD_1_1, SOD_1_I4 Second: SOD_1_10, SOD_1_7, SOD_1_I1
SOD_1_1	MA	Unmod	F	First: SOD_1_9 Second: SOD_1_7, SOD_1_I1, SOD_1_I4
SOD_1_I4	J	-	-	First: SOD_1_9 Second: SOD_1_1
SOD_1_7	J	Unmod	-	Second: SOD_1_1, SOD_1_9, SOD_1_I1, SOD_1_I4
SOD_1_10	YA	Annular Oblique	F	Second: SOD_1_9
SOD_1_I1	J	-	-	Second: SOD_1_9, SOD_1_1
SOD_1_2	YA	Unmod	F	Second: SOD_2_I3
SOD_2_I3	J	-	-	Second: SOD_1_2

The possible isolated *capacocha* offering found above and to the west of the Unit 1 *machay*, (Context 3) was found to be local based on isotopic and genetic evidence, with no relatives in the sample. Thus far, studies show more elaborate Inca *capacochas*, but at its basic level it is an offering to the sacred mountains representing Inca power and incorporation of that landscape through shared ideology (Andrushko et al., 2011; Clinker, 2022). The Inca were present at Sondor during the LIP, while they were still at a state level, the local child offering found in Unit 1, Context 3 may be an early representation of take-over and a *capacocha*. Alternatively, child sacrifices were found beneath the individual in Unit 2 and under an individual in Unit 5, both of which were in the same age range (~1-3 years old) as the child in Unit 1, Context 3, and this may have been a local practice. However, DNA and isotopes could not be done for these offerings, and the context differs for Unit 1, Context 3. Finally, another is the Unit 1, Context 3 child was an additional abandonment practice, similar to the individuals found under the floor in Unit 5. The child was local, in a bundle position, and placed upright into the ground, similar to the individuals in Unit 5. To confirm this practice, future excavations would have to explore *Muyu Muyu* for more child sacrifice bundles.

The two articulated male individuals buried together in Unit 2 are from the general area based on isotopes and genetic markers, but are not related to each other, despite having the same highly modified *annular erect* CVM, perimortem BFT, and being buried together. It was hypothesized that these individuals were buried in a cist tomb with a child sacrifice below them due to a status or accomplishment in life, such as leaders, or warriors based on their violent deaths. The cist tomb could have also been a marker of these individuals coming from a higher elevation where the practice was more common, but the isotopes do not indicate that they were born at higher elevations and the expectation would be that related individuals would be buried together, which they are not.

Unfortunately, only one individual had a successful extract in Unit 5, SOD_5_7, the young adult unmodified male buried within the household. This individual did not share any close relatives with Units 1 or 2, but similar to their isotopic results, the individual matched the local expectation for the region. Aside from the one non-local individual buried outside the house, the individuals in the house were local and likely shared similar genetics to individual SOD_5_7, pointing to local individuals being used for the abandonment rituals at Sondor.

Conclusions

The addition of genetic analyses further illuminated the complexity of social structure and activities within Andahuaylas during the early and late LIP. The populations at Cachi, Ranracancha, Pucullu, and Sondor were found to match the regional expectations, with closer affiliations towards the east (Ollantaytambo), some flow from the west (SouthPeruHighlands), and older genetic structure similarities to Amazonia, N Chile, and Coastal populations. The diversity of these populations was found in both the early and late LIP, showing genetic continuity, despite Inca presence in the region during the late LIP.

Based on the $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ analyses, the early LIP contexts at Cachi and Ranracancha shared patterns of in-migration of males from the E/SE. However, genetic analyses revealed that these male individuals have close genetic relatives with local of $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values. The new evidence points to these males being part of the first migration of individuals into Andahuaylas from the east, which matches the broader associations with the population at Ollantaytambo. In addition, some non-local females were found to have come from the west, explaining the associations with the SouthCentralPeru population. There is evidence of occupation in Andahuaylas during the MH, but archaeological evidence shows a population increase/influx during the early LIP after the Wari Empire collapsed (Bauer et al., 2010; Kurin, 2012). First-generation migrants may have founded the new kin groups during the early LIP.

The early LIP Cachi contexts of MPM and Sonhuayo Caves 1 and 2, share patterns of first-degree relatives being buried in separate caves from each other. These contexts only have second- and third- degree relatives buried together, with Sonhuayo Caves 1 and 2 showing patterns of kin attachment with a brother and sister buried in different caves. Here, the siblings and other close kin being buried and possibly marrying locally, which could be due to violence and competition from other groups. Other studies have showed scored the increased violence during the early LIP, with these sites being built on fortified hilltops (Bauer et al., 2010; Kurin, 2012). Finding a marriage partner or building an alliance may not have been feasible. It appears the influx of individuals to Cachi was large enough to keep a diverse population for the first couple of generations of occupation, though. Although no close genetic relatives were found in the sample at Pucullu, the same patterns are seen with a possible first-generation migrant male coming from the E/SE, except from a different region than the Cachi males

Ranracancha has a non-local young adult male with similar $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values as the non-local males at Cachi. There is a chance the two populations migrated from the same area originally. However, a much smaller population migrated to Ranracancha, with only one burial cave present at the site. The site is isolated, and appears to have also remained genetically isolated for the few generations that lived there, with high-degrees of inbreeding present. The individuals at Ranracancha may have stayed relatively hidden for protection during the increased violence in the region, with little to no gene flow between Ranracancha and other communities.

The archaeological evidence for the late LIP shows a dramatic drop in population size in the region (Bauer et al., 2012), but the radiocarbon dates, isotopic, and genetic analyses reveal that the Chanka persisted at Cachi in lower numbers. The radiocarbon dates at Cachi place caves MCH and Sonhuayo Caves 3, 5, and 7 within the late LIP. Each cave has fewer individuals buried together than the early LIP caves, and long runs of homozygosity pointing to a smaller gene pool. This is especially prominent at MCH that also has less diversity present with first-degree relatives buried together, and may have stayed isolated like Ranracancha. However, in the Sonhuayo sector Caves 2, 3, and 5, we see that the practices of kinship at Cachi continued to smaller degrees through time. First- to second- degree relatives are identified in different caves of different generations, with a possible grandparent in early LIP Cave 2 and grandchild in the LH/colonial Cave 5, and a late LIP mother in Cave 3 and LH/colonial daughter in Cave 5. Through this we see the continuation of kinship practices that persisted despite population decline and presence of the Inca.

What is also identified is a kin basis for CVM practices. Although the picture is incomplete, there is no evidence of CVM present in Andahuaylas before the LIP, and if people migrated into the region, they brought the practice with them. The early LIP sites, where exchange between kin groups/caves is present, we see higher degrees of mixed cranial modifications and unmodified individuals, especially within the bigger caves of MPM and Sonhuayo Cave 2 (see Appendix B). The mixture can be explained by the exchange of marriage partners between kin groups, with marriage partners being buried in the *machay* of the group they married into. Close kin (second- to third- degree) are also more likely to have the same CVM. However, first-degree relatives (siblings, mother-daughter) were found without matching CVM, with one unmodified and the other modified. The decision here may be due to lineage patterns and birth order deciding who has a modification. Further evidence for CVM kin relations is the more isolated kin group at Ranracancha holds a higher degree of closely related individuals buried together, with all related individuals displaying the same CVM (*annular oblique*).

The activities and behaviors at Sondor are very different from what is observed at the early and late LIP sites of Cachi, Ranracancha, and Pucullu. Here there is evidence of populations migrating or being brought to Sondor from different regions and elevations, displaying a broader range of $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values, but not so distant that they differ genetically. Within the Unit 1 *machay*, non-local women have local kin through the establishment of a second generation, with burial placement appearing to be based on kinship with these non-local women. The mortuary style and goods match what is observed for the early LIP Chanka, providing further evidence that the women are not from a distant location, just further west and lower elevation. Arguments have been made for the Chanka utilizing all elevations for food procurement (Bauer et al., 2010; Kellett, 2022; Skar, 1982), and these women may have come from a low-elevation valley Chanka occupation. The presence of these women may also support the colonial texts stating that the Inca brought women to Sondor for labor (Andrushko et al, 2009; Julien, 2002).

Sondor Unit 2 adds to the complex picture of activities during the late LIP. Unit 2 consists of two cist tombs, with a juvenile in one cist tomb, and two adult males in the other. The two adult males are local, and unrelated but have the same CVM, and died in violent manners. The cist tombs may be evidence of higher elevation burial practices being brought to Sondor, but the cist tombs may have also been a choice to honor or separate prominent individuals in the community.

Finally, Unit 5 at Sondor marks the shift in relations with Inca after at least a couple of hundred years of Inca presence at Sondor. No radiocarbon dates thus far have found Chanka occupation at Sondor after the late LIP/early LH, indicating a population shift or movement out of the site. Unit 5 matches other excavations at Sondor showing that the *Suyturumi* sector has abandonment rituals, with individuals placed on or under the floors of houses. The individuals placed under the floor of Unit 5 are all local, with the one non-local individual found buried outside the house. It is also possible that the child sacrifice in Unit 1, Context 3, is a part of the abandonment ritual since the child is local and placed in a similar position to the *Suyturumi* individuals, but this would have to be explored further in future excavations.

The use of osteological, isotopic, and genetic methods each adds a piece to the complex social landscape of the Chanka during the early and late LIP.

CHAPTER 8- SUMMARY AND CONCLUSIONS

The goal of this dissertation is to assess and understand what happens to families and communities during sociopolitical change by looking at changes in social organization and inter-community relationships through time. Focusing on the Late Intermediate Period (LIP) Chanka in Andahuaylas, Peru, a multi-method approach using genetics, isotopes, and osteological analyses reconstructed aspects of kinship, community composition, and group identity from mortuary populations. The Chanka experienced a large degree of upheaval between the Middle Horizon (MH), when the Wari reigned over the area, and Late Horizon (LH), when the Inca rose to full power. Observing social structure during the early LIP represents a time when Chanka communities formed and took on their own cultural attributes, while the late LIP represents the changes occurring when external forces (i.e., the Inca) became prominent in the region. Archaeological and osteological analyses were used to look at continuity and change in mortuary style, trauma rates, and cranial vault modification throughout the LIP. The isotope analyses ($^{87}Sr/^{86}Sr$ and $\delta^{18}O$) sought to identify non-locals in the population to interpret how changing socio-political conditions affected past mobility, and finally, the ancient DNA brought it all together by reconstructing how past Chanka populations fit within the broader context of the Andes and South America, and how individuals within and between sites were related to each other. Combining these lines of evidence provides a detailed picture of how local community composition and interaction in Andahuaylas was affected by the LIP socio-political perturbations. As with any society going through major changes in a short period of time, the multi-method approach revealed a complex landscape of kinship and social organization.

Results Summary

Expanded radiocarbon dating from the Andahuaylas sites confirms occupation of Sondor during the late LIP, and earlier occupation of Cachi, Ranracancha, and Pucullu during the early LIP. Previous evidence showed the early LIP sites were largely abandoned by the late LIP to LH, with little evidence to support continued occupation (Bauer et al., 2010; Kurin, 2012). However, the new dates indicate continuous, but greatly reduced, occupation at the site of Cachi from the early LIP through the late LIP and into the Late Horizon. These findings are supported by a decline in genetic diversity in the late LIP mortuary population at Cachi. The evidence is also supported by a statement saying that by colonization, the region of Andahuaylas was sparsely occupied by the Chanka (Bauer et al., 2010). Small numbers of Chanka were thus still living at other sites in Andahuaylas when Inca influence and diversified burial traditions are registered at Sondor. Similar mortuary and material culture changes are not observed at Cachi, Ranracancha nor Pucullu despite the potential for contemporary occupation of these sites alongside Sondor in the late LIP. Early Inca influence in Andahuaylas thus seems largely restricted to only a few sites in the region (see Bauer et al., 2010), with the most prominent being Sondor.

Previous osteological work in Andahuaylas documented high rates of skeletal trauma and the novel adoption of cranial vault modifications (CVMs) in Andahuaylas during the early LIP (Kurin 2012; 2016). These trends are associated with rapid socio-political change and conflict following the collapse of the Wari state. Increased trauma likely reflects competition over territory and resources, while the newly introduced CVMs reflect the introduction of this practice through in-migration or the need to communicate individual or group identity within a reorganized landscape of communities and cultural affiliations. Comparative osteological analyses conducted at Sondor show much lower rates of trauma and trepanation, as well as cranial vault modification during the late LIP, reflecting a changing social and political environment with the expansion of Inca influence. Decreases in CVM rates during the Late Horizon could indicate a desire to abandon a cultural practice associated with earlier Chanka communities, or it could indicate that the newly emerging systems of status and identity in the region disrupted the social divisions previously communicated with CVMs in Andahuaylas.

$^{87}Sr/^{86}Sr$ and $\delta^{18}O$ isotopic analyses were used to observe the movement of people during the LIP. All study sites were composed of mostly local individuals, but individuals originating from several different regions were identified. At the primarily early LIP sites of Cachi, Ranracancha and Pucullu, the outlier individuals may be first-generation migrants to Andahuaylas when populations increased during the early LIP. Alternately, the observed patterns of migration may be tied to different kin agreements and marriage exchange between communities to the east and west of Andahuaylas. Combining the osteological and isotopic results and broader genetic analyses with degrees of relatedness, the argument towards the non-locals at Cachi, Ranracancha, and Pucullu being first-generation migrants to the area becomes stronger. With non-local males related to local individuals (even first-degree relatives), instead of having moved away during childhood, it is more likely they migrated to the area before close kin were born. The genetic analysis also complements the isotopic data by indicating that the isotopic outliers came from the direction of genetic ancestry for the region, with most of the contribution from the east, and some contributions from the west.

Based on isotopic analyses, the non-local late LIP individuals at Sondor may have originated from more distant locales in comparison to the other study sites. These results fit the expectation based on colonial texts, stating the Inca moved non-local workers to Sondor during the Late Horizon, including women workers (Carabajal 1974 [1586], Julien, 2002, Markham, 1872; Ramos Gavilan 1988 [1621]). The genetic analyses were able to narrow down the potential regions of origin for the non-local individuals at Sondor. Although, the non-local females had isotopic values connecting them to regions potentially as distant as the North Coast of Peru, the genetic data suggests that non-local individuals originated from regions much closer to Andahuaylas. Therefore, these non-local women were likely brought into Sondor, or migrated by choice, from a less distant lowland valley.

Genetic degrees of relatedness also revealed patterns of kinship and inter-community connections. There is little evidence for extensive inter-community interaction or integration via kinship connections since the sites clustered separately and there were no close relatives between sites. The site of Ranracancha was particularly isolated genetically, suggesting that the site was founded by a relatively small population that remained insular in the face of external regional conflict.

Within Andahuaylas, mortuary contexts were not simply differentiated according to genetic relatedness or cranial vault modifications. Instead, closely related individuals (including first-degree relatives) were often interred in different burial contexts. Similarly, burial contexts contained a mixture of individuals with and without CVMs, and CVMs of varying styles. This would be expected if first-degree relatives of family units were buried with their marriage family, not the family they were born into. The late LIP *machay* at Sondor specifically indicates potential burial organization according to matrilineal lines since all the women in the burial cave (including those identified as non-local) are closely related. This pattern was not observed at the other Chanka sites analyzed in this study.

Although some close kin were more likely to share similar CVM, some first-degree relative pairings differed in the style or presence/absence of CVM. These results suggest that CVM did not just communicate direct kinship connections but may have instead indicated birth order or some other aspect of individual status. Also of note, no close kin shared *opposite* modification styles (i.e., annular vs. erect), which suggests that these divergent styles were used to distinguish between lineages or other kinship-based identities. Each of these research questions is revisited in turn below.

Research Questions Revisited

The radiocarbon, excavation, osteological, isotopic, and genetic results answer my research questions pertaining to Chanka community, kinship, and social organization throughout the early and late LIP in Andahuaylas, Peru.

1) How did migration and kinship affiliations structure community composition and interaction in Andahuaylas during the early LIP?

With the prior knowledge that the LIP was a tumultuous and unstable time in Andahuaylas following the Wari collapse, I sought to understand more about community composition and interactions to build upon previous research. Past archaeological surveys of Andahuaylas indicate an increase in population size at higher elevations during the early LIP, which is in contrast to the prior period (Qasawirka) where sites were found from low to high elevations to utilize agriculture. The concentrations of people at hilltop sites in the early LIP may have moved from the lower elevation Qasawirka sites that were largely abandoned after the MH

(Bauer et al., 2010). In contrast, colonial texts state the Chanka came in from outside Andahuaylas from the west or northwest, such as the Chanka origin story saying people emerged from Laguna de Choclococha, (Bauer et al, 2010; Garcilaso de la Vega, 1961) and another chronicle saying the Chanka came from Huamanga (Wari heartland) (Sarmiento, 2007 [1572]).

My expanded isotopic analyses coupled with the use of ancient DNA provides evidence to assess these previous descriptions. The findings suggest that the early LIP Chanka communities in Andahuaylas coalesced from regional movement of populations with some additional in-migration from distant areas. With the understanding that isotopic findings are an under representation of all possible non-locals, a study done by Knudson (2008) looking at first-generation migrants during the MH, found small numbers of migrants to the region of Chen Chen, indicating a small first-generation migration with local population growth. The same can be hypothesized about the populations at Andahuaylas, a quick growth after migration. However, combined genetic and isotopic data for the Andahuaylas sites provides greater detail regarding where the non-local segments of the population originated from and why we see genetic diversity. First-generation migrants primarily flowed into the region from the east, which contradicts previous suggestions from the chronicles, with smaller numbers of individuals coming in from the west. Instead of an in-flux of one previously established group, the isotopic and genetic analyses show migration from different areas, contributing to the genetic diversity present at the sites. I found that some people migrated from lower elevations and/or the west, possibly from the lowland valleys that were abandoned during the Middle Horizon (Bauer et al., 2010), but the largest portion came from the east. Going back to the chronicles, Huancohualla and Uramarca from the Chincheros province (near Ollantaytambo, to the east) are mentioned as being associated with/part of The Chanka Confederation. Although the Chanka were composed of independent communities, there may be more to the relationship with these regions than previously thought (Kellett, 2010). Future researchers may want to explore Chincheros and surrounding areas to gather additional genetic and isotopic studies due to the potential to fill in further gaps of knowledge.

Once in Andahuaylas, the expanded population that became the local Chanka were faced with high degrees of competition and violence, which is reflected through the fortified hilltop sites, weapons, and trauma and stress markers on individuals (Bauer et al., 2010; Kurin, 2012). Although populations at Cachi, Ranracancha, and Pucullu may have migrated from the same region or nearby regions with quick population growth, the genetic evidence indicates a lack of inter-community interaction in terms of marriage and kinship relationships once these communities were established. With the efforts taken to fortify the area and display ancestors in burial caves around the boundaries of each site, these communities laid claim to their new homes and resources, and did not use kinship ties to connect or integrate with other nearby communities. Genetically, each community grouped more closely with themselves, and no first-, second-, or third-degree relatives were found between the sites. Pucullu did not have any close genetic relatives within the site, but that may be due to sampling error. Cachi on the other hand, showed a complex mosaic of first-, second-, and third-degree relatives within burial contexts during the early LIP. The results show that first-degree relatives were not found within the same burial caves, and instead marriage determined burial location, separating brothers/sisters and mothers/daughters. Ranracancha's geographic isolation was mirrored in the site's homogenous genetic profile. The population that moved to Ranracancha was much smaller compared to Cachi, with only one burial cave identified. The population stayed isolated with closely related individuals found buried together and high degrees of inbreeding present. These actions were an extreme measure of protection during times of conflict and competition.

The differences that reflect the features of social structure within Chanka society are therefore not seen through artifacts or other cultural signals (except CVM, see research question 2), but in the lack of interaction between communities once they moved to Andahuaylas. The focus on kinship defining group identity speaks to the importance of the boundaries created during the early LIP when violence was prevalent. Looking back at our understanding of the *ayllu*, the early LIP communities had the markers of *ayllu* kinship – ancestor veneration seen through above ground and visible burial structures around sites to define social borders and territories (Isbell, 1997). Records of the Chanka *ayllu* system after colonialism state that individuals married across moieties within *ayullus* (patrilocal and avoidance of inbreeding) (Skar, 1982), leading to the expectation that the LIP Chanka would marry across sites (moieties) with ancestors also shared. However, the *ayllu* is also stated as being highly flexible depending on the social environment of a region (Barth, 1969; Isbell, 1997; Skar, 1982). The early LIP Chanka do not share ancestors between sites, therefore there is no indication of a marriage *ayllu* alliance. Instead, there is internal kinship structure, which may have been the only option after migrations to the region and competition between groups. The larger population at Cachi utilized different family linages (reflected in *machays*) to determine marriage and burial locations, which could be the basis for what was seen after colonialism, while Ranracancha went against these expected structures completely due to their isolation.

Documenting the degree of Chanka community integration and interaction is significant to our broader understanding of the degree of Chanka socio-political power and centralization during the early LIP. Although chronicles accounts and early archaeological studies portray the

Chanka as a powerful and politically centralized ethnic group, this characterization is challenged by recent archaeological work in Andahuaylas, indicating that the Chanka were a smaller polity composed of more independent communities (Bauer & Smit, 2015; Covey, 2008). The current study supports a less centralized view of Chanka socio-political organization, which has implications for how understanding later Inca imperial strategies in the region (see research question 3).

2) How do patterns of cranial vault modification articulate with kinship and geographic origins within early LIP Andahuaylas communities?

CVM was not a practice used in the region prior to the LIP. It was previously argued that the practice was adopted by locals due to the changing socio-political landscape of Andahuaylas after the Wari collapse and the need to visibly display kin association (Kurin, 2016; Black & Kurin, 2021). The reasons for using CVMs are still valid, but the results show that the practice may have been brought to the area through migration and not adopted by a population already present in the region. This is argued through the high rate of CVM present in the first-generation migrants identified in this study and lack of modification prior to this migration.

The results also show an affiliation between lineage and CVM style. The early LIP contexts at Cachi found heterogeneity of modified (*annular erect* and *oblique*) and unmodified individuals within burial contexts. The mixture likely pertains to marriage between kin groups within Cachi since second- and third- degree relatives were more likely to hold the same style of modification. The presence of unmodified individuals can also be explained by a born status or birth-order because the first-degree relatives showed pairs of unmodified and modified, but never a cross between modification style. The degree of CVM may have also been a purposeful choice based on status conferred at birth. I found that the males that migrated to Cachi were more likely to have higher degree of modification, with one of the males being more closely related to individuals in Cave 2 (contributor to the lineage). More support for a kin basis to CVM decisions was the overwhelming presence of *annular oblique* modification style at Ranracancha, an isolated and closely-related community.

CVMs are associated with some aspect of kinship affiliation, but the relationship is complex and appears embedded within nested levels of identity and group affiliation. These findings reflect the expectations of Chanka *ayllu* and kinship affiliations. As bioarchaeologists, we have to remind ourselves that kinship can be defined by a combination of consanguineal and fictive kinship, such as a status imparted on one at birth. According to Skar (1982), first-born sons were honored and given rights over *machays*, therefore imparting a different status within society and kinship obligations. The patterns of CVM at Cachi may be a reflection of the consanguineal and fictive kinship in action. The exact meaning of CVMs within the focal communities is not yet clear, but the multi-method approach of combining osteological, isotopic and genetic analyses allowed me to identify patterns and associations that were not visible before. Expanded multi-method research on this issue may therefore yield future insights.

The use of CVMs to designate kinship or community-based affiliation was expected for LIP communities in Andahuaylas, due to the need to visibly communicate aspects of local/regional identity or affiliation within the emergence of smaller-scale socio-political systems following the collapse of the Wari state. The decreased use of CVMs in Andahuaylas during the Late Horizon reflects a reversal of this trend with the expansion of Inca influence in the region. The desire to display kinship and community-based aspects of identity during the early LIP may have been replaced in importance by socio-political affiliations defined at broader spatial scales with the rise of the Inca state.

3) How do patterns and rates of migration change in Andahuaylas between the early and late LIP?

Within a generation of moving to Andahuaylas, the Chanka stayed local at Cachi, Ranracancha, and Pucullu, and stayed isolated from each other because of the high degrees of violence and competition over resources. Radiocarbon dates show that by the late LIP, the Inca already held a presence in, and some influence over the nearby site of Sondor. At the same time, the social landscape of Andahuaylas changed, with evidence of a population decrease in the region (Bauer et al., 2010). The additional radiocarbon dates at Cachi and Pucullu showed that despite this decline, and close proximity to Sondor, the Chanka still persisted in smaller numbers during the late LIP. The evidence at Cachi shows that the caves used in the late LIP had much smaller mortuary populations than the ones used in the early LIP, but relatives can be traced from an early LIP cave, to a late LIP cave, and finally a LH/colonial cave indicating population continuity. Excavations by Kurin (2012) showed no evidence of Inca artifacts in the caves, with the only Inca presence found as small numbers of ceramic sherds on the surface during survey of the sites (Bauer et al., 2010). This shows not only the persistence of the Chanka lineage at the site, but the continuation of the Chanka culture. In addition, these lineages were the beginnings of what later became the flexible *ayllu* structure recorded during colonialism (Skar, 1982).

The evidence of early Inca influence on the region is evident with the population decline in Andahuaylas during the late LIP, but also through the events observed at Sondor. It is also critical to note that what occurred at Sondor was an early expansion of the Inca during the LIP, before their full rise to power in the LH. Visibly, the site of Sondor looks like a grand display of Inca power on the landscape. However, the 2017 excavations revealed the presence of the Chanka at Sondor with Inca and Chanka-Inca ceramics incorporated into burial contexts. The site of Sondor was occupied by people prior to Inca presence, but the late LIP contexts indicate people migrated or were forcefully moved to Sondor from sites in or around Andahuaylas. The Inca were not at the level of control and power during the late LIP to be able to move people from far-away locations such as the coast, but instead may have moved more distant Chanka, from varying elevations around Andahuaylas, to Sondor. Andahuaylas was influenced by the Inca early, which usually means more change will be seen through time (Bray, 2015). Sondor shows us that for a time, the Chanka were still living at Sondor, even if they were forcefully moved there, but at some point, the interaction/agreements between the Chanka and Inca changed, leading to Chanka abandonment. These hypotheses should be explored further in future excavations, but isotopic values and burial contexts indicate more variation than expected for generations of local people at a site. Unit 1 showed a possible matrilineal context that began with non-local females, Unit 2 is a non-communal higher-status cist tomb burial for two individuals who died violent deaths, and Unit 5 is an indicator of when the site was abandoned by the Chanka with local individuals buried beneath the floor. The movement of people, incorporation of Inca iconography into burial contexts, and adjustments to a new situation are all reflected in these units.

Inca decisions regarding how to best hold sway over Andahuaylas could also further reflect the degree of Chanka socio-political power and centralization during the early LIP. Throughout their empire, the Inca employed various means of integrating conquered populations into the imperial system. Strategies varied according to the local ecology and resources, the degree of cultural resistance encountered, and the region's distance from the imperial capital (Shreiber, 1987). More aggressive strategies involved physical occupation of a region, or forced population resettlements (*mitimaes*), while less invasive strategies involved strategic marriage alliances and integration of communities into Inca economic systems involving taxation, tribute and redistribution ((Buikstra & Nystrom, 2015; Silverblatt, 1988). In Andahuaylas, there is some evidence for forced population movement, but continuity in regional populations suggest rebuilding of communities from within the areas surrounding Andahuaylas. This could be expected if the Chanka mounted some resistance to Inca influence, but did not have broad socio-political coordination across the region (i.e., if Chanka communities were largely autonomous). Although ethnohistoric accounts portray the Chanka as a powerful and politically-centralized ethnic group, this characterization is challenged by the current study as well as other recent archaeological work in Andahuaylas, (Bauer & Smit, 2015; Covey, 2008).

Conclusions

The study of the evolving Chanka kinship and social structure through various periods of external pressures speaks to the broader understanding of major socio-political transitions of Andean state formation and collapse. The Chanka used specific strategies and mechanisms to adjust to changing conditions across the landscape, and showed persistence through these changes. The multi-method approach of osteological, isotopic, and genetic analyses was able to reveal levels of analysis not previously possible. I was able to build from the individual markers of identity, place of origin, and family ties to the broader patterns of movement and socio-political events occurring through time. Being able to study the Chanka at the community and individual level reminds us that these were people under a tremendous amount of stress and pressure, with several political upheavals and intense violence occurring within a few generations. Nonetheless, the Chanka developed and adjusted kin relations and behaviors based on these changing conditions. The strength and persistence of the Chanka resonates with the contemporary community in Andahuaylas. Throughout the region, iconography of Chanka warrior strength is seen in town square statues, paintings, clothing, names of businesses, and the annual festival at Sondor celebrating the Chanka origin story. Being a large part of Andahuaylas identity, the consensus among the contemporary local populations is that the Chanka continued beyond Inca presence in the region. The archaeology finally supports these claims, while providing an inter-generational story of the Chanka beginnings and tenacity.

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APPENDIX

APPENDIX A

Radiocarbon dates for all samples in study.

Lab Code	Site	Sector	Unit	Cultural Period	δ13 C	14C age	calAD 95.4% prob	Mid
MCH.01.01	Cachi	Mina	-	Late LIP	-13	680 ± 15	1279-1384	1331
MCH.01.01.xx*	Cachi	Mina	-	MH	-22.9	1230 ± 30	681-885	783
MCH.01.01.xy*	Cachi	Mina	-	MH	-17	1150 ± 30	773-988	880
MCH.01.03.02*	Cachi	Mina	-	Late LIP	-11.8	560 ± 30	1312-1428	1370
MPM.01.01.01	Cachi	Mina	-	Early LIP	-12.7	830 ± 15	1205-1264	1235
MPM.01.03	Cachi	Mina	-	Early LIP	-10.5	925 ± 15	1040-1165	1103
MPM.1.13	Cachi	Mina	-	Early LIP	-13.5	850 ± 30	1054-1267	1161
MPM.01.01.16*	Cachi	Mina	-	MH	-14.4	1170 ± 30	772-974	873
MPM.01.18	Cachi	Mina	-	Early LIP	-13.4	750 ± 15	1259-1285	1272
SON.01.Rinco*	Cachi	Sonhuayo	Cave 1		-10.8	770 ± 30	1220-1282	1251
SON.01.01.05	Cachi	Sonhuayo	Cave 1	Early LIP	-10.2	810 ± 15	1220-1266	1243
SON.01.01.11	Cachi	Sonhuayo	Cave 1	Early LIP	-11.7	870 ± 15	1162-1219	1191
SON.02.02.05*	Cachi	Sonhuayo	Cave 2	Early/Late LIP	-10.3	730 ± 30	1229-1378	1304
SON.02.02.11	Cachi	Sonhuayo	Cave 2	Early LIP	-10.2	855 ± 15	1165-1224	1195
SON.02.02.12	Cachi	Sonhuayo	Cave 2	Late LIP	-10.7	635 ± 15	1296-1394	1345
SON.02.03.25	Cachi	Sonhuayo	Cave 2	Early LIP	-11.5	865 ± 15	1164-1220	1192
SON.02.04-1.48	Cachi	Sonhuayo	Cave 2	Early LIP	-10.1	805 ± 15	1221-1268	1245
SON.02.04.57	Cachi	Sonhuayo	Cave 2	Early LIP	-8.3	860 ± 30	1052-1263	1158
SON.03.01.06	Cachi	Sonhuayo	Cave 3	Late LIP	-9.6	680 ± 15	1279-1384	1332
SON.04.01.2008*	Cachi	Sonhuayo	Cave 4	LH/colonial	-13.6	340 ± 30	1474-1638	1556
SON.05.01.05	Cachi	Sonhuayo	Cave 5	LH/colonial	-10.9	370 ± 15	1457-1624	1541
SON.07.01.02	Cachi	Sonhuayo	Cave 7	Late LIP	-10	600 ± 15	1306-1401	1354
RCC.01.01.04*	Ranracancha	-	-	Early LIP	-13.6	850 ± 30	1054-1267	1161
RCC.01.01.24	Ranracancha	-	-	Early LIP	-15.1	860 ± 20	1158-1228	1193

RCC.01.01.42	Ranracancha	-	-	Early LIP	-16	930 ± 15	1041-1162	1102
PCU.01.01.03	Pucullu	-	-	Late LIP	-12.9	575 ± 15	1321-1410	1366
PCU.01.01.10	Pucullu	-	-	Early LIP	-12.9	960 ± 15	1030-1155	1093
PCU.01.01.13	Pucullu	-	-	Late LIP	-12.4	625 ± 20	1298-1396	1347
PCU.01.01.26	Pucullu	-	-	Early LIP		810 ± 30	1178-1276	1227
SOD_1_1	Sondor	Muyu Muyu	1	Late LIP	-14.7	710 ± 20	1289-1394	1342
SOD_1_I1	Sondor	Muyu Muyu	1	Late LIP	-13.3	540 ± 20	1327-1430	1379
SOD_1_2	Sondor	Muyu Muyu	1	Late LIP	-14	690 ± 20	1276-1384	1330
SOD_1_3	Sondor	Muyu Muyu	1	Late LIP	-11	685 ± 25	1275-1388	1332
SOD_1_I3	Sondor	Muyu Muyu	1	Late LIP	-10.8	680 ± 25	1276-1388	1332
SOD_1_6	Sondor	Muyu Muyu	1	Late LIP	-10	630 ± 20	1296-1396	1346
SOD_1_7	Sondor	Muyu Muyu	1	Late LIP/LH	-11.8	500 ± 20	1408-1442	1425
SOD_1_9	Sondor	Muyu Muyu	1	Late LIP	-15.4	605 ± 20	1303-1401	1352
SOD_1_10	Sondor	Muyu Muyu	1	Late LIP	-11.9	745 ± 25	1227-1293	1260
SOD_1_C2	Sondor	Muyu Muyu	1	EIP/MH	-11	2515 ± 30	543-786	665
SOD_1_C3	Sondor	Muyu Muyu	1	Late LIP	-12.2	645 ± 20	1289-1394	1342
SOD_2_I1	Sondor	Muyu Muyu	2	Late LIP	-10.3	630 ± 20	1296-1396	1346
SOD_2_I2	Sondor	Muyu Muyu	2	Late LIP	-10.3	745 ± 20	1229-1291	1260
SOD_2_I3	Sondor	Muyu Muyu	2	Late LIP	-10	545 ± 25	1323-1431	1377
SOD_2_1	Sondor	Muyu Muyu	2	Late LIP	-10.4	695 ± 20	1275-1383	1329
SOD_2_2	Sondor	Muyu Muyu	2	Late LIP	-10.7	690 ± 20	1276-1384	1330
SOD_5_1	Sondor	Suyturumi	5	Late LIP	-10.1	660 ± 20	1283-1390	1337
SOD_5_3	Sondor	Suyturumi	5	Late LIP	-12.8	640 ± 20	1290-1395	1343
SOD_5_5	Sondor	Suyturumi	5	Late LIP	-12.5	675 ± 25	1278-1389	1334
SOD_5_7	Sondor	Suyturumi	5	Late LIP	-13.8	700 ± 30	1276-1388	1332

*Individual not included in the genetic/isotope analyses reported in this dissertation

APPENDIX B

The osteological, genetic, and isotopic data for each individual. Kurin (2012) and/or Lofaro et al (2018) values are in grey.

	MCH.01.01	MCH.01.02	MCH.01.03	MCH.01.03.05	MCH.01.03.07	MCH.01.03.11
Site	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi
Unit/Cave	MCH	MCH	MCH	MCH	MCH	MCH
Age	MA	YA	OA	YA	OA	YA
Sex	F	F	F	M	F	M
CVM	Unmod	Annular Erect	Annular Erect	Annular Erect	Annular Erect	Annular Erect
Degree	-	2	3	-	1	-
Trauma	N	N	N	Y	Y	N
Trepanation	N	N	N	Y	N	N
calAD	1279-1384	-	-	-	-	-
Period	Late LIP	-	-	-	-	-
87Sr/86Sr	0.70698	0.70713	-	0.70767	-	0.70741
δ18O	-9.8	-10.1	-	-9.5	-	-8.81
Relatedness	First: sibling MCH125(135) Second: MCH13112	-	-	First: sibling MCH11 Second: MCH13112	-	Second: MCH11, 125

MPM.1.13	MPM.1.12	MPM.1.11	MPM.1.10	MPM.1.1	MPM.01.18	MPM.01.17	MPM.01.01.06	MPM.01.01.01
Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi
MPM	MPM	MPM	MPM	MPM	MPM	MPM	MPM	MPM
MA	MA	OA	MA	YA	YA	J/YA	YA	YA
M	M	M	M	M	F	M	U	F
Annular Erect	Unmod	Annular	Unmod	Annular Slight	Annular Erect	Annular Oblique	Unmod	Annular Erect
2	-	-	-	1	-	-	-	-
Y	N	Y	Y	Y	Y	Y	Y	Y
N	N	N	N	N	N	N	N	N
1054-1267	-	-	-	-	1259-1285	-	-	1205-1264
Early LIP	-	-	-	-	Early LIP	-	-	Early LIP
-	0.70703	-	0.70716	-	0.70734	0.70767	-	0.70744
-	-8.11	-	-9.9	-	-8.29	-8.66	-	-8.79
-	Third: MPM110	-	Third: MPM112	-	-	Second: MPM111	-	Second: MPM117, 13

MPM.1.9	MPM.1.8	MPM.1.7	MPM.1.6	MPM.1.5	MPM.1.4	MPM.1.3	MPM.1.2	MPM.1.19	MPM.1.16	MPM.1.14
Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi
MPM	MPM	MPM	MPM	MPM	MPM	MPM	MPM	MPM	MPM	MPM
MA/OA	MA	YA	OA	MA	MA/OA	YA/MA	YA	OA	YA	YA/MA
M	M	F	M	M	F	M	M	M	M	M
Annular Erect	Annular Erect	Annular Slight	Annular Erect	Annular Erect	Annular Oblique	Annular Erect	Annular Erect	Annular Erect	Unmod	Unmod
3	4	1	2	3	4	4	3	4	-	-
Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N
N	N	N	N	N	N	N	N	N	N	Y
-	-	-	-	-	-	1040-1165	-	-	-	-
-	-	-	-	-	-	Early LIP	-	-	-	-
-	-	0.70753	-	-	-	0.70781	-	-	0.70706	0.70687
-	-	-9.97	-		-	-8.58	-	-	-9.62	-10.8
-	-	-	-	-	-	-	-	-	-	-

SON.01.01.11	SON.01.01.10	SON.01.01.06	SON.01.01.05	SON.01.01.04	SON.01.01.03	SON.01.01.01
Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi
Sonhuayo, Cave 1	Sonhuayo, Cave 1	Sonhuayo, Cave 1	Sonhuayo, Cave 1	Sonhuayo, Cave 1	Sonhuayo, Cave 1	Sonhuayo, Cave 1
YA	MA	OA	MA	MA	MA	YA/MA
F	M	M	M	M	F	F
Annular Erect	Annular Erect	Annular Erect	Annular Erect	Annular Erect	Annular Erect	Annular Erect
2	4	3	3	2	3	2
N	Y	Y	Y	Y	Y	Y
N	N	N	N	N	N	N
1162-1219	-	-	1220-1266	-	-	-
Early LIP	-	-	Early LIP	-	-	-
0.70732	-	-	0.70730	0.70740	0.70729	0.70721
-8.08	-	-	-9.19	-9.28	-8.35	-8.47
First: Siblings, SON2325 Possible Second: SON113	-	-	Possible Second: SON020329	-	Second: SON2329; Possible Second: SON1111	

SON.02.02.10	SON.02.02.05	SON.02.02.04	SON.02.02.03	SON.02.02.01	SON.01.01.15	SON.01.01.12
Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi
Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 1	Sonhuayo, Cave 1
YA/MA	YA/MA	MA	YA	MA	YA	MA
M	M	M	M	M	M	F
Annular Erect	Annular Oblique	Annular Erect	Annular Erect	Annular Erect	Annular Erect	Annular Oblique
4	3	3	4	4	2	-
Y	Y	Y	Y	Y	Y	N
N	N	N	N	N	N	N
-	1229-1378	-	-	-	-	-
-	Late LIP	-	-	-	-	-
0.70757	-	0.70739	0.70756	0.70802	-	-
-11.59	-	-8.50	-9.20	-9.65	-	-
-	-	-	-	-	-	-

SON.02.03.29	SON.02.03.26	SON.02.03.25	SON.02.03.21	SON.02.02.12	SON.02.02.11
Cachi	Cachi	Cachi	Cachi	Cachi	Cachi
Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2
MA	J/YA	MA	YA	MA	YA
M	F	M	F	F	M
Annular Erect	Annular Erect	Unmod	Unmod	Annular Erect	Annular Oblique
4	-	-	-	3	2
Y	N	-	Y	N	N
N	N	-	N	N	N
-	-	1164-1220	-	1162-1267	1165-1224
-	-	Early LIP	-	Early LIP	Early LIP
0.70929	0.70743	0.70955	0.70573	0.70716	0.70755
-10.64	-8.47	-8.53	-9.25	-8.59	-8.76
Second: SON020212, SON2330A, SON113	-	First: SON1111, Siblings Possible Second: SON2329	-	Second: SON020329, SON517 Possible Third:	-

SON.02.04.1.71	SON.02.04.1.70	SON.02.04.1.69	SON.02.04.1.57	SON.02.03.31	SON.02.03.30A
Cachi	Cachi	Cachi	Cachi	Cachi	Cachi
Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2
MA	MA	YA	YA/MA	YA	MA
F	M	F	M	F	F
-	Annular Erect	Annular Oblique	Annular	Annular Erect	Annular Erect
-	3	2	-	2	3
Y	Y	N	Y	N	Y
N	N	N	N	N	N
-	-	-	1052-1263	-	-
-	-	-	Early LIP	-	-
0.70724	0.70729	0.70732	0.70778	0.70731	0.70701
-8.08	-8.22	-9.51	-9.5	-7.75	-6.93
-	-	-	-	-	Second: SON2329

SON.03.01.04	SON.03.01.03	SON.03.01.01	SON.02.04-1.55	SON.02.04-1.48	SON.02.04.2.p.58
Cachi	Cachi	Cachi	Cachi	Cachi	Cachi
Sonhuayo, Cave 3	Sonhuayo, Cave 3	Sonhuayo, Cave 3	Sonhuayo, Cave 2	Sonhuayo, Cave 2	Sonhuayo, Cave 2
MA	MA	YA	MA	YA	OA
M	F	F	M	F	F
Annular Erect	Unmod	Annular Erect	Annular Erect	Annular	Annular Erect
3	-	4	-	-	2
N	Y	N	-	N	N
N	N	N	-	N	N
-	-	-	-	1221-1268	-
-	-	-	-	Early LIP	-
-	0.70695	-	0.70704	0.70719	0.70706
-	-	-	-9.63	-9.82	-9.5
-	First: SON515, mother-daughter	-	-	-	-

SON.05.01.08	SON.05.01.07	SON.05.01.06	SON.05.01.05	SON.05.01.04	SON.05.01.03	SON.03.01.06
Cachi	Cachi	Cachi	Cachi	Cachi	Cachi	Cachi
Sonhuayo, Cave 3	Sonhuayo, Cave 3	Sonhuayo, Cave 3	Sonhuayo, Cave 3	Sonhuayo, Cave 3	Sonhuayo, Cave 3	Sonhuayo, Cave 3
MA	YA	YA	YA	MA	MA	YA
F	M	M	F	M	F	F
Annular Erect	Annular Erect	Unmod	Annular Erect	Annular Oblique	Annular Erect	Annular
3	3	-	-	4	2	-
Y	N	N	-	Y	N	N
N	N	N	-	N	N	N
-	-	-	1457-1624	-	-	1279-1384
-	-	-	LH/colonial	-	-	Late LIP
-	0.70693	0.70757	0.70761	-	-	0.70734
-	-8.56	-9.45	-9.10	-	-	-7.46
-	Second: SON020212	-	First: SON313, mother-daughter	-	-	-

RCC.01.01.06	RCC.01.01.05	RCC.01.01.04	RCC.01.01.28	SON.07.01.05	SON.07.01.03	SON.07.01.02
Ranracancha	Ranracancha	Ranracancha	Ranracancha	Cachi	Cachi	Cachi
-	-	-	-	Sonhuayo, Cave ?	Sonhuayo, Cave ?	Sonhuayo, Cave ?
YA	YA	YA	-	YA/MA	OA	MA
F	U	M	F	M	M	M
Annular Oblique	Annular Oblique	Annular Oblique	Annular Oblique	Annular Erect	Annular Erect	Annular Slight
3	4	-	4	2	3	1
Y	-	-	-	N	Y	Y
N	Y	-	-	Y	N	N
-	-	1054-1267	-	-	-	-
-	-	Early LIP	-	-	-	-
0.70799	-	0.707712	0.70749	-	-	0.70734
-9.2	-	-9.12	-8.72	-	-	-9.1
-	-	-	Second: RCC1139, 1142, 1144, 1121?	-	-	-

RCC.01.01.21	RCC.01.01.20	RCC.01.01.19	RCC.01.01.15	RCC.01.01.14	RCC.01.01.10	RCC.01.01.08
Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha
-	-	-	-	-	-	-
MA	OA	YA	YA	YA	MA	YA/MA
M	F	M	F	F	M	M
Annular Oblique	Annular Oblique	Annular Oblique	Annular Oblique	Annular Oblique	Annular Erect	Annular Erect
4	3	2	3	4	3	3
N	Y	Y	N	N	Y	Y
N	N	N	N	N	N	N
-	-	-	-	-	-	-
-	-	-	-	-	-	-
0.70742	-	0.70737	0.70752	0.70744	-	-
-9.86	-	-10.28	-9.93	-11.3	-	-
Second: RCC1114, RCC1115, RCC1142,	-	Second or Third: RCC1121? Third: RCC1142?, 22121?	Father: RCC1142, Sibling: RCC1114 Second: RCC1121	Father: RCC1142, Sibling: RCC1115	-	-

RCC.01.01.35	RCC.01.01.33	RCC.01.01.32	RCC.01.01.30	RCC.01.01.26	RCC.01.01.24	RCC.01.01.23
Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha
-	-	-	-	-	-	-
CH/YA	OA	OA	OA	MA	YA	YA
F	M	M	M	M	F	F
Annular Oblique	Annular	Annular Oblique	Annular Erect	Annular Oblique	Annular Oblique	Annular Oblique
3	-	3	4	3	3	4
-	N	Y	N	N	-	-
	N	N	N	N		
-	-	-	-	-	1158-1228	-
-	-	-	-	-	Early LIP	-
0.70769	-	-	-	-	0.70826	0.70773
-9.1	-	-	-	-	− 8.6	− 9.7
	-	-	-	-	-	-

RCC.1.3	RCC.1.2	RCC.1.1	RCC.01.01.07	RCC.01.01.44	RCC.01.01.42	RCC.01.01.39	RCC.01.01.38
Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha	Ranracancha
-	-	-	-	-	-	-	-
YA	MA	OA	J/YA	YA	MA	CH/YA	MA
M	M	M	M	F	M	F	M
Annular Oblique	Annular Oblique	Annular Oblique	Annular Oblique	Annular Oblique	Annular Oblique	Annular Oblique	Annular Oblique
3	4	4	3	4	3	2	4
N	Y	Y	N	N	Y	-	Y
Y	N	N	N	N	N	N	N
-	-	-	-	-	1041-1162	-	-
-	-	-	-	-	Early LIP	-	-
-	-	-	0.70919	0.70765	0.70748	0.70734	-
-	-	-	− 9.3	− 8.7	-9.84	-9.73	-
-	-	-	Second or Third: RCC1121	Second: RCC1121, 1128, 1139, 1142?	Children: RCC1115, RCC1114 Second: RCC1121	Second: RCC1128, 1142, 1144, 1121?	-

PCU.01.01.13	PCU.01.01.12	PCU.01.01.11	PCU.01.01.10	PCU.01.01.08	PCU.01.01.03	PCU.01.01.02	RCC.1.4
Pucullu	Pucullu	Pucullu	Pucullu	Pucullu	Pucullu	Pucullu	Ranracancha
-	-	-	-	-	-	-	-
MA	OA	YA	MA	MA	YA	YA	YA
M	M	F	F	M	F	M	M
Annular Oblique	Annular Erect	Annular Erect	Annular Erect	Annular Erect	Unmod	Unmod	Annular Oblique
2	3	2	2	2	-	-	4
Y	Y	N	N	Y	N	Y	Y
N	N	N	N	N	N	N	N
1298-1396	-	-	1030-1155	-	1321-1410	-	-
Late LIP	-	-	Early LIP	-	Late LIP	-	-
0.70709	0.70764	0.70731	0.70725	0.71004	0.70711	-	-
− 9.7	-9.63	-8.15	-9.57	− 8.5	-9.8	-	-
-	-	-	-	-	-	-	-

PCU.01.01.25	PCU.01.01.22	PCU.01.01.20	PCU.01.01.19	PCU.01.01.18	PCU.01.01.17	PCU.01.01.16
Pucullu	Pucullu	Pucullu	Pucullu	Pucullu	Pucullu	Pucullu
-	-	-	-	-	-	-
OA	YA	MA	YA	YA	MA	YA
M	F	F	-	F	M	M
Unmod	Unmod	Annular Oblique	Unmod	Annular Erect	Annular Erect	Annular Slight*
-	-	-	-	3	4	3
Y	-	-	-	N	N	Y
-	-	-	-	N	N	Y
-	-	-	-	-	-	-
-	-	-	-	-	-	-
0.71070	0.70751	0.70751	0.70752	0.70747	-	0.70737
-9.95	-10.09	-9.92	-9.18	-10.16	-	− 9.5
-	-	-	-	-	-	-

SOD_1_I4	SOD_1_I3	SOD_1_I2	SOD_1_J2	SOD_1_J1	SOD_1_3	SOD_1_2	SOD_1_I1	SOD_1_1	PCU.01.01.26
Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Pucullu
Muyu Muyu	Muyu Muyu	Muyu Muyu	Muyu Muyu	Muyu Muyu	Muyu Muyu	Muyu Muyu	Muyu Muyu	Muyu Muyu	-
-	-	-	1-3 years	1-3 years	MA	YA	-	MA	YA
-	-	-	-	-	F	F	-	F	M
-	-	-	-	-	Unmod	Unmod	-	Unmod	Annular Oblique
-	-	-	-	-	-	-	-	-	3
-	-	-	-	-	Y	Y	-	Y	Y
-	-	-	-	-	N	N	-	N	Y
-	1276-1388	-	-	-	1275-1388	1276-1384	1327-1430	1289-1394	1178-1276
-	Late LIP	-	-	-	Late LIP	Late LIP	Late LIP	Late LIP	Early LIP
0.70630	0.70650	0.70800	-	-	0.70790	0.70530	0.70750	0.70502	-
-7.52	-8.95	-8.82	-	-	-8.47	-2.76	-8.07	-3.39	-
First: SOD_1_9 Second: SOD_1_1	-	-	-	-	-	Second: SOD_2_I3	Second: SOD_1_9, SOD_1_1	First: SOD_1_9 Second: SOD_1_7,	-

SOD_2_I2	SOD_2_I1	SOD_1_C2	SOD_1_C	SOD_1_11	SOD_1_10	SOD_1_9	SOD_1_J3	SOD_1_7	SOD_1_6
Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor
Muyu	Muyu	Muyu Muyu,	Muyu	Muyu	Muyu	Muyu	Muyu	Muyu	Muyu
-	-	~9 years old	1-3 years	YA	YA	MA	1-3 years	4-6 years	MA
-	-	-	-	M	F	F	-	-	M
-	-	-	-	Annular	Annular	Unmod	Unmod	Unmod	Annular
-	-	-	-	4	2	-	-	-	4
-	-	N	N	N	N	Y	N	N	Y
-	-	N	N	N	N	Y	-	N	N
1229-1291	1296-1396	543-786	1289-1394	-	1227-1293	1303-1401	-	1408-1442	1296-1396
Late LIP	Late LIP	EIP/MH	Late LIP	-	Late LIP	Late LIP	-	Late	Late LIP
0.70690	0.70850	0.70730	0.70810	0.70730	0.70710	0.70520	-	0.70730	0.70730
-8.62	-9.14	-8.5	-9.66	-8.97	-7.65	-3.26	-	-8.76	-7.98
-	-	-	-	-	Second: SOD_1_9	First: SOD_1_1, SOD_1_I4 Second:	-	Second: SOD_1_1, SOD_1_9, SOD_1_I1	-

SOD_5_7	SOD_5_J1	SOD_5_5	SOD_5_4	SOD_5_3	SOD_5_2	SOD_5_1	SOD_2_2	SOD_2_1	SOD_2_I3	SOD_2_I4
Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor	Sondor
Suyturumi	Suyturumi, Unit 5	Suyturumi, Unit 5	Suyturumi, Unit 5	Suyturumi, Unit 5	Suyturumi, Unit 5	Suyturumi, Unit 5	Muyu Muyu	Muyu Muyu	Muyu Muyu	Muyu Muyu
YA	newborn	~2 years	~9 months	YA	1-3 years	MA	YA	MA	-	-
M	-	-	-	F	-	M	M	M	-	-
Unmod	-	-	-	Unmod	-	Unmod	Annular Erect	Annular Erect	-	-
-	-	-	-	-	-	-	-	-	-	-
N	-	N	N	N	N	Y	Y	Y	-	-
N	-	N	N	N	N	N	N	N	-	-
1276-1388	-	1278-1389	-	1290-1395	-	1283-1390	1276-1384	1275-1383	1323-1431	-
Late LIP	-	Late LIP	-	Late LIP	-	Late LIP	Late LIP	Late LIP	Late LIP	-
0.70740	-	0.70730	-	0.70730	-	0.71900	0.70720	0.70670	0.70650	-
-9.15	-	-7.8	-	-9.44	-	-9.17	-8.24	-8.86	-8.94	-
-	-	-	-	-	-	-	-	-	Second: SOD_1_2	-