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The Roots of Social Inequality: Archaeology of the Kaillachuro mounds, Titicaca Basin, Peru, 5.3-3.0 ka

By

LUIS A. FLORES-BLANCO

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Anthropology

in the

OFFICE OF GRADUATE STUDIES

of the

UNIVERSITY OF CALIFORNIA

DAVIS

Approved:

_____

Randall Haas, co-Chair

_____

Jelmer Eerkens, co-Chair

_____

Mark S. Aldenderfer

_____

Cristina Moya

Committee in Charge

2024

The Roots of Social Inequality: Archaeology of the Kaillachuro mounds, Titicaca Basin, Peru, 5.3-3.0 ka

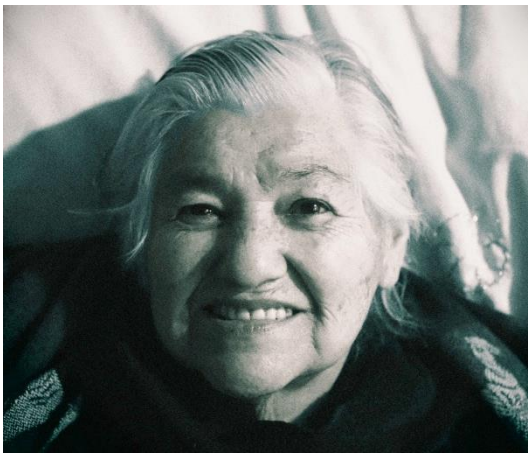
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by

LUIS ANGEL FLORES-BLANCO

I dedicate this dissertation to the ancestors of Kaillachuro and

to my own ancestor, **Genoveva Blanco**.



ABSTRACT

This dissertation examines the extent to which emergent complexity entailed inequality in a small-scale society about 5,000 years ago in the South-Central Andean highlands. The Kaillachuro burial mound site in the southwest Lake Titicaca Basin, Peru, is the main case under investigation. I begin with a review of the theoretical models that guide this study and previous studies of the Archaic-Formative transition in the South-Central Andes. I then present three analyses. Analysis 1 presents the results of archaeological excavations, stratigraphy, and radiocarbon dates, which reveal that the Kaillachuro burial mounds were used from 5,300–3,000 cal B.P. and establishes them as the earliest known manifestation of monumental architecture in the Titicaca Basin. For at least 2,000 years, Kaillachuro was a burial place with visible mound construction. This finding reveals a previously unknown architectural history and encourages us to rethink how ritual relates to the emergence of complex socioeconomic organization in the South-Central Andean highlands. Analysis 2 examines the demographics and diets of 17 individuals identified at Kaillachuro. Most individuals interred in the mounds were adults, with a male-biased burial practice. Interestingly, two infants were interred in elaborate stone tombs with ocher deposits, obsidian fragments, charred materials, and large stone slabs, suggesting heavy investment in children. Stable isotope chemistry of human bone collagen demonstrates that all individuals consumed a largely vegetable diet with lesser input from animal protein. None of the individuals showed evidence of a privileged diet. These findings indicate a social structure that lacks institutionalized inequality but reveals a sex bias, where mostly male were eligible for mound burial. Analysis 3 examines Lake Titicaca Basin projectile points, 11–1.0 cal. ka., to investigate the potential role of archery technology during the Archaic-Formative transition. A metric analysis of 1179 projectile points reveals a dramatic decline in size around 5000 years ago, spanning the Late-Terminal Archaic Period boundary and

suggesting that archery technology emerged during the Terminal Archaic Period. This technological innovation thus occurred at a time of increasing village size, emergent obsidian exchange, limited inter-group violence, and incipient agropastoralism. These processes would later culminate in the emergence of massive ceremonial sites during the Formative Period. Rather than inciting conflict, archery technology appears to have facilitated regional trade and cooperation, ostensibly by creating new subsistence opportunities or increasing the costs of non-cooperative behaviors, thus permitting new cooperative norms. This study shows that the relatively egalitarian communities of the Titicaca Basin Terminal Archaic Period engaged in complex burial ritual, mound construction, exchange, and community interaction, contradicting the idea that emergent social complexity necessarily entails institutionalized inequality in human societies.

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Chapter 1. **INTRODUCTION**

1.1. **Main idea and Aims**

This dissertation examines the evolution of inequality, leadership, and social mechanisms that supported social transformations in the South-Central Andes, where complex socioeconomic systems with agropastoral economies and urban centers emerged endogenously some 2000 years ago. The South-Central Andes thus presents a rare case study in emergent complexity. The research reported here is specifically concerned with one of these seeds of complexity, social inequality—how the last hunter-gatherers became the first farmers, how ancient society was organized in the Titicaca, and the extent to which inequality and leadership were causal or consequences of the complex socioeconomic structures that would follow. Previous archaeological research identifies this economic transition between 5,000–3,500 years ago, during the Terminal Archaic Period. The Terminal Archaic Period site of Kaillachuro is the focus of this study because its inhabitants were the first in the region to inter their dead in above-ground mound structures, indicating a degree of emerging inequality. The extent and nature of that inequality are focal points of this research.

Before addressing the aforementioned questions, we outline the theoretical basis for the research questions, provide some Andean ethnographic examples, unravel the structure of egalitarian societies, and describe the different types of leaders that could have emerged during Andean neolithization.

1.2. **Classic concerns**

One of the major objectives of social scientists worldwide has been to investigate the drivers of human inequality. Archaeologists have researched inequality as one of the facets of a complex social structure (Paynter, 1989). Traditionally, it was suggested that only hierarchical and stratified

societies exhibited social inequality, while societies without an institutional power structure were thought to lack inequality (Fried, 1967; Service, 1978). According to classic postulated evolutionary sequences, egalitarian or band societies are seen as the starting point of developmental schemes, representing the most naturalistic depiction of our origins as "*the equality is the blank slate of nature upon which social complexity is written*" (Wiessner, 2009).

Egalitarian society was defined as one in which "*there are as many positions of prestige in any given age-sex grade as there are persons capable of filling them" and "it does not have any means of fixing or limiting the numbers of persons capable of exerting power*" (Fried 1967: 33). Scholars who proposed employing the term egalitarian, either as a social stage or as a descriptive component of a social type, understood that social equality was socially impossible as it was non-existent (Fried, 1960, 1967; Service, 1975). Moreover, they recognized that an egalitarian society may organize its members and provide them with varying levels of prestige and rank based on their age and sex. Morton Fried argued that society has processes that encourage uniformity within the limits of diversity. Thus, an egalitarian society is characterized by the absence of institutions, few high-status positions compared to qualified individuals, and lack of status inequalities based on wealth.

1.3. **Inequality and Complexity among Equal Societies**

Current research, in contrast, observes that inequality is an inherent characteristic of many species. Researchers from ethology demonstrate that hierarchy and inequality are social relationships with deep roots (Garfield et al., 2019; A. J. King et al., 2009). As an illustration, chimpanzees typically exhibit a hierarchical structure characterized by dominant leaders who secure advantageous dietary resources and access to females (De Waal, 2007).

Anthropologists and archaeologists study how human societies have navigated social relationships beyond kinship, including the development of new social institutions like markets and religion. They examine how mechanisms like emerging leadership and punishment have contributed to this process and helped maintain social order (Carballo & Feinman, 2016; Henrich et al., 2001, 2015; Stanish, 2017).

Moreover, societies can be complex without inevitably exhibiting institutionalized inequality. Complexity reflects internal differentiation and the variety of relationships (Paynter, 1989). In societies that prioritize equality, the complexity of the situation occurs in the community's effort to prevent ambitious and competent leaders from accumulating resources, exerting influence over others' decisions, and gaining a disproportionate degree of social status. Even in trans-egalitarian societies, when these competent individuals attain a higher status, they succeed because they ensure that their group receives benefits. Leadership is both achieved and situational. Therefore, in order to maintain equality, societies develop complex institutions and beliefs, build trust, standardize important information, and make broad exchange networks more predictable. Thus, an egalitarian society might also be complex in terms of its institutions and unequal in terms of status according to gender and age (Wiessner, 2002, 2009).

1.4. **Theoretical Models of Leadership**

Two classic theories of anthropology from a structuralist and cultural-ecological perspective, known as the alliance theory (Lévi-Strauss, 1969) and the surplus production theory (Sahlins, 1963, 1972), provide a basis for explanations of how complexity and social inequality among hunter-gatherers could have developed (Bender, 1978; Hayden, 1987, 1995, 2014). According to these proposals, hunter-gatherers needed to interact across territories, either for subsistence or for social purposes. Social motivations included the formation of social alliances and kin relationships.

Such social ties required maintenance through periodic visits and ritual ceremonies between groups. Sahlins (1972) suggested that this mechanism generated achieved leaders, or "Big Men," as observed in Melanesian societies, in which ambitious leaders accumulated debt and wealth and attracted followers who helped them economically and promised protection. Thus, "*leadership is a creation... of fellowship*" (Sahlins, 1972). Big men compete against other ambitious men in a political career, using large feasts, for example, as the *potlatch* and *moka* systems (Boas, 1897; Sahlins, 1963). During these competitive celebrations, the factions in public shared food and gifts as a form of economic reciprocity. Additionally, these festivities provided an opportunity for wealthy families to form marriage alliances, which ultimately increased women's status. It is important to note that these transactions led to social indebtedness, such as the payment of dowries or death compensation, which ultimately contributed to the emergence of social inequality (Hayden, 1995, 2014; Mauss, 1990). Nevertheless, Big Men cannot exercise the same degree of authority and power over the groups as the *chiefs* do. Unlike a Big Man, a *Chief* has a permanent position of leadership, overseeing the production process and allocating resources to provide extravagant hospitality to other chiefs, fund artisanal manufacturing, and facilitate large-scale building (Sahlins, 1972).

Another type of leadership is the Great Man, as described by Maurice Goodelier from the Baruya society of New Guinea. Great Men are individuals who achieve or inherit a specific social status not through auspicious accumulation of wealth, as is the case with the Big Man, but rather due to their exceptional intrinsic or extrinsic skills. These may include prowess as a hunter or salt producer, victories as warrior leaders, or accurate prognostications as shamans. Great men manage the rules of kinship, fertility, land, and violence in accordance with an ideology of male superiority over women, which maintains social inequality (Godelier, 1986).

Archaeologists frequently favor the big-man model for tracing the origins of institutionalized inequality and the evolution of leadership; however, some scholars identify inconsistencies in its assertions (Hayden, 1995; Roscoe, 2012; Stanish, 2017; Wiessner, 2009). Sahlins' big man model compels us to consider the existence of a singular archetypal leader, an economic entrepreneur, thereby obscuring the extraordinarily diverse reality of other forms of leadership in small-scale societies. However, the traditional image of the big man was not common in New Guinea (Roscoe, 2012), but rather the so-called *headman* described by Marvin Harris (1993). The headman was a leader without formal and real power, a situational leader, the majority of whom are males, but not exclusively because there are spaces for headwomen. An instance that exemplifies this type of leadership is seen in Inuit societies, where an individual with recognized success in hunting assumes the role of group headman. Headmen are incapable of imposing physical punishment on uncooperative individuals or demanding obedience; rather, they depend solely on their reputation, hard work, and extreme generosity to exercise influence over other group members (M. Harris, 1993: 356-358).

Andean ethnography is replete with examples of prestigious local leaders who, despite their lack of power, serve to represent their communities or temporarily manage the town's feasts. While our analysis is not a comprehensive examination of the power dynamics within Andean communities, we do provide a brief outline of the particular types of leadership that are prevalent in these communities.

Among contemporary Aymara and Quechua communities, there are, firstly, community presidents, who act as temporary leaders who make decisions for the entire community and are responsible for advocating on matters pertaining to public administration. Aymaras refer to them as *maycos*. Second, there are respected, permanent religious leaders who are well-known for their

religious knowledge, called *yatiris*, or wise Aymaras. To preserve their prestige, religious leaders must lead an exemplary life, be charismatic individuals who keep their word, and serve as guardians of the community's traditions. Third, there is a kind of organizer or manager of the communal festivities who is responsible for leading this community objective and, at the same time, allowing them to become full members of their community. These individuals are required to occupy a transitory position (*cargos*), during which they assume a series of ceremonial responsibilities. Due to the rotational nature of certain positions, the high level of commitment and investment necessary for each position prevents any of these leaders from amassing power and exerting unilateral authority over the people (Celestino & Meyers, 1981; Fernández Juárez, 2004; Grillo, 1991; Quispe Escobar, 2017).

More recent evolutionary theoretical approaches concern themselves with addressing how people contribute to the public good, especially when doing so comes at personal cost. These studies characterize the presence of prestigious leaders who may not possess absolute power and suggest that societies that solve cooperative dilemmas grow in scale because they maintain reliable interaction in an increasingly wide and complex socioeconomic sphere among strangers. As a result, they realize the benefits of economies of scale, such as decreased per-unit costs of material goods, reliable exchange, and the production of shared infrastructure. This solution required leaders to generously transmit cultural information to their followers, generating among them prosocial behaviors, generalized reciprocity, and religious beliefs. However, such coordinators lack both the power to exercise exceptional privileges and the means to enforce those privileges (Aldenderfer, 2004; Boyd & Richerson, 2002; Henrich, 2009; Henrich et al., 2010, 2015; Henrich & Boyd, 2001; Henrich & Gil-White, 2001; Stanish, 2017).

In response to the broad range of leaders described in various ethnographic studies, archaeologists have postulated empirical indicators that discriminate between different types of leaders in the record. An attempt has been made to reconcile empirical archaeological data and ethnographic cases documented by anthropologists. For example, Hayden (1995) defined four distinct types of leaders, each exhibiting archaeological traits: *despots*, *reciprocators, entrepreneurs,* and *chiefs*. Nevertheless, the preservation of archaeological evidence perpetually constrains and restricts archaeologists, which complicates the search for detailed ethnographic and sociopolitical structures in the archaeological record.

1.5. **Dissertation History**

I decided to thoroughly investigate the Kaillachuro archaeological site because it is one of the few settlements in the Titicaca Basin and the Andean Altiplano that previous research has identified as having potential burial mounds from the Terminal Archaic Period, making it potentially important for understanding social dynamics during a period of major socioeconomic transformation. Despite Kaillachuro's significance, it was only minimally tested in the late 1990s and early 2000s (Aldenderfer, 2004, 2012; Craig, 2012).

My interest in the site began over a decade ago when I recognized the valuable material available on Kaillachuro and utilized the published data to develop an interpretation regarding the development of monumental landscapes, which I incorporated into my master's thesis (Flores-Blanco, 2014). While I offered a theoretical model to understand the Terminal Archaic mound at Kaillachuro, my work lacked empirical anchoring.

In the summer of 2019, I took part in the Archaic project in Titicaca led by Randall Haas, when I piloted new field investigations at the Kaillachuro site. I performed a full surface survey, topographical mapping, and 3D modeling of the site. Then, even though subsequent fieldwork was

halted by the COVID pandemic in 2020, I was able to analyze projectile point data for the Titicaca Basin to evaluate the potential roles of projectile technology in Terminal Archaic dynamics (Chapter 4). Additionally, I compiled previously unpublished data from Mark Aldenderfer's field notebooks and field drawings from the prior investigations in the 1990s (Chapter 3).

In the summers of 2021 and 2022, I undertook archaeological excavations and analyzed materials found at the Kaillachuro site. During the 2021 field season, I conducted exploratory excavation on 76m^2 in six blocks, including mounds 1, 4, 5, and 6, and a unit in a moundless area. I discovered archaeological features from the Archaic and Formative Periods, mostly in mounds 4 and 6. In 2022, I returned to Puno city to examine the materials during July and August. Then, in October, I conducted excavations at the site. I excavated deeper into mound 4 and the area between this mound and M6. Also, I excavated a 2x2 meter unit outside the mounds, initially considering it could be a plaza. We excavated a total of 12m^2 in 2022. Finally, I continued working in Peru uninterrupted throughout the summer and autumn of 2023 to conduct laboratory analysis of most of the archaeological artifacts unearthed during my interventions in Kaillachuro.

1.6. **Organization of the Dissertation**

The dissertation is organized into six chapters. It starts with an in-depth examination of the archaeology of the Andean Altiplano from 5300 to 3000 cal BP, covering the whole period of occupation at the site being studied (Chapter 2). In Chapter 3, I introduce new evidence from the archaeological site of Kaillachuro, indicating that the construction of the region’s first monumental architecture commenced around 5000 years ago-nearly a millenium earlier than anticipated placing the behavior at the beginning of the Terminal Archaic Period. This finding reveals the significant influence of ritual practice related to the deceased in the development of this social complexity. In Chapter 4, I investigate the individuals buried in the mounds of the Kaillachuro. The major

motivation for this work is to determine if this construction type was influenced by social inequality and necessitated the organization of influential leaders. I present new empirical evidence to confront three theoretical models for emergent complexity in human societies. The investigation evaluate whether the individuals who received mound burials were wealthy leaders according to the traditional Big-Man / Chief model (Sahlins, 1963), or if they were instead situational leaders lacking authority, akin to community coordinators as suggested in recent neoevolutionist theories (Stanish, 2017). Another potential explanation is that the place functioned as a cemetery that was accessible to all members of the community in the context of what is traditionally known as an egalitarian society. In Chapter 5, I provide results from an extensive database analysis of project points recovered from the Titicaca Basin. I assess the introduction of bow and arrow technology in the region and its influence on the evolution of social complexity. Finally, I present the conclusions of my research in Chapter 6.

Chapter 2. **TIME OF MAJOR CHANGE IN SOCIAL COMPLEXITY IN THE ANDEAN ALTIPLANO, 5.3-2.8 ka: A REVIEW OF EXISTING LITERATURE**

2.1. **Introduction**

Altiplano inhabitants lived as foragers at least for 7,000 years between 12,800 to 5000 years B.P. (Albarracin-Jordan & Capriles, 2011; Aldenderfer, 1989; Capriles & Albarracin-Jordan, 2013; J. Chen et al., 2024; Gayo et al., 2015; R. Haas et al., 2015, 2020; R. Haas & Viviano, 2015; Kitchel et al., 2022; Muscio & López, 2016; Osorio et al., 2011). Beginning around 5000 years ago, a sequence of social, economic, and political events initiated the neolithization process in the South-Central Andes. This corresponds with the widely recognized transition between the Archaic and Formative Periods in Andean archaeology. Archaeologists worldwide have been greatly concerned with the origins and evolution of agricultural and sedentary lifeways, widely regarded as the most consequential change in human lifestyles and a process that occurred independently in multiple locations around the world. Archaeologists generally hold that this process marks a shift from small, mobile hunter-gatherer populations to more densely populated, permanent settlements dependent on food production and the emergence of new technologies such as ceramic, architecture, metals, and bow-and-arrow (Bellwood, 2023; Bender, 1978; Childe, 1951; Dillehay, 2011; Flannery, 1972, 1973; Gebauer & Price, 1992; Kelly, 2013; Redman, 1978).

Andean scholars have made considerable progress in studying the Archaic and Formative Periods in the Andean Altiplano and the South-Central Andes over the past thirty years. Despite efforts to consolidate this information, the focus has mainly been on each period separately (Aldenderfer, 1989, 2009, 2012; Aldenderfer & Flores Blanco, 2011; Bandy, 2006; Beck, 2004; Capriles, 2023c; Capriles & Albarracin-Jordan, 2013; Flores Blanco, 2017; Hastorf, 2008;

Janusek, 2004; Marsh, 2015; Martinez, 2019; Muñoz, 2004; L. Núñez, Cartajena, Carrasco, De Souza, et al., 2006; Pintar, 2014; Santoro et al., 2016; Sepúlveda et al., 2018; Standen et al., 2004; Stanish, 2003; Tantaleán, 2017). There has been insufficient attempt to synthesize this information across the transition between both these periods (Aldenderfer, 2004; Hocsman & Babot, 2018; Kitchel et al., 2022; Marsh, 2015; L. Núñez, Cartajena, Carrasco, de Souza, et al., 2006; L. Núñez & Santoro, 2011; Sepúlveda et al., 2018). In this regard, the Andean Altiplano represents a key data source to elucidate these profound transformations and explore whether it followed the same line of changes that are widely accepted for the Neolithic transition in other regions (Bellwood, 2023; Childe, 1951; Flannery, 1973; Kelly, 2019; Price, 2000; Price & Feinman, 1995; Redman, 1978).

This chapter reviews the state of archaeological studies in the Altiplano region from the Terminal Archaic (5000–3500 cal BP) to the Early Formative (3500–2800 cal BP) periods, which span over two thousand years. I limit the review to the topics developed later in the dissertation, including chronology, monumental architecture, mortuary practices, and major technological innovations, such as lithic material and ceramics. The overview provides context for the topics covered in Chapters 3, 4, and 5, with conclusions presented in Chapter 6.

2.2. **Territory**

2.2.1. ***The Altiplano in the South-Central Andes***

The Altiplano is a vast region, bordered on the west and east by tall mountain ranges in the South-Central Andes. The territory, also known as Meseta del Collao, is the world's largest plateau, covering around 205,000 km^2. The area is characterized by its cold climate and high altitude and has been repeatedly submerged by large ancient lakes.

The Altiplano is divided into two main regions: 1) the Northern Altiplano, centered around the Lake Titicaca Basin, which is the highest (~3812 meters above sea level) and the most wet of the two. More than twenty rivers flow into this endorheic basin, with the Ramis, Huancane, and Ilave rivers being the longest. 2) The Southern Altiplano is an endorheic basin formed by the Uru Uru and Poopo lakes. The Desaguadero River connects the southern altiplano to the northern altiplano, encompassing shallow saline lakes and salt flats, including Uyuni, the world's largest salt flat. The southern dry puna also encompasses the sources of the Grande de Lipes and Pucamayu rivers, with a lower altitude of around 3670 meters above sea level (Arellano, 2000; Fornari et al., 2001; Thompson et al., 1998; Troll, 1968) (Figure 1).

2.2.2. ***Paleoenvironment***

Scholars concur that the climatic conditions in the highlands of the South-Central Andes were relatively favorable, with increased precipitation, approximately 4000 years ago (Grana et al., 2016; Guédron et al., 2023; Jara et al., 2020; Latorre et al., 2003; Mourguiart et al., 1998; Orellana et al., 2023; Servant & Servant-Vildary, 2003). This period of increased rainfall followed a prolonged period of drying and environmental fragmentation during the Middle Holocene (8000–4000 BP) (Baker et al., 2005; D'Agostino et al., 2002; Seltzer et al., 1998). This climatic improvement did not extend across the entire Altiplano region.

Lake Titicaca's water level increased during the Late Holocene, and the lake reached its current level (>3810 masl) around 3500 BP (Baker et al., 2001; Guédron et al., 2023; Mourguiart et al., 1998; Servant & Servant-Vildary, 2003). This event may have occurred earlier in the northern Titicaca Basin than in the Bolivian highlands (Abbott et al., 2003).

In other Andean areas, studies indicate periods with higher and lower levels of precipitation. For example, an increase in humidity in the dry highlands of the western valleys of Chile

between 4000-3400 cal BP is indicated by a change in vegetation (Jara et al., 2020). By contrast, conditions in the Suches lagoon basin in Tacna, Peru, were arid between 4750-3200 cal BP, but not as severe as during the Middle Holocene (Vining et al., 2019). In general, evidence indicates that dry climatic conditions persisted as a significant challenge in many areas of the South-Central Andes until at least the first half of the Terminal Archaic Period.

2. 3. **Archaeological Evidence**

2.3.1. ***Chronology***

The chronology used here is based mainly on the proposals made for the South-Central Andes (Aldenderfer, 2009; Aldenderfer & Flores Blanco, 2011; Flores Blanco, 2017; Hastorf, 2008; Stanish, 2003; Tantaleán, 2017). This review focuses on the Terminal Archaic and Early Formative Periods (Tables 1 and 2).

Table 1. Chronology of the Titicaca Basin from the Late Archaic Period to the Formative Period. The shaded section marks the occupancy of the Kaillachuro site.

years cal B.P.	Chronology		
	Rowe (Ica sequence)	**Stanish 2003 / Aldenderfer 2009 (Titicaca sequence)**	**Titicaca Sites**
	Early Intermediate	Upper Formative	Pucara, Tiwanaku
2000			
	Early Horizon	Middle Formative	Chiripa
2800/3000	Initial Period	Early Formative	Jiskairumoco, Kaillachuro, Chiripa, Muruqullu
3500		Terminal Archaic	Pirco, Jiskairumoko, Kaillachuro, Muruqullu
5000			Pirco
	Preceramic	Late Archaic	
			Soro Mik'aya Patjxa
7000			

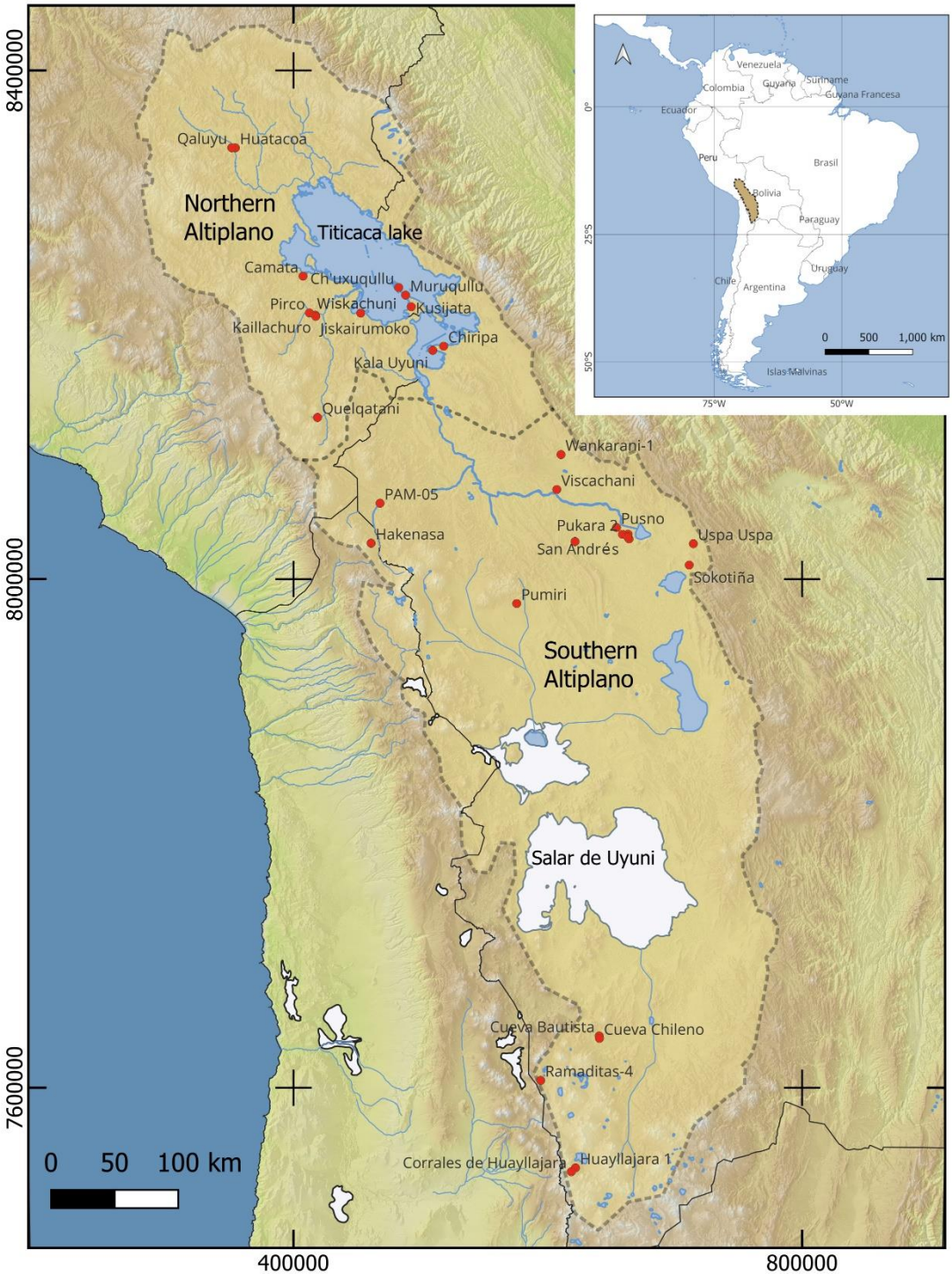


Figure 1. Location of archaeological sites (red dots) dated to the Terminal Archaic and Early Formative Periods in the Altiplano region (orange polygonal). The Altiplano divides into two regions: the Northern Altiplano, which basically includes Lake Titicaca, and the Southern Altiplano.

2.3.1.1. The Terminal Archaic Period (5000-3500 AP)

The Terminal Archaic Period is characterized as "*a transition from a mobile foraging lifeway to one that was far more sedentary, with an economy based on camelid herding and intensive chenopod utilization*" (Aldenderfer, 2009: 77). Important sites include the open-air site of Asana (Osmore River), Qelqatani shelter (Chila River), and Jiskairumoko (Ilave River), all in Peru, as well as many rock shelters in northern Chile, including Hakenasa. Radiocarbon dates place the Terminal Archaic between 5000 and 3500 cal BP. This particular chronological term has been primarily used by Aldenderfer and his colleagues (Aldenderfer, 2009; Aldenderfer & Flores Blanco, 2011; Craig, 2012; Kitchel et al., 2022); however, the notion of a distinctive cultural period that marks this important socio-economic shift dates back at least 20 years prior to Aldenderfer's proposal. Santoro and Chacama (1989) suggested a phase named "Transition" occurring between 4000-3000 BP, using evidence from the final occupancy of the Patapatane cave and the middle levels of Piñuta, indicating the beginnings of agricultural practices. Most Andean researchers use the term "Late Archaic" (6000/5500-4000 BP) or refer to it, using a more local phase, such as the Hakenasa phase in Chile. Nonetheless, they have explicitly alluded to the existence of a "transitional" period characterized by significant societal transformations, such as the "Archaic-Formative transition" (Aschero & Hocsman, 2011; Hocsman & Babot, 2018; L. Núñez & Santoro, 1988; Santoro, 1980, 1989; Santoro et al., 2016).

Regardless of the terminology, the number of excavated and reviewed sites with this transitional period represented has increased markedly over the last 20 years, showing clear stratigraphy and a broad range of radiocarbon dates. Recently data from sites providing evidence for this period include Tulan-52 in the salt puna of Atacama (L. Núñez & Perlès, 2018), the Late Archaic Period level of the Hakenasa cave in the dry puna of northern Chile (LeFebvre, 2004),

various sites in the upper part of the Azapa valley (Gayo et al., 2015; Sepúlveda et al., 2018), newly dated sites in the Bolivian Altiplano (Capriles, 2023c, 2023a), and recently Kaillachuro (Ilave River) in the Titicaca Basin (Flores-Blanco & Aldenderfer, 2024).

Northern Altiplano

In total, there are 26 radiocarbon dates from Late/Terminal Archaic Period sites in the Titicaca Basin, most of them from the Peruvian side of the Basin. The best-known site from this period is Jiskairumoko, where 21 dates were produced from the preceramic levels. The earliest phase, with three radiocarbon dates, extends Jiskairumoko's occupation to 5500 cal BP into the Late Archaic Period. But the most extensive occupation was during the Terminal Archaic Period, with 18 dates indicating a settlement between 5000 and 3400 cal BP. As will be seen in Chapter 3, Kaillachuro, a site in close proximity to Jiskairumoko, has 17 AMS dates that similarly place its Archaic occupancy between 5450 and 3570 cal BP. Two radiocarbon dates from preceramic stratum 5 in Camata place occupation between 3830 and 3490 cal BP (Steadman, 1995: 21–22). Here, I also present a previously unpublished date obtained from a unique burial discovered at the Pirco site, which ranges from 3970 to 3700 cal BP. The date from Pirco does not exclude the chance of previous occupations at the site, as indicated by the numerous projectile points from the Late Archaic Period, which may be linked to an early short-term residential settlement (Craig, 2005). On the Bolivian side of the basin, a solitary date obtained from the Ch'uxuqullu site on Isla del Sol provides an extensive interval of potential values spanning around 4780 to 3640 cal BP (Stanish et al., 2002).

Southern Altiplano

Fewer southern Altiplano sites are dated. The Hakenasa rock shelter in the Chilean Altiplano provides the most accurate date for this location. The site is in the endorheic system of the Coipasa

salt flat, near the Caquena River at 4100 masl. This site was used to define the "Hakenasa phase" of the Late Archaic in the northern Chilean highlands and is dated between 4000 and 5300 cal B.P. (LeFebvre, 2004: 49: Table 1; Santoro, 1989: 47). The Pumiri rock shelter (URR-01), close to the town of Turco, produced an AMS date from Layer 45, at 1.85 m in depth, at 4860–5070 cal BP (Capriles & Albarracin-Jordan, 2013; Méncias, 2018). In addition, Bautista Cave, Sora Valley, and Lípez Desert produce a single date from this time period at 3730 to 4215 cal BP (Capriles et al., 2016). Other sites in the Lípez region are the El Chileno cave dated between 3824-4088 cal BP, and the open-air sites of Ramaditas-4 and Huayllajara 1 also dated to the Terminal Archaic (Albarracin-Jordan et al., 2014; Capriles, 2023a, 2023c; Nielsen et al., 2010).

2.3.1.2. The Early Formative Period (3500-2800 AP)

Northern Altiplano

The Early Formative Period is characterized as the onset of village life and signifies a shift towards an economy that is progressively more dependent on agriculture, yet still with substantial consumption of goods derived from hunting, gathering, and fishing. As a source of resources, Lake Titicaca took a more prominent role in promoting population growth. Ceramic and metal artifacts, as well as exotic goods like obsidian, came to be utilized more extensively during this period (Aldenderfer, 1989; Hastorf, 2008; Stanish, 2003). As Stanish (2003: 99) has pointed out, "*The transition from Late Archaic to Early Formative lifeways was a long process, not an event*."

Radiocarbon dates place the Early Formative Period in the Altiplano between 3500 to 2800 cal BP. Archaeological evidence indicates the period is marked by distinctive ceramic types, often with local variations, such as undecorated Early Qaluyu pottery in the northwest of the Basin and Early Chiripa ceramics on the Bolivian side of the Lake Titicaca Basin.

Table 2. Summary of the radiocarbon dating of the Altiplano for the Terminal Archaic and Early Formative Periods.

Region	Site	Location	# of dates*	Earliest cal. BP	Latest cal. BP	Reference
Northern Altiplano	Jiskairumoko	Ilave Valley	26	5576	3218	Craig 2005
	Ch'uxuqullu	Island of the Sun	3	4779	2868	Stanish et al. 2002:451
	Kaillachuro	Ilave Valley	1	4351	4157	Craig 2005
	Pirco	Ilave Valley	1	3969	3700	Flores-Blanco
	Quelqatani	Chila Valley	2	3969	2934	Eisentraut 1998: 45
	Chiripa	Taraco Peninsula	23	3686	2720	Browman 1998:323; Ralph 1959:57; Whitehead 1999:18; Capriles & Hastorf 2023: Table 2
	Camata	S of Puno, Titicaca	5	3826	2785	Steadman 1995
	Qaluyu	Ramis Valley	5	3565	2784	Ralph 1959: 57; Mohr Chavéz 1997: 1144-1145
	Kusijata	Copacabana Peninsula	1	3439	3076	Capriles 2023
	Huatacoa	Ramis Valley	3	3385	3000	Cohen 2010
	Wiskachuni	Juli, Titicaca	6	3366	2731	Herhahn 2004: 153
	Kala Uyuni	Taraco Peninsula	6	3070	2745	Whitehead 2007:15; Bruno 2008:670
	Total		82			
Southern Altiplano	Hakenasa	Caquena Basin	4	5311	2756	LeFebvre, 2004; Santoro, 1989: 47
	Huayllajara 1	Potosí	1	5271	4617	Nielsen et al. 2010:1370
	Cueva Bautista	Potosí	2	4225	3077	Capriles et al. 2016:469
	Cueva del Chileno	Potosí	1	4089	3727	Albarracin-Jordan et al. 2014:455
	Chuquiña	N of Poopo lake	20	3828	2350	Fox 2007: 30; Capriles 2023
	Sokotiña	Oruro	1	3395	3072	Stuckenrath 1967:335
	Wankarani	N of Poopo lake	4	3577	1934	Ponce Sanginés 1970: 47; Wendt et al. 1962: 107
	La Barca	N of Poopo lake	17	3485	2141	Capriles 2023
	PAM05	Markanasa Valley	1	3483	3230	Capriles & Albarracin-Jordan 2013:49
	Kella Kellani	Oruro	3	3381	2784	McAndrews 2005:57
	Pusno	N of Poopo lake	6	3314	2730	Fox 2007: 30; Capriles 2023
	Uspa Uspa	N of Poopo lake	5	3333	2359	Capriles 2023
	Corrales de Huayllajara	Potosí	1	2960	2737	Nielsen et al. 2010:1370
	Ramaditas-4	Potosí	1	4418	3986	Capriles 2023
	San Andrés	La Joya	5	3827	2722	Bermann & Estévez 1993:324; Estévez & Bermann 1995:16
	Total		72			

* The dates that were rejected by the authors or showed a significant standard deviation, specifically an error of 150 years or more, were excluded from the data analysis. I have made every effort to verify the dates' provenance; however, in situations where excavation reports are unavailable, we have been compelled to rely on the Bolivian radiocarbon database (Capriles, 2023b).

The Titicaca region contains most of the well-dated Early Formative sites in the Altiplano. On the Bolivian side of the Titicaca Basin, this includes Chiripa (Hastorf, 2003; Whitehead, 1999), Ch'uxuqullu on Isla del Sol (Stanish et al., 2002), Kala Uyuni (Bruno, 2008; Whitehead, 2007), and Kusijate (Capriles, 2023b). The Peruvian side important sites include Qaluyu (Mohr-Chávez, 1977; Ralph, 1959), Huatacoa (Cohen, 2010), Camata (Steadman, 1995), San Bartolomé-Wiscachani (Herhahn, 2004), Jiskairumoco, and Kaillachuro (Craig, 2005).

Chiripa is the best-known archaeological settlement from the Early Formative Period. Seventeen radiocarbon dates help define the Early Chiripa phase (3500–3000 BP), a time when there was no evidence of large-scale buildings at the site. Additionally, 15 dates to help establish the Middle Chiripa phase (3000–2800 BP), which marks the beginning of monumental architecture in the latter part of the Early Formative Period (Hastorf, 2008; Whitehead, 1999). Several sites around Lake Titicaca appear to date to the same time as Chiripa, such as Kala Uyuni near the Coa Collu community, whose six dates from the Early Formative Period place it between 3000 and 2750 cal. BP. Kala Uyuni lacks evidence for monumental architecture until the Middle Formative Period. Finally, archaeologists date layers 17 and 20 of the Ch'uxuqullu site, Isla del Sol, between 3380 and 2540 cal BP (Bandy & Hastorf, 2007; Bruno, 2008; Stanish et al., 2002; Whitehead, 2007), showing it too overlaps the Early and Middle Formative Periods.

Two sites in the Ilave River Basin have occupations primarily from the Terminal Archaic Period, but they also extend into the Early Formative. Jiskairumoko has three dates falling within the time frame of 3580 to 3215 cal BP, while Kaillachuro has five dates with ages ranging from 3590 to 3000 cal BP (Craig, 2005; Flores-Blanco & Aldenderfer, 2024).

In the Ramis River valley, in the northern Titicaca Basin, several sites have been dated to this same time period. For instance, five of the seven radiocarbon dates from the Qaluyu site range

between 3565-2780 cal BP, consistent with the Early Formative Period. The earliest date derives from Trench 1, which is 1.60 meters deep. The remaining dates at the site correspond to the Middle and Late Formative Periods (Mohr-Chávez, 1977: 1144-1145; Ralph, 1959: 57). Similarly, five dates from Camata indicate an Early Formative Period settlement from 3300 to 2500 cal BP, and three dates from the Huatacoa site are from the Early Formative, one of which dates an early house between 3385 and 3170 cal BP, while the remaining two dates date public architecture features between 3380–3000 cal BP. Finally, Wiskachuni has six dates between 3370 and 2730 cal BP (Cohen, 2010; Herhahn, 2004; Steadman, 1995).

Southern Altiplano

Contemporaneous with Chiripa, the "Wankarani complex" emerged in the Southern Altiplano (Bermann & Estévez Castillo, 1993, 1995; Capriles, 2014b, 2023c, 2023a; Capriles et al., 2021; Fox, 2007; Jiménez, 2012; McAndrews, 2005; Pérez, 2005; Rose, 2001). Surprisingly, though, after Ponce Sanginés conducted this pioneering research at the Wankarani site, this settlement has been understudied and, as a result, is not well-dated. Because they are from the 1970s, the four existing dates from Wankarani-1 have a considerable margin of error. Nevertheless, two of the dates, at 3580–2500 cal BP, fall within the Early Formative Period range; the remaining two dates are more consistent with the Middle Formative Period (Ponce Sanginés, 1970; Wendt et al., 1962). Since the 1970s, additional Wankarani sites have been studied and dated. A series of radiocarbon dates from La Barca, Chuquia, Kella Kellani, Pukara 2, Pusno, San Andrés, Uspa-Uspa, KCH21, and Sokotia, place some of the occupations at these sites between 3500 and 2700 cal BP place them as contemporaneous with Early Formative Wankarani. La Barca (3330–4240 cal BP) and San Andrés (3370–3730 cal BP) have the oldest dates, although in the first case with a large margin of error. Occupation at these sites continued through the rest of the Formative Period (Bermann &

Estévez Castillo, 1993, 1995; Capriles, 2014a, 2023c, 2023a; Capriles et al., 2021; Fox, 2007; McAndrews, 2005; Rose, 2001, 2001; Walter, 1994).

Other sites include the high-altitude (3985 m) PAM-05 rock shelter near the Qaquena River. A camelid bone sample from the first preceramic stratum there was initially considered to be from the Terminal Archaic Period (Capriles & Albarracin-Jordan, 2013), but its calibrated (3230–3460 cal B.P.) fits better within the Early Formative Period. The sample might have come from the first stratigraphic layer with Formative pottery, 48–52 cm deep, although the site may also contain an Archaic Period component due to its stratigraphic depth of up to 70 cm (Jiménez, 2012: 246-252).

Finally, three dates from three distinct sites in the Lipez region—Corrales de Huayllajara, Puente Mayu, and a level of Cueva Bautista—are also consistent with the Formative Period. The dates from these sites span 3400 to 2740 cal BP (Capriles, 2023a, 2023c).

2.3.2. ***Settlement Patterns***

Regional data shows varied settlement patterns in the Altiplano from 5000–2800 BP. This section summarizes current knowledge of the Northern and Southern Altiplano.

Northern Altiplano

Pedestrian surveys have covered around 1000 km^2 of the northern Altiplano region (Albarracin-Jordan & Mathews, 1990; Aldenderfer, 2002; Aldenderfer & Flores-Blanco, 2008; Bandy, 2001; Calla Maldonado, 2011; Cipolla, 2005; Cohen, 2010; Craig et al., 2010; R. Haas et al., 2015; Klink, 2005; La Favre, 2016; Stanish et al., 2005, 2014; Stanish & Steadman, 1994; Stanish & Umire, 2004; Tantaleán & Zapata Benites, 2014). During the Late Archaic Period (6000–4400 BP), the number of sites in the highland regions of the Southwest Titicaca Basin, particularly in the upper reaches of the Huenque River (Ilave River Basin), increased slightly from the preceding Middle

Archaic Period. In the subsequent Terminal Archaic Period, population density shifted from the upper to the lower Huenque region (Klink, 2005).

Similarly, researchers have observed a notable shift in the settlement pattern in the middle valley of the Ilave River between 3800 and 4000 BP. The total number of sites decreases between the Late and Terminal Archaic Periods, but the area of settlements expands, allowing scholars to propose a process of population aggregation in the middle valley. The settlement area increased by 68%. Two sites clearly demonstrate this change: Jiskairumoko and Kaillachuro. Excavation at Jiskairumoko established the presence of pithouses and village organization (Figure 2). Survey revealed the neighboring Kaillachuro site to cover an area of 3 hectares (Aldenderfer, 2002; Craig, 2012; Craig et al., 2010; Flores-Blanco, 2014; Flores-Blanco et al., 2023a; Flores-Blanco & Aldenderfer, 2024).

Increasing sedentarism during the Terminal Archaic Period is also evident along the Chila River, in the vicinity of the upper basin of the Ilave River, where inhabitants appear to have reduced their mobility to the high puna by using the Quelcatani rock shelter as a temporary residence beginning in 4500 BP and then transforming it into a permanent residence by 3700 BP. The residential base was distinguished by the presence of dense middens and rectangular structures made from field stones (Aldenderfer, 1989, 2002).

In the Ramis and Huancane valleys, to the northwest of the Titicaca Basin, scholars have undertaken numerous regional surveys (Aldenderfer & Flores-Blanco, 2008; Cipolla, 2005; Cohen, 2010; Stanish et al., 2014; Stanish & Umire, 2004; Tantalean, 2006). In the Ramis region, researchers have documented the presence of three Archaic sites on the east side of the river in a 60 km^2 survey area in the Quilcamayo-Tintiri valley, Azángaro. These sites exhibit temporal specificity within the Archaic Period. Then, eight sites linked to Qaluyu ceramics indicate Early

and Middle Formative periods occupations (Tantaleán & Zapata Benites, 2014). Within a prospected area of 25 km^2 to the north and south of the archaeological site of Pukara, fifteen sites associated with water resources and dating to the Early and Middle Formative periods using Qaluyu ceramics have been identified. It appears that no archaeological sites date to the Archaic Period (Cohen, 2010: 65–66). The survey conducted in the middle basin of the Ramis River, encompassing an area of 400 km^2, yielded a minimum of 29 archaeological sites and a significant quantity of isolated artifacts dating back to the Archaic Period (Aldenderfer & Flores-Blanco, 2008). Therefore, based on the scant evidence of Archaic period sites discovered in the middle Ramis valley, it appears that the number of sites did not increase significantly during the Terminal Archaic Period in this region. However, the extent of the settlement area did expand. As an illustration, archaeologists have documented a substantial and statistically significant 86% expansion of the habitation area in the Ramis during the Terminal Archaic Period (Flores-Blanco et al., 2023a) (see Chapter 5). On the other hand, they have documented a surge in the quantity of archaeological sites in the middle Ramis valley, dating back to the Formative period and exceeding a century (Aldenderfer & Flores-Blanco, 2008). Conversely, researchers have identified sixty Archaic sites in the lower portion of the same basin. The Formative Period brought a notable rise in the quantity of sites in the valley (Stanish & Umire, 2004).

Archaeologists have identified a minimum of one hundred Archaic Period sites encompassing 450 km^2 in the Huancane valley. During the Terminal Archaic Period, there was a decrease in the number of sites from 26 in the Late Archaic Period to 14 (Cipolla, 2005). Subsequent studies have suggested that the overall quantity of Terminal Archaic sites in Huancane is likely comparable to that of the Late Archaic Period due to challenges in distinguishing the diagnostic material of this time independently (Stanish et al., 2014). The majority of Huancane's

sites are located inland, away from the lakeshore, highlighting the importance of pasture areas and water sources for camelid pasture (Cipolla, 2005). Regrettably, we lack information regarding the fluctuations in the size of the settlement areas in Huancane during this period.

During the Terminal Archaic Period, several sections of the Lake Titicaca Basin were barely populated (La Favre, 2016). No archaeological sites from the Archaic Period were found in the 85.2 km^2 survey conducted on the Taraco Peninsula, Bolivia. This data aligns with the discovery of only two separate Archaic points identified in the Tiwanaku valley survey (Albarracin-Jordan & Mathews, 1990; Bandy, 2001). Subsequent survey later reported the discovery of seven small sites (less than 1 ha) from the Late Archaic Period in the upper valley of the Tiwanaku Valley, where there are pastures, springs, and colluvial areas (Calla Maldonado, 2011). Researchers have documented additional evidence of Archaic Period activity at the Isla del Sol and the Copacabana Peninsula. Furthermore, within a 360 km^2 area around the lake between Juli and Desaguadero, researchers have identified at least seven Archaic sites (Juengst et al., 2017; Stanish et al., 1997, 2002).

During the Early Formative Period, the settlement pattern near Lake Titicaca saw significant changes, particularly in its second phase (3000–2800 BP). Within the Taraco Peninsula, researchers have identified 9 Early Chiripa sites and 23 Middle Chiripa sites. These sites exhibit a high population density, with villages initially housing up to 200 individuals and later expanding to house up to 300 people. For instance, the Chiripa site started as a 2-hectare village during the Early Formative I Period and later grew to 4.25 hectares, showing a preference for public architecture. Bandy (2001: 105) attributes the growth to potential population migration from valleys such as Ilave. In the case of the upper Tiwanaku Valley, it has been impossible to determine

if there was inhabited during the Early Formative Period. However, this could be because there has been no direct dating of the sites (Calla Maldonado, 2011: 113).

Southern Altiplano

New regional study has exposed this southern highland settlement pattern in the last twenty-five years. One of the most thorough and systematic surveys was conducted in La Joya, the Kochi River, and the plain between them, as well as in a non-probabilistic way in Belén, encompassing 201 km^2. Archaic occupations are unknown in those regions (McAndrews, 2005). Eighteen sites linked to Wankarani pottery from the Formative Period have been documented. The settlement pattern was primarily characterized by nucleated villages, each with a history of occupation spanning hundreds of years. The sites were often situated in the foothills, close to farmlands and pastures, with some also positioned near rivers. In the La Joya region, the average site area was 0.78 hectares, with the largest site being Chuquiña at 1.6 hectares. In the Kochi region, the sites have a rather consistent size, averaging 1.41 hectares. The largest site, Huayllamarca, spans 2.14 hectares. Jallahuana is the largest site in Belen, covering 1.94 hectares with an average site size of 1.28 hectares. It seems that the sites were not organized in a hierarchical manner, but rather disparities in size were a result of natural population increase and aggregation (McAndrews, 2005).

Archaeologists have found thirty-five Archaic sites and forty-five Formative Period sites in a small 38 km^2 survey located northwest of Lake Uru Uru. Only six of the sites contain both Archaic and Formative habitation, which are the largest settlements (Capriles et al., 2011). The Formative site KCH21 was thoroughly studied and dated to be between 2,290 and 1,730 cal BP. The transition to the Formative Period demonstrates a rise in the number of sites by 29% and a significant increase in the occupied area by 8.68 hectares (149% more). At least thirty-five open-air sites from the Archaic Period have been discovered near the confluence of the Karakollu River

with Lake Uru-Uru, close to the town of Iroco. The sites in this region have a density of 0.91 sites per km^2, with an average site area of 0.17 hectares (Capriles 2014: 49).

In the Lipez Altiplano, sites from the Archaic Period with temporary residential occupancy were found, particularly south of Laguna Colorada. Specifically, Huayllajara-1 has been dated to approximately 4890 cal BP (Nielsen et al., 2010). Researchers have documented a significant number of preceramic sites in the highland region of Lípez, although further research is needed to accurately identify their dates (Arellano, 1984, 2000; Capriles & Albarracin-Jordan, 2013).

Later in the Formative Period, the Lípez region, particularly its southernmost sector, remained a high-mobility transit hub. The Potosi Formative sites consist of ceramic elements concentrated on the surface near rivers or on the slopes of adjacent hills (Lecoq, 2002). The best-known site is Churquini Chullpa Playa, situated close to the town of Puna. It contains circular buildings with diameters ranging from 2 to 4 meters. They date back to roughly 2000 cal BP, indicating a Late Formative occupancy (Lecoq, 2002: 235). Archaeologists have identified at least two sites from the Formative Period in the Eduardo Avaroa National Reserve in the extreme south, but the exact age has not been specified. The Ojo del Novillito and Dulce Nombre settlements are situated at an altitude of 4500 meters above sea level. These locations showcase basic stone constructions with a circular structure, potentially serving as the foundation for simple parapets. Both Archaic and Formative occupations used rock shelters or later modest and simple buildings, privileging those locations on the Puna and coast contact routes (Arellano, 2000: 255; Nielsen, 1999).



Figure 2. The image provides panoramic views of two important archaeological sites located on the Peruvian side of the Lake Titicaca Basin. a) In the foreground is the Qaluyu site, whose main mound is destroyed by the Puno-Cusco highway. In the background is a hill, at the base of which is the Pukara site. b) An aerial view of Jiskairumoko today, people walking around the area where archaeological investigations were previously conducted.

2.3.3. ***Ceremonial and Monumental Architecture***

Northern Altiplano

Researchers widely accept that monumental architecture began in the Northern Altiplano region by at least the Formative Period. The forms of construction observed at Qaluyu and Chiripa, discussed further below, are two recognized examples of early public architecture in Titicaca. The possibility of non-domestic architecture during the Terminal Archaic Period has not previously been described. For example, Jiskairumoko's only contemporary architecture is a set of residential pithouses (Aldenderfer, 2004, 2012; Craig, 2005, 2012). Below, I review clear cases of Formative Period ceremonial and monumental architecture. In Chapter 3, I argue that the Kaillachuro site exemplifies the earliest ceremonial architecture, with some degree of monumentality, in the Titicaca Basin.

Qaluyu refers to both a ceramic type and an early phase of the Formative Period in the northern Titicaca region. The site itself is stratified, approximately 700 x 210 m, with at least one mound and a subterranean patio with two uncarved Pucara monoliths (Figure 2). Published results on the site are not extensive, but studies suggest two overlapping occupations: an early phase known as Qaluyu and a later one dubbed Pucara (Kidder, 1956; Mohr-Chávez, 1969, 1977; Rowe, 1956). A more recent survey described the Qaluyu largest mound as being at least 40 meters long and 4 meters high, along with six sunken courts (Cohen, 2010: 354–355).

In contrast, the Chiripa site has been the subject of more intensive research, and the results have been more widely published (Bandy, 2001, 2006; Bennett, 1936; Blom & Bandy, 1999; Browman, 1989; Bruno & Whitehead, 2003; Capriles, 2023b; Chávez, 1988; Goodman-Elgar et al., 2023; Hastorf, 1999, 2003; Hastorf et al., 2001; Kidder, 1956; M. Miller et al., 2021; Ponce Sanginés, 1970; Steadman, 1999; Whitehead, 2006, 2007). Associated burials have been

discovered on a large, plastered surface, presumably within a walled adobe enclosure whose function is unknown, which dates to the first phase of Chiripa in the Santiago region (3500–3000 BP). The oldest monumental architecture at the site was discovered in the Choquehuanca sector of the site, dating back to the Middle Chiripa phase (3000–2800 BP). The structure is a square-shaped partially underground area with stone bases, a yellow plaster floor, and dimensions of around 14x14 meters (Hastorf, 1999, 2003, 2008; Hastorf et al., 2001).

Archaeologists have recently uncovered additional evidence from Titicaca that dates to the Early Formative Period, revealing the existence of large-scale construction during that time. The oldest evidence of monumental public architecture in the Altiplano has been found in Area B of Huatacoa, Ramis Valley. The evidence consists of a yellow clay floor, interpreted as an open plaza, with remnants of burning events dating between 3260 and 3000 cal BP. The stratigraphic position indicates the construction of a sunken court later, with its upper floor bearing an older AMS date between 3380 and 3160 cal BP. However, both floors' calibrated ages have significant overlap. The researcher's findings support the sequential construction of both structures within a short time span (Cohen, 2010).

Between these three sites, it is clear that early public architecture was widespread in the Northern Altiplano by at least 3300 and 2800 cal BP (Cohen, 2010: 148-158).

Southern Altiplano

The best-known monumental construction in the southern Altiplano region is from the mounds of Complex Wankarani. Investigations suggest such mounds reached a height of 2.8 m, but some may have been up to 5 m, as in the La Barca and Chuquiña sites. At their base, studies show mounds were up to 250 meters on each side at sites, as at the sites of Sorasora and Toluma (Bermann & Estévez Castillo, 1993; Pérez, 2005; Ponce Sanginés, 1970; Rose, 2001; Walter, 1994; Wasson,

1967). Rose (2001: 39-41) explained that the Wankarani mounds were formed gradually through the addition of a range of materials, including collapsed constructions (stone and adobe walls), discarded materials from occupancy, and natural sediments.

Archaeologists have identified possible temples and residential structures located on top of the mounds. For example, La Barca has three distinct ceremonial structures across different zones of the site. At Zone 3, Structure 3A, linked to residential units, is the most intriguing. The 3A building is a circular construction with dual walls, measuring 6 meters in diameter. The floor space of the ceremonial edifice is significantly greater at 34 m^2 compared to the average 7 m^2 of the houses. Zone 4 contains a ceremonial edifice with a floor size of 68 m^2. Another significant contrast in the dwellings is seen in the boulders utilized for constructing structure 3A, which were notably larger, with some showing evidence of further modification through smoothing. Structure 3A is partially underground, with an inner floor situated 20 cm below the foundation wall. It did not show any signs of household use and had at least five enclosed chambers utilized as storage bins placed into the wall foundation. Two burial tombs were discovered in the northern section of the building (Rose, 2000: 79–81).

2.3.4. ***Burials and grave goods***

Northern Altiplano

Archaeologists in the Titicaca Basin have documented two distinct mortuary practices of relevance to this dissertation. The first and most widespread burial practice dates from the Early Archaic Period and includes burials placed in pits. Graves in stone cists comprise the second form, less well documented for the Archaic Period but more common in the Formative Period.

Pit-burials have been documented for five human burials at Jiskairumoko in the Ilave Valley. These burials were mostly found in secondary contexts (i.e., had been reburied) and were

found near pit-houses. They have been dated to both the Late Archaic and Terminal Archaic Periods. Four were adults, with two female and two of indeterminate sex, and one was a non-adult of indeterminate sex. The tombs included turquoise beads, chipped and ground stones, and flakes made of local and non-local materials such as obsidian. Additionally, researchers discovered at least one camelid bone effigy (Craig, 2005, 2012) (Figure 3). The site gained renown for yielding the oldest evidence of gold in the Americas, in the form of tubular beads that were components of a necklace that was found in association with an adult and child double burial (Aldenderfer et al., 2008). A review of the items in the Jiskairumoko tombs reveals that only two burials contain the majority of prestigious goods, one associated with a woman and the other associated with the adult and non-adult pair described above (see to Chapter 4).

Settlements from the Ramis valley, including Huatacoa and Qaluyu, reveal remarkable mortuary contexts. The most significant of the three individuals unearthed in Qaluyu was discovered flexed on its left side and had fronto-occipital artificial cranial modification. It had been unearthed from the debris using a bone tool and subsequently painted with red ocher. The burial, which dates from 3215 to 2855 cal BP, was found alongside plain Qaluyu pottery (Mohr-Chávez, 1969: 50; 1977: 1144).

Locations close to the shore of Lake Titicaca have also produced significant mortuary remains. Secondary human burials in pits from sector A of the Huatacoa site include the remains of infants and adults, the majority without associated grave offerings. Despite the lack of direct dating, all are associated with Early Qaluyu pottery, suggesting belonging to the Early Formative Period (Cohen, 2010: 118–135). On a different part of the site (Sector B), an intriguing subrectangular burial structure includes a single deceased person whose bones were coated with red ocher. This discovery is linked to the Middle Sunken Court Complex of the Late Qaluyu phase,

which is speculated to belong to the Middle Formative Period despite the absence of radiocarbon dates (Cohen, 2010: 171–172, Fig. 6.16).

A singular preceramic burial from the Camata site consists of a headless adult discovered in unit 3 of a burial trench dug into rock (Steadman, 1995: 22). This burial likely belongs to the Terminal Archaic Period, representing the earliest known activity at the site. After the initial burial, subsequent burials date to various phases of the Formative Period. These later burials were typically located in rectangular chambers defined by vertical slabs, some topped with one or more horizontal slabs, lack grave goods, and consist mostly of single skeletons, including adults and non-adults, many of whom had cranial modification (Steadman, 1995). The oldest Formative burial chamber is constructed with stone slabs and is rectangular in outline, measuring 45x75x35 cm. It contained the remains of a young adult aged between 15 and 21 years, displaying cranial modification. At the feet of this individual, researchers uncovered the skull of a non-adult, aged between 12 and 15 years, also displaying cranial modification. This context is from the Late Qaluyu 1 phase, dating between 2875 and 2410 cal BP, placing it in the Middle Formative Period (Steadman, 1995: 18).

Viskachuni, a lesser-known Early Formative site, has at least seven tombs, three of which are in stone cists (Herhahn, 2004). Viskachuni Tomb 2, the largest and best-built at the site, contains a flexed burial of a 45-year-old female. It is 1.10 m long x 0.65 m wide x 0.60 m deep. The individual dated from 2900 to 3100 cal BP and had ocher stains, a bone weaving instrument under the skull, and many fish bones associated with them. The tomb was covered by four big stone slabs and a refuse deposit approximately the same age as the tomb, suggesting that the midden material was deposited shortly after the burial event (Herhahn, 2004: 136–138). Another burial, tomb 3, includes a 15–20-year-old in a stone-lined cist with stone slabs as a cover. A bead

and brownware sherds were among the grave fills. Last, tomb 1 is a rectangular slab cist with scattered human remains of at least one 8–12-year-old non-adult. A bracelet with sodalite and turquoise beads and two tubular gold beads constitute the burial goods. Incised ceramic sherds of a local Qaluyu species were also found in the fill (Herhahn, 2004: 140–144).

At the multicomponent site Muruqullu on the Copacabana Peninsula, 14 burials have been identified on the Bolivian side of the basin. On the basis of the lack of ceramics and evidence of points characteristic of this era, the site has been dated to the Terminal Archaic Period (Juengst et al., 2017). Yet, exact radiocarbon dates and the archaeological context of the tombs are still unpublished, limiting a detailed comparison to the other sites discussed above.

Finally, archaeologists have identified seven cobblestone and unlined burial pits at Chiripa, dating mainly to the Early Chiripa phase (3500–3000 BP) during the Early Formative Period. There are three multiple burials, mostly females and non-adults. For example, locus 1404 includes a well-preserved female skeleton, together with two adult skulls and fragments of a non-adult, a pottery bowl, a stone tablet, and blue sodolite beads placed around her neck. Another multiple burial with a primary individual being an adult female aged between 44 and 55 years old (loci 1236/1237). She received sodalite beads, three ground stones, the skeletal bones of a fetus, a 4-year-old child, and an elderly individual. Additionally, there are four singular burials, mostly non-adults, and at least three of them date to the Early Chiripa phase. The most elaborate single burial is of an individual approximately 12 years old (loci 565 and 2055), possibly a woman, accompanied by manos, bone implements, raptor remains, and a small adjoining enclosure with two cooking vessels (Blom & Bandy, 1999: 92, 118-119; Hastorf, 2003: 315-316).

In addition to burial pits, there are also tombs with stone walls. Approximately one-third of the Chiripa burials are built tombs (Blom & Bandy, 1999: 118). The initial phases, Early and

Middle Chiripa, consist of three variations: circular, oval, and quadrangular shapes discovered in the Santiago sector. Thus, tomb constructions from the Chiripa site are present, but the limited dating information on them complicates associating them within a specific Formative Period and, hence, characterizing the evolution of the cist tombs (Blom & Bandy, 1999; Machicado, 2009).

Southern Altiplano

Researchers have not discovered burial features from the Terminal Archaic Period in this area, and burials from the Formative Period linked to the Wankarani tradition have not been radiocarbon dated. Based on associated artifacts and stratigraphy, most of the latter burials date from times around or about 2800 cal BP, though could align with the Early Formative (Capriles, 2014a; Fox, 2007; Rose, 2001; Walter, 1994; Wasson, 1967). At Wankarani, over 30 burials have been documented. These burials include individuals interred under floors or amidst house debris in pits or stone cists. Based on stratigraphy, the earliest burials seem to be basic graves of adults and children with cranial modification, buried in the ground without any accompanying offerings (Walter, 1994).

The Pusno site has yielded evidence of at least two adult skeletons, both exhibiting cranial modification, one of which was found alongside a pot offering. Utilitarian funerary goods are interred alongside the remains of Pusno and Chuquiña, indicating that these communities were likely egalitarian in social organization. Period III, which spans 3100-2800 BP, has been assigned to these early burials (Fox, 2007).

Finally, archaeologists have reported three human burials at La Barca. Two bodies were recovered beneath the foundations of the north wall of structure 3A, flexed, on their left sides, and lacking associated funerary items (Rose, 2000: 81-83). Another individual, also flexed, was discovered under a pile of unmodified stones in the outer region between the houses. The person

was linked to Qaluyu or Pucara "*sopladores*" pottery, suggesting a burial from the Middle or Late Formative Period.

2.3.5. ***Diet***

Northern Altiplano

Archaeologists have spent considerable time studying diet using a range of different methods. Traditional techniques of lithic, archaeobotanical, and zooarchaeological analyses have yielded valuable indirect data on what ancient people consumed (Bruno, 2005; Bruno & Whitehead, 2003; Capriles et al., 2014; Herhahn, 2004; Kitchel et al., 2022; M. Miller et al., 2010; K. Moore, 2011; K. Moore et al., 1999, 2010; Rumold, 2010; Rumold & Aldenderfer, 2016; Warwick, 2012; Whitehead, 2006). More recently, isotopic studies have been carried out on these populations, yielding information that is sometimes contradictory to the indirect data (Juengst et al., 2021; M. Miller et al., 2021).

Paleobotanical studies have shed light on the economy that supported the development of early communities in the Titicaca Basin. One line of research has focused on quinoa (Chenopodium quinoa) and whether it was gathered from natural "wild" stands or had been cultivated. Domesticated quinoa seeds are larger and have thinner testas (<20 μm) compared to wild or "black quinoa" (Bruno, 2005; Bruno & Whitehead, 2003; Murray, 2005). The earliest evidence of consuming cultivated quinoa has been found at the Jiskairumoko site. The 38 quinoa seeds examined originate mostly from burial 3 and pithouse 3 of the Terminal Archaic Period, as well as from rectangular constructions 1 and 2 of the Early Formative Period. Domesticated quinoa is abundant at the site during both periods. 97% of the seeds had thin testa (i.e., below 20 μm), with an average of 11.7 μm, and 95% exhibit truncated margins, consistent with the range found in domesticated varieties (Murray, 2005).

Quinoa is also the dominant plant species at Chiripa. Roughly 3% of the seeds are larger than 1.18 mm, and just 0.34% are larger than 2 mm by the Early Chiripa phase. In the Late Chiripa, though, 9% had a length greater than 1.18 mm. The researchers have noticed a more significant change in the seed's testa thickness. Only 8% have thin testa during the Early Chiripa, while 59% in the Late Chiripa do (Whitehead, 2014: 268–269). Thus, both wild and cultivated quinoa have both been found in Early Formative contexts, according to researchers. Two competing hypotheses could account for these findings. First, Chiripa people may have cultivated crops while also benefiting from native varieties that grew in their fields. Second, early farmers may have grown both varieties in their personal gardens rather than in established fields. This last alternative is more strongly supported by the data (Bruno & Whitehead, 2003: 350–352).

Highland inhabitants clearly consumed tubers long before the period discussed in this chapter. For example, analyzing the teeth of 5 out of 11 individuals from the Soro Mik'aya Patjxa site in the Ilave valley revealed evidence of a type of tooth wear known as lingual surface attrition of the maxillary anterior teeth, which is commonly associated with tuber processing, suggesting that foragers ate significant amounts of wild tubers at least 7000 years ago, during the Middle Archaic (Watson & Haas, 2017).

More relevant to this dissertation, archaeologists discovered evidence of people ingesting potatoes (*Solanum tuberosum*) at the Jiskairumoko site, which dates to the Terminal Archaic to Early Formative Periods. Scholars detected starch grains in 14 grinding instruments, identifying five of them as potatoes. At least 38 Solanum grains have been found on implements dating back to the Late Archaic Period. Those studies also detected starch from beans (*Phaseolus* sp.), and other unidentified plant remains. Rumold emphasizes that the archaeological Solanum starches

found at Jiskairumoko match those of the cultivated potato (Rumold, 2010; Rumold & Aldenderfer, 2016).

Tubers, like certain types of potato and oca (*Oxalis* sp.), have been found in small quantities in the Early Formative strata in Chiripa. Tubers are most abundant during the Late Chiripa phase (Middle Formative), but their prevalence was always far lower than that of quinoa. Preservation issues hinder the identification of actual tubers in the archaeological record, preventing the correct determination of the tubers' species and whether the seeds are from domestic or wild plants (Bruno, 2014; Whitehead, 2006).

Archaeologists have also used the abundance of projectile points and bifacial thinning flakes as a marker of the intensity of hunting as dietary activity (Kitchel et al., 2022). Unfortunately, zoarchaeological data have played a less prominent role in paleodietary studies in the Titicaca region (compared to archaeobotanical studies), although there are significant findings worth noting (K. Moore, 2011; K. Moore et al., 1999; Warwick, 2012; Wing, 1978). Initial zoarchaeological studies found predominantly camelid bones, along with some fish, dogs, and unidentified mammals at locations like Qaluyu and Q'elloqa, a cave from the Middle Formative Period (Wing, 1978: Table 1). More recent and detailed research has centered on the Formative contexts of the Huatacoa, Pucara, and Chiripa sites. The Early Qaluyu layers of Huatacoa show that camelid bones and unidentifiable large mammal bones are the most abundant among the identified animals. Cavia sp., deer, ducks, vizcachas, and other birds have also been identified (Warwick, 2012).

Large mammal bones, primarily from camelids, have been found in large numbers in five excavation sites on the Taraco Peninsula dating back to the Formative Period. These bones are mainly remnants of food consumption (Moore, 2011: 262-264). Analysis of zooarchaeological

samples from Chiripa finds that almost 93% of the protein comes from the meat of large mammals, with at least half of them identified as camelids. 65% of the remains were from large camelids, suggesting they were domesticated animals. This indicates the presence of pastoral societies throughout the Early Formative Period. Large mammals were also widely exploited at the Wiskachuni site throughout the Early Formative Period, although whether there hunted or herded remains uncertain (Herhahn, 2004: 200).

Archaeologists have emphasized the significance of lake resources as far back as the Late Archaic period (Stanish, 2002: 108). Researchers have found a significant number of fish bones, particularly from *Orestias* sp. (pupfish) and *Trichomycterus* sp., in excavations at Chiripa, Kala Uyuni, and three other sites in Taraco. These findings are mainly from the Early Formative Period (Capriles et al., 2014; M. Miller et al., 2010; K. Moore, 2011; K. Moore et al., 1999). Archaeologists have argued that fishing supported growing populations during the Early Formative Period but declined as populations grew and social organizations became more complex in the Middle and Late Formative Periods. This decline was also influenced by the lake's coastline moving three thousand years ago (Capriles et al., 2014: 72; Moore, 2011: 258). During the late part of the Formative Period, there was a shift towards increased reliance on agricultural activities, evidenced by technological advancements like the widespread use of stone hoes since the Middle Formative Period and the development of agricultural infrastructure such as raised-fields (*waru waru*) and *qochas* since the Late Formative Period (Cohen, 2010; Erickson, 1988; Flores Blanco et al., 2012; Herhahn, 2004; Steadman, 1995). Other wild animals were rarely and infrequently consumed, such as birds and rodents (Moore et al., 1999: 111; Moore, 2011: 259-262).

Finally, recent data derived from isotopic analyses of collagen and apatite samples extracted from Terminal Archaic and Early Formative human remains, primarily discovered on the

peninsula of Taraco and Copacabana Bay, indicate that ancient populations subsisted primarily on terrestrial resources, C3 plants including potatoes and quinoa, and consumed camelid meat during both periods (Juengst et al., 2021; M. Miller et al., 2021).

Southern Altiplano

Archaeobotanical data from the southern Altiplano is much more limited, with just a few studies conducted during the past decade (Langlie et al., 2011; Langlie & Capriles, 2021). A novel variety of cultivated *Chenopodium* was identified at the La Barca site, dating to the Early Formative Period. The seeds of Chenopodium de La Barca have an average size of 1.087 mm +/- 0.1, and their testa measures less than 20 μm (average 6.2 μm +/- 2.9). This previously unidentified variety of *Chenopodium* displays distinct morphological characteristics compared to those documented in the Titicaca Basin (Langlie et al., 2011). Moreover, three sites in the Iroco Altiplano, Oruro, dating back to the Late Formative Period, showed indications of eating quinoa, *kañahua*, and tubers (Langlie & Capriles, 2021).

Researchers have found zooarchaeological remains at Wankarani sites including La Barca, Quisquina, and Pusno, indicating a diet that included camelids, deer, birds, and fish (Fox, 2007; Rose, 2000: 109). In Quisquina and Pusno, it has been observed that the consumption of camelids increased in significance throughout time (Fox, 2007: 189).

The isotopic composition of individuals in the southern Altiplano indicates that a significant portion of their protein intake was derived from herbivorous animals, including domesticated llamas, C3 crops (likely chenopods and tubers), as well as wild fish, birds, and freshwater plants (Capriles et al., 2021).

2.3.6. ***Lithic technology***

Northern Altiplano

While archaeologists have paid a lot of attention to stone tools from this area, most reports focus on projectile point analyses, although a few also report other chipped stone tools and ground stones. Evidence has been used to answer important questions about the ancient diet, changes in settlement pattern, territorial movement, and the introduction of new weapons technologies like the bow and arrow (C. Chen et al., 2021; Cipolla, 2005; Cohen, 2010; Craig, 2005; Flores-Blanco et al., 2023b; R. Haas et al., 2015; Herhahn, 2004; Kitchel et al., 2022; Klink, 2005; La Favre, 2011; Rumold & Aldenderfer, 2016; Steadman, 1995; Watson & Haas, 2017) (see also Chapter 4).

Significant developments in technology may be observed in the lithic tools from the Late Archaic Period to the Early Formative Period. The projectile points have been significantly reduced in size to 18 mm wide, 4.3 mm thick, 3.2 g in weight, and 38.7 mm long. Archaeologists have started to recognize these aspects in the artifacts found at sites dating back to the Terminal Archaic Period, suggesting the usage of archery from at least 5000 years ago (Flores-Blanco et al., 2023b; Kitchel et al., 2022). This size variation is linked to changes in forms, transitioning from stemmed points to straight-based and convex-based triangular forms (specially Type 5D) (Figure 3). During the Terminal Archaic Period, there was a shift in the selection of raw materials from local volcanic rocks and quartzites to fine-grained rocks like flint and obsidian. Obsidian use significantly increased during the Formative Period, particularly in the northern basin (Cipolla, 2005; Cohen, 2010; Craig, 2005; Flores-Blanco et al., 2023b; Kitchel et al., 2022; Klink, 2005; La Favre, 2011).

During the Early Formative Period, there was a consolidation of existing technologies rather than the introduction of significant new technologies. The primary chipped artifacts at Wiskachuni are projectile points, particularly small Type 5Ds, and scrapers. Obsidian and flint were mainly used for making these tools (Herhahn, 2004: 165-175).

Archaeologists have conducted an extensive study of 387 ground stone artifacts from the Jiskairumoko site collection. 98 of them were categorized as milling tools. Similarities in the number of such tools in both the Late Archaic and Early Formative Periods suggest that plant processing was a persistent activity at the site in both time periods. When milling tool density is expressed relative to total occupation area, results suggest grinding technology was more numerous in the Late Archaic Period. However, when researchers examined the intensity of use of individuals tools, the opposite pattern emerged. Thus, the fraction of tools with faceted areas equal to or greater than 75 cm^2 increased from 37% in the Late Archaic to 79% in the Early Formative. Curated tools gradually increased from 31% during the Late Archaic Period to 51% in the Early Formative Period. In other words, although the number of grinding tools decreased, the intensity of use for any individual tool increased (Rumold, 2010; Rumold & Aldenderfer, 2016).

While technological change in the Early Formative Period was minimal, there are noteworthy developments into the Middle Formative Period. For example, while use of andesite is rare in Early Formative contexts, such as at the sites of Camata and Chiripa in Titicaca, Middle Formative people started significantly using andesite for crafting hoes (Bandy, 2010; Steadman, 1995: 31-33). Likewise, hoe fragments are uncommon in Wiskachuni and Huatacoa, and when they are found, they are typically discovered in the higher strata of these sites associated with the Middle Formative (Cohen, 2010: 260; Herhahn, 2004: 188-189). Frye and Steadman suggested that Incatunahuiri, located near Chucuito, served as the olivine basalt quarry and production hub for these hoes. Therefore, there was likely an extensive exchange network of raw materials for producing this artifact, allowing the Taraco Peninsula to export around 250,000 hoes, as suggested by Bandy (2010: 146-147).

Southern Altiplano

La Barca has a high concentration of debitage and flakes in all four zones of the site, with a notably larger amount in zones 1 and 3. Zone 3 contains a higher concentration of projectile points, primarily made from basalt and quartzite. Zones 3 and 4 include a higher concentration of cores, blanks, and macros. Hoes are minimally present in zones 3 and 4. Zone 3 consists of a ceremonial structure flanked by residential sections, whilst zone 4 featured the main ceremonial structure of the site. The majority of metates and manos were discovered on the ground level of the houses and constructed from local sandstone. Zones 3 and 4 have the highest concentration of uncommon raw materials such obsidian, basalt, and quartzite, which are sourced from long distances away (Rose, 2010).

Chipped stone was significant in other Wankarani sites like Chuquiña and Pusno, with a greater abundance in Chuquiña. Most of the tools were bifacially worked, including small projectile points and massive holes. A shift in biface technology is evident in both sites, with Chuquiña displaying a particularly significant transition. In phase 1 (prior to 3325 BP), there were more points than holes at both sites. In phase II (3325-3100 BP), points became predominant (90%) over points (7%) at Chuquiña. By phase III (3100-2800 BP), hoes were the predominant chipped instruments (95%) at Chuquiña and the primary instrument at Pusno (69%). Groundstone is found in both sites, particularly as metates and manos, but it is more common in Pusno. The quantity of groundstone decreased over time as agricultural economies increased, contrary to expectations (Fox, 2007: 157-183).

2.3.7. ***Pottery***

Northern Altiplano

The origins of ceramic technology in the Andes are typically associated with the Formative Period. Researchers in the Titicaca Basin have traditionally distinguished between two ceramic styles

known as Qaluyu and Chiripa. Yet, another style of ceramic, known as Pasiri, has been suggested to be the oldest in Titicaca. This ceramic style has been found at multiple sites dating back to the Late Archaic and Early Formative Periods, with at least eleven sites identified during the Juli – Desaguadero regional survey. Within this ceramic style, "*...sherds are poorly fired, unslipped, with heavy inclusions of fiber and coarse sand*." The recovered rims indicate vessel shapes characterized by thickened and somewhat flared rims, along with a few jugs (Stanish et al., 1997: 40; Stanish, 2003: 102). Early ceramics were potentially present during the Terminal Archaic Period, as indicated by three ceramic sherds found in the "preceramic" stratum 5 at the Camata site, dating to around 3600 cal BP. However, the researcher rejected these potsherds, suggesting they were intrusive (Steadman, 1995: 22). Subsequently, findings of pottery dated 3900 cal BP at level WXXIV of the Quelqatani Cave in the Chila River Basin suggest that ceramic technologies may have begun earlier than previously thought, and may indicate that the Camata sherds mentioned above are not intrusive, but belong to the Terminal Archaic Period (Eisentraut, 1998: 63-64).

In contrast to the remarkable antiquity of the Pasiri Terminal Archaic ceramics, most other early ceramics in the Titicaca Basin date more than two thousand years later, including at the sites of Qaluyu (3417 cal BP), Pizacoma (3445 cal BP), Chiripa (3376 cal BP), Ch'uxuqullu (3264 cal BP), and Camata (3194 cal BP). All of these align with the Early Formative Period (Mohr-Chávez, 1977; Stanish et al., 2002; Steadman, 1995).

Archaeologists studying the northern basin of Lake Titicaca have classified the region's early pottery as Qaluyu style (Kidder, 1956; Lumbreras, 1981; Mohr-Chávez, 1977; Rowe, 1956). Mohr-Chávez (1977: 1020–1022) identified two divisions. The first division of Qaluyu ceramics (3400–3000 BP) is composed of the lower and upper lots of Qaluyu, which are compatible with

the Marcavalle A and B ceramics. The lower Qaluyu lots include short spout pots with handles directly attached to the base of the spout, pots with everted rims, thick lugs, and applied ridges. There is an absence of painted or slip-decorated ceramics. This ceramic is compared to Marcavalle A. The upper Qaluyu lots are bowls with white/red paint on the exterior and red slip on the interior, which allows for comparison to the cream/brown ceramics of the Marcavalle B. Cream-on-brown ceramics in the lowest layer of trench 1, dated using radiocarbon to approximately 2850 cal BP. Ceramics adorned with dotted patterns in regions containing hematite on the outside have been recognized. Additionally, there are only a small number of pottery fragments with the distinctive red-brown/cream slip that is typical of the Qaluyu style. The second division of ceramics (3000–2600 BP) has not been discovered in Qaluyu but has been previously reported by other researchers like Kidder and Chavez Ballon. These ceramics are painted dark brown or reddish brown on a cream background (Mohr-Chávez, 1977: 1020-2022).

The Camata ceramic assemblage provided the necessary materials to establish the Qaluyu pottery style. The oldest pottery found at this location has been divided into two phases: Early Qaluyu 1 (about 3200-3000 BP) and Early Qaluyu 2 (around 3000-2800 BP) (Steadman 1995: 37-38). Pottery vessels are predominantly large, reddish-brown in color, and completely oxidized, with preferences for bowled shapes with beveled, plain, and shelf rims and neckless pots. Shelf-rim bowls are unique to this early phase. The paste is semi-hard and contains dense, medium-sized, opaque white inclusions. Most of the vessels have red and dark brown slips. Decorated specimens are uncommon, and the ones that do exist are monochrome incisions, dotted, and modeled.

Early Qaluyu 2 ceramics closely resemble the previous phase, with some variations in the dominance of certain characteristics. For instance, bowls remain the most prevalent shapes, while the quantity of neckless pots dropped. Vessels have shelf edges, while the usage of beveled rims is

reduced. The vessels remain large in size. Mineral-temper dominates, though small numbers of fiber-tempered sherds are present. Decorated pots are still uncommon, but in this new phase, appliques are also incorporated (Steadman, 1995: 154-200).

The other type, Chiripa pottery, has been extensively studied and dated using stratigraphic superposition and radiocarbon dates from its eponymous site and other sites like Kala Uyuni (Steadman, 1999, 2007). From the Chiripa site collection, Steadman identified three ceramic phases: Early, Middle, and Late. In Chiripa, the first two phases are defined as the Early Formative Period. Fiber-tempered Early Chiripa ceramics (3500-3000 BP) have two pastes with tempered mica and visible mica on sherd surfaces, and over half have exterior burnishing. While slips are uncommon (33%), they include reddish, brown, and reddish-brown, where the red is brighter compared to other phases. Decoration is rare, and short-necked and neckless vessel shapes dominate. Beveled, everted, and wide-banded rims are present, with most bases rounded. Tempered Chiripa Medio ceramics (3000-2800 BP) have translucent inclusions; however, as opposed to the early phase, mica is rare. Smooth vessels are more prevalent.

The majority of Chiripa Medio vessels are medium-necked pots (45%) with smooth rounded rims, though bowls (15%) are present. Neckless pots are scarce and short-necked pots are almost absent. The only decorated pottery is a rectilinear design painted in red slip on a dark brown unslipped background (Steadman, 1999: 61-64). These two early Chiripa ceramic phases have been found in Kala Uyuni, with only minor variations. The Early and Medium Chiripa ceramic assemblage (Early Formative) from Kala Uyuni is utilitarian, without decoration, and has a higher percentage of sherds with ash and stucco, indicating a more domestic nature than Chiripa ceramics. Kala Uyuni's Chiripa Medio ceramics have fewer red slips, a rare dense, fine-textured, high-fired

paste, and no large vessel forms, suggesting they are not for cooking and share on a larger regional scale (Steadman, 2007: 68-71).

Later, researchers from other projects have also carried out other significant ceramic analyses in the Titicaca Basin (Chávez Justo, 2014; Cohen, 2010; Herhahn, 2004; Tantaleán & Zapata Benites, 2014). However, there has been a lack of correlation between the ceramic data and a site's chronology, primarily because the source data (i.e., sherds) are derived from regional surveys without precise dating. Consequently, this limits the utility of these analyses for identifying the types of ceramics associated with sites from the Early Formative Period and earlier.

Southern Altiplano

Wankarani ceramics represent the Formative Period in the southern Altiplano. While the evolution of ceramic technologies is not fully understood, efforts have been made to examine parts of this process (Ayala et al., 2008; Ayala & Uribe, 2003; Bermann & Estévez Castillo, 1993; Fox, 2007; Ponce Sanginés, 1970; Rose, 2001; Wasson, 1967). Ceramic wares discovered on the surface of Formative Period mounds were initially noted for their lack of decoration. Pots were a common type; they rarely had handles, and while most had a thick lip around the mouth of the jug. Moreover, ceramic figurines representing humans, camelids, and dogs with separate legs and heads from the body are also common (Ponce Sangines, 1970: 32; Wasson, 1967: 152).

Efforts have been undertaken to develop a Wankarani ceramic sequence. Carlos Ponce Sangines (1970: 32-34) was the first to suggest three phases, with the earliest characterized by spatula-polished ceramics, which he compares to Tiwanaku I pottery. This ceramic type was highly favored. The second phase enhances the smoothness by refining and polishing the surface. The third phase includes vessels adorned with red slips and are equipped with handles.

Later, researchers have since conducted more detailed studies on the pottery from each of the locations mentioned above (Ayala et al., 2008; Ayala & Uribe, 2003; Bermann & Estévez Castillo, 1993; Fox, 2007; Rose, 2001). These studies show, for example, that the ceramics found in the Wankarani site predominantly consist of containers (69%), with significant numbers of figurines (33%), and more rarely spoons (7%). Some researchers have expressed uncertainty about whether the various forms are typical of the Formative Period or a later time (Ayala et al., 2008; Ayala & Uribe, 2003), especially because it has been difficult to accurately identify Wankarani ceramics from single-component archaeological contexts. For instance, some express skepticism over the presence of red jugs, ultimately concluding that they likely date to the Late Formative Period or beyond.

Ceramics from the Wanakarani Formative Period are mostly ceremonial in nature, including figurines, miniatures, pots, cups, and modeled bowls. At Uspa-Uspa, the local ceramics are characterized by granular pastes rich in mica, with vessels designed for storage, as exhibited by high rates of exterior smoothing. Both collections are linked to ceremonial activities, suggesting that the Wankarani mounds served both domestic and ritual purposes (Ayala et al., 2008; Ayala & Uribe, 2003).

Fox (2007: 136-137) discovered that Wankarani ceramic styles at Pusno and Chuquiña sites contain a substantial quantity of mica. Pastes range in color from grayish orange to a more orange tone (Orange-Brown type, 89-95%). Towards the end of the sequence, the brighter and more common color is the Bright Orange type. Orange-Brown pottery is often undecorated, with the most prevalent shapes being pots, bowls, and a few jars. This ceramic type is now undiagnostic due to its presence in the entire series. “Aboriginal Grift” is a unique type of pottery that is found in tiny quantities and is characteristic of the earliest period. This ceramic is made of a black to

brown paste with a coarse black or dark gray sand of volcanic origin. The pottery displays a smooth exterior and a frequent use of incised and punctuated decoration, typically found around the rims and shoulders of the vessels. The most common form is the pot. It is associated with the oldest and most well-dated layers of Chuquiña and Pusno. Fox also observed that the average thickness of pot rim sherds increased over time, with the earliest pots having rim thicknesses less than 7.5 mm.

Ceramics from the Formative Period in Lipez, located in the extreme south of the Altiplano, have not been extensively researched. Existing references describe ceramics made of dark, black, or brown paste with smoothed or polished surfaces and incised designs (Nielsen et al., 1999: 108). It is unclear if this ceramic is from the Early, Middle, or Late Formative Period.

Overall, the early Wankarani ceramics have a paste including coarse and medium grain inclusions, together with mica, displaying colors ranging from orange-brown to gray. Common forms include figurines, pots, and a bowl with a thick rim. This pottery is frequently found in Wankarani mound sites but is less common in non-mound sites like Jachakala, where the earliest pottery is distinguished by a mica-tempered paste in an orange and brown color (Bermann & Estévez Castillo, 1993).

2.3.8. ***Metalworking***

Early evidence of metal use in highland areas, dating back to the Formative Period, was initially documented in a report by Ponce Sanguines (1970: 52) on the Chiripa and Wankarani sites. Gold sheets and copper slag were discovered during the Chiripa phase. He offered more detailed information from the Wankarani site, reporting that copper slag was found at a depth of 1.89 m in excavation pit 1 of the mound. Copper slags were found at additional sites of the Wankarani tradition, including Pukara de Belén and the Joya mound (Ponce Sangines, 1970: 42).

New data revealed the precise time when metals were first utilized in the northern Altiplano. The earliest evidence discovered is from the Jiskairumoko site, where nine gold beads were found in the tomb of an adult and a non-adult, dating back to roughly 4000 cal BP. The beads are thick cylinders with varying lengths but consistent diameters, ranging from 6 to 7 mm. The oldest dated metal artifacts were manufactured using the process of cold hammering native gold nuggets. Jiskairumoko is a site that provides extensive information on the utilization of metals, an aspect that has not been published more widely. An alloy disk made of gold and copper was found near Rectangular Structure 2, dating back to the Formative Period of the site. However, its context is uncertain, as it was discovered in a plowed deposit (layer II) (Craig, 2005: 625, Fig. 11.43). A gold disk measuring 30 mm in diameter was discovered near Rectangular Structure 2 (Figure 3). It appears to be made by joining two pieces together through cold hammering. The researcher discovered the artifact in layer IV, which showed no signs of disturbance. This suggests that its likely dates to the Early Formative Period, although its exact age remains unknown.

Silver mining was introduced to the metallurgical practices of this region during the latter part of the Formative Period. Its production and utilization have been documented in the Bay of Puno for almost two millennia (Schultze et al., 2009). Early mining activity in the Altiplano was likely minimal, as it was not detected in isotopic analyses of sediments from Lake Titicaca until the rise of the Tiwanaku state after 1200 BP (Guédron et al., 2021).



Figure 3. Archaeological artifacts from some of the Andean Altiplano sites. 1: gold disk from the Jiskairumoko Formative level (Craig, 2005: 662). 2: Camelid effigy recovered from Jiskairumoko burial 2 (Craig, 2005: 574). 3-4: Projectile points (Type 5D) recovered from Aldenderfer excavations at Kaillachuro. 5. Obsidian scraper recovered from Kaillachuro. 6: Stone beads from Kaillachuro.

2.4. **Discussion**

I presented an in-depth review of the archaeological landscape of the South-Central Andes during the Archaic Period over a decade ago (Aldenderfer & Flores Blanco, 2011). We left a number of unanswered questions on the agenda, which I am now able to address with the support of the more comprehensive data provided in this chapter from the Peruvian-Bolivian Altiplano, to which I have additionally added data from the Early Formative Period. Only those subjects that are most closely related to the dissertation are the focal points of this discussion. This study examines the temporal development of ceremonial and monumental architecture in the region, as well as the mortuary remains and ancient food, in order to investigate the extent and nature of inequality in society.

Additionally, it seeks to assess the potential impact of new technology, such as the bow and arrow, on this dynamic.

Considering the fact that the Titicaca Basin has played an important part in the development of various aspects of societal complexity in the South-Central Andes, it is noteworthy that there is a lack of early indications of monumental or ceremonial buildings during the Terminal Archaic Period. Researchers have extensively documented the existence of ceremonial and monumental architecture in many areas of the South-Central Andes during this period of time, including Asana (Aldenderfer, 1990) and Tulan-52 (L. Núñez & Perlès, 2018). Monumental architecture in the Andean Altiplano was absent until the Early Formative Period. Cohen has shown the existence of public architecture dated circa 3300 cal BP at the Huatacoa site, located to the north of the Ramis River valley. Qaluyu is the most renowned site in the same valley and has the earliest recorded dates for the Early Formative of the region; however, due to the absence of thorough research on the site, these dates cannot be linked to any specific architectural feature. Researchers have found early empirical evidence at Wankarani tradition sites in the Southern Altiplano, including La Barca and San Andrés, going back to 3500 cal BP. However, it remains uncertain whether these radiocarbon dates are linked to monumental architecture. After 3000 cal BP, there is an increasing prevalence of monumental architecture in the Andean Altiplano.

This review has effectively delineated two distinct mortuary traditions. First, pit-burials dating to the beginning of the Archaic Period are the oldest. The Jiskairumoko pit-burials are a particularly notable example within the time period examined in this dissertation. Second, stone cists are the second tradition, which is evident in Early Formative sites like Chiripa and Viskachuni. However, its origins can be traced back to the Kaillachuro site during the Terminal Archaic period.

Upon examining the characteristics of individuals interred in these sites during the Terminal Archaic and Early Formative Periods, it becomes evident that a significant proportion of them lacked sexual determination. The site of Chiripa has been identified as the primary location for determining sex, with a predominant presence of female burials. The assessment of age has shown more favorable results, with a notable recurring occurrence of non-adults observed in all instances. Regarding the burial goods linked with these sites, certain locations, such as Jiskairumoko, Chiripa, and Viskachuni, exhibit remarkable goods, although few in number. However, there are also places, such as Huatacoa or the Wankarani sites, where scholars have observed limited and ordinary offerings.

Andean archaeologists have traditionally relied on standard methods of paleobotany and zooarchaeology analysis to study the diet. Paleobotany in the Altiplano has provided insights on the process of quinoa domestication, dating back to the Terminal Archaic Period. Consumption of tubers occurred as well; however, the process of their domestication remains unknown. Insufficient research has been conducted in the field of zooarchaeological study, despite the considerable efforts made by archaeologists to emphasize the significance of hunting and the subsequent agropastoral economy. Over the past ten years, recent research on stable isotopes has changed archaeologists' understanding of the ancient diet of the Andean Altiplano. These results have emphasized the significance of plants in the diet of ancient foragers (J. Chen et al., 2024). The investigation of this particular time under consideration in this dissertation is currently limited, with just three research conducted thus far. One study focuses on the Terminal Archaic Period, while the other two studies cover the Formative Period (Capriles et al., 2021; Juengst et al., 2021; M. Miller et al., 2021). One area that requires further development is the utilization of this data to

investigate the potential existence of disparities in food accessibility, which will be examined in Chapter 4.

Technological innovations characterize this transitional time. However, it is necessary to conduct a more thorough evaluation to determine whether these technologies were a result of major societal changes, such as the introduction of a more complex lifestyle, or if they actually facilitated the adoption of this new way of life. Addressing this profound inquiry extends beyond the scope of this chapter; yet I will get into one aspect in Chapter 5, which pertains to the significance of archery within this societal framework. Jiskairumoko, Hakenasa, and other Terminal Archaic sites on the Altiplano show the emergence of a new technology with small triangular points (Type 5D). This technology gradually increased in prevalence during the Early Formative Period. Evidently, the presence of grinding stones during this period is consistent with the available evidence regarding the early utilization of wild plants. In contrast, the Terminal Archaic and Early Formative Periods witnessed a dearth of specialized stone equipment designed for agricultural use, such as hoes. The aforementioned implements are exclusively observed within the lithic assemblage of Middle Formative communities, and subsequently gained popularity in subsequent periods.

Chapter 3. **KAILLACHURO: THE EARLIEST CEREMONIAL ARCHITECTURE OF THE TITICACA BASIN, 5300-3000 BP**

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Authors: Luis Flores-Blanco & Mark Aldenderfer



This manuscript reports the earliest evidence of ceremonial architecture, as burial mounds, in the Titicaca Basin at Kaillachuro, Peru. Excavations and radiometric dates show human burial practices occurred for 2000 years between 5300–3000 BP. Stratigraphic analysis reveals diverse mortuary practices that involved above-ground mounds and stone-masonry tombs. This finding unveils new information about a previously unknown architectural tradition wherein, for the first time, human burials were rendered highly visible in the landscape. Kaillachuro forces us to reflect on the role of ritual in the development of agropastoral economies and complex socioeconomic organization among highland peoples of the South-Central Andes.

Keywords: Andes; Titicaca Basin, burial mound, ceremonial, Terminal Archaic, Early Formative

3.1. **Introduction**

Corporate architecture (often labeled monumental, public, or ceremonial depending on size, complexity, and details) is common on the coast and highlands of central and northern Peru as early as 5000 cal BP and is presumed to have been constructed by hierarchical, sedentary societies (J. Haas et al., 2004; Pozorski, 1987; Shady et al., 2001; Stanish, 2003). In contrast, there is little evidence of similarly complex constructions before the Early Formative Period (3500–2800 cal BP) in the Lake Titicaca Basin (Aldenderfer, 2004; Cohen, 2010; Craig, 2005). Explanations for the difference between the regions generally focus upon the abundance of coastal resources and the ability of elites in the north to generate surpluses that could be used to create such structures,

whereas in the basin, resource availability was more limited and surplus generation could only be achieved after the appearance of intensive agropastoral societies (Moseley, 1974).

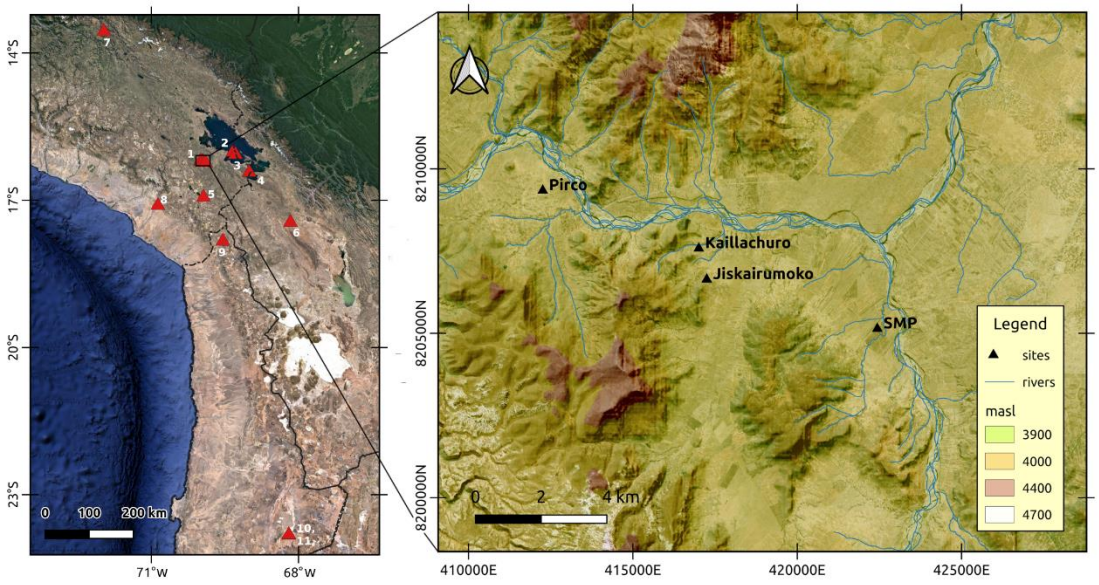


Figure 4. A: Late Archaic/Terminal and Early Formative sites mentioned in the text (1=Kaillachuro, Jiskairumoko, Pirco, Soro Mik'aya Patjxa (SMP), 2=Ch'uxuqullu, 3=Muruqullu, 4=Chiripa, 5=Quelqatani, 6=Viscachani, 7=Kasapata, 8=Asana, 9=Hakenasa, 10=Tulán-54, 11=Tulán-52). B: Location of Kaillachuro and other sites in the Ilave middle Basin.

Archaeological research at Kaillachuro in the Rio Ilave drainage of the Lake Titicaca Basin of southern Peru offers a challenge to reconstructions of the past that assert that the construction of corporate architecture necessarily required the generation of resource surpluses. Recent archaeological and ethnographic research from around the world, however, indicates that hunter-gatherer groups occasionally constructed monumental architecture without residential sedentism and institutionalized inequality (Dietrich et al., 2012; Klokler, 2017; López, 2001; Ortmann & Kidder, 2013; Pintos, 1999; Sassaman, 2005; Saunders, 2012; Schmidt, 2010).

Kaillachuro (3930masl), on the highest terrace in the middle Ilave drainage, was discovered during an archaeological survey in 1995 (Figure 4). Nine low mounds were recorded (Aldenderfer,

2004, 2012; Craig, 2005). Mounds 4 and 6 were test excavated in 1996, 1997 and 2002 (Figure 5), and at least six human burials were found between the ash and stone layers in Mound 4. The most remarkable discovery was a small stone box containing a child's bones covered in fine ocher dust and obsidian flakes. The feature's charcoal dates to 4350 cal BP. At Mound 6, two more burials were uncovered, one likely female with a stone hoe, presumed to date from the Early Formative Period (Craig 2005: 676–677). These chronometric observations are consistent with diagnostic projectile points, 69% dating to the Terminal Archaic (5000–3500 cal BP) and Formative (3500–1500 cal BP) periods recovered from the site. The sum of these observations indicates the mounds are funerary features of surprising antiquity. Nevertheless, the features' dating hinges on coarse typological observations and a single radiocarbon date on charcoal, which is sensitive to old wood and post-depositional mixing effects. Thus, the site's chronometric position remains unknown.

Provisionally, Kaillachuro suggests that ceremonial burial practice commenced in the Titicaca Basin during the Terminal Archaic Period, a period of neolithization among residentially mobile, egalitarian hunter-gatherers who showed the first signs of sedentism, population aggregation, low-level food production, expanding exchange networks, and possible archery technology (Aldenderfer, 2004, 2012; Craig, 2005; Flores-Blanco et al., 2023b; Kitchel et al., 2022; Rumold & Aldenderfer, 2016). This is 1500 years earlier than Early Formative Period corporate architecture and funerary structures found at Chiripa, Qaluyu, Huatacoa, and San Bartolomé-Wiskachuni (Cohen, 2010; Hastorf, 2003, 2008; Herhahn, 2004; Mohr-Chávez, 1977). Determining the chronology and functionality of Kaillachuro is thus crucial to our understanding of the emergent complexity in the Titicaca Basin.



Figure 5. Initial excavations at Kaillachuro took place in the late 1990s and early 2000s. a) the first archaeological excavation conducted in Mound 4; b) a northeast-southwest view taken from Mound 6 prior to any archaeological intervention.

3.2. **Materials and Methods**

Kaillachurro was surveyed and excavated over five field seasons (Figures 6 and 7). This study includes both unpublished material and new data from Kaillachuro. The second author led test excavations in a $4m^2$ unit at Mound 4 in 1996 and 1997. The first author conducted a systematic survey in 2019 and excavations totaling $56m^2$ in 2021 and 2022, targeting mounds, artifact scatters between mounds, and surface areas without artifacts. Archaeological stratigraphic principles were followed to record each stratigraphic unit (SU) (E. Harris, 1989). All excavated material was sifted for artifacts using a 1mm mesh screen. Radiocarbon dating includes materials from earlier and recent seasons, mostly from direct dating of bones. Dates were calibrated using OxCal v4.4.4 (see Appendix 1).

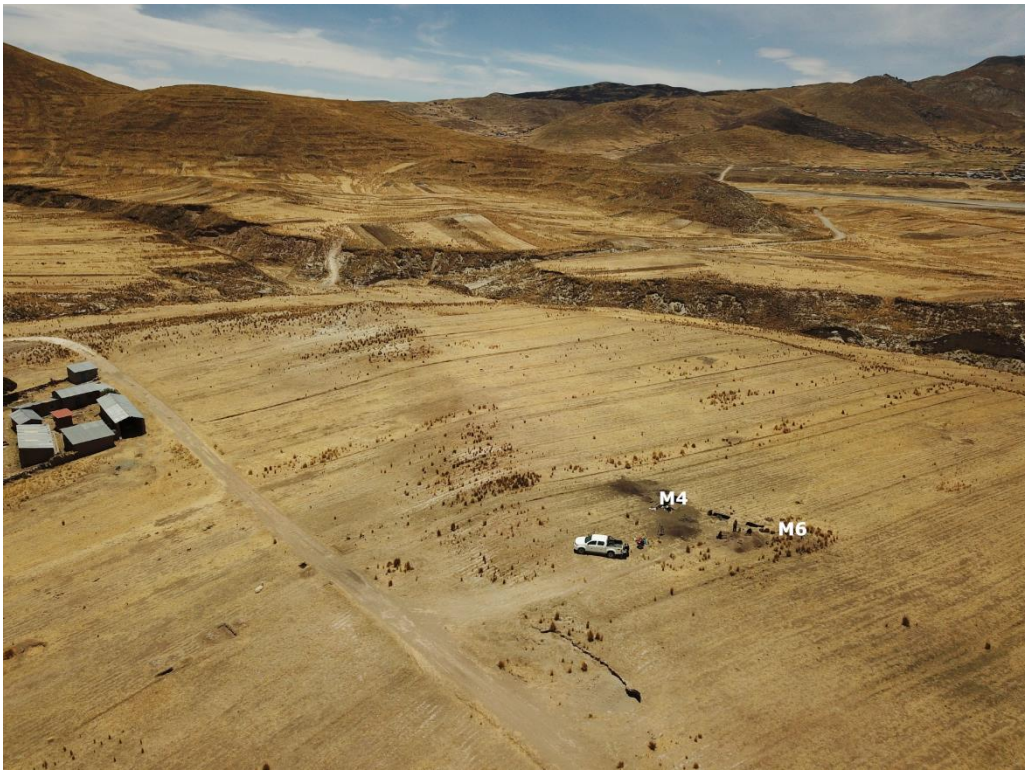


Figure 6. A southeast-to-northwest aerial perspective of the Kaillachuro site, located on an alluvial terrace in the highland Ilave Basin. The image shows archaeological excavations in mounds 4 and 6.

3.3. **Findings**

3.3.1. ***Site Structure***

The Kaillachuro survey revealed spatial relationships between mound features and artifact concentrations over a 3-hectare area (Figure 7). Projectile points are primarily associated with burial mounds M4 and M6, while ground stone tools are found in both mounds and non-mound areas. Mounds are aligned north-south, and M2-M6 surrounds an open central area. More than 76 000 artifacts were recovered, mostly from subsurface contexts; 97% of these were debitage from lithic reduction. Bone, ochre, and ground stone tools were also recovered. The very large majority of diagnostic projectile points date from the Terminal Archaic and Formative periods (Klink & Aldenderfer, 2005). Ceramics mostly came from the plow zone, with 42% broadly dated to late ceramic styles, corroborated by two radiocarbon dates from the Inca Period (383 and 493 cal BP). Only 6.6% of the pottery recovered is from the Formative Period. These typological dating results indicate that the site was utilized between the Terminal Archaic Period and the Early Formative Period (5300–3000 cal BP), with a minor Inca intrusion in mounds M1, M6, and M10 (Figure 11).

3.3.2. ***Stratigraphic sequence***

Excavation units were placed in four mounds (M1, M4, M5, and M6) and three extra-mound contexts. M4 was the most intensely excavated where we observed a complicated stratigraphic sequence involving phases of construction, use, accumulation, and renewal (Figures 8 and 9). Human burials, at least 24 individuals, were encountered throughout M4's sequence. Most of these burials are secondary and fragmented, although there are at least two primary burials (the stone box burial and Burial 5). Many burials are arranged individually, although there are also instances of multiple burials (e.g., Burials 3 and 4). Based upon these excavations, five phases of use of Kaillachuro can be identified (see Appendix 2).

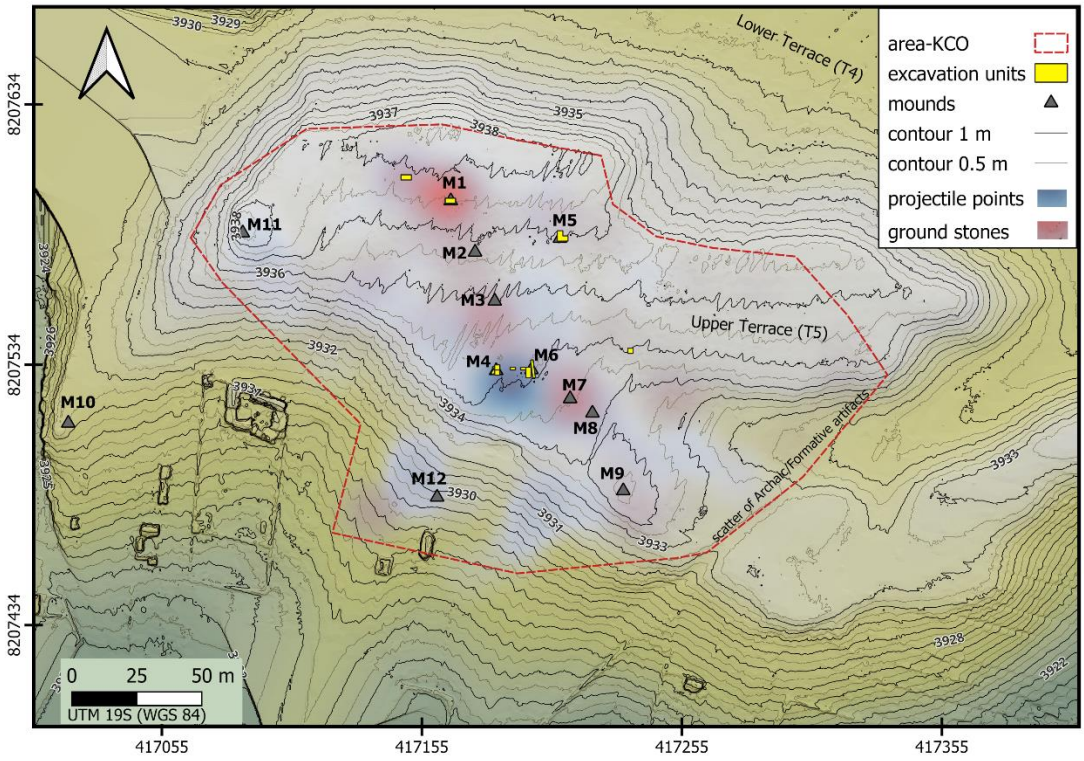


Figure 7. Kaillachuro topographic map using a drone and 3D modeling. A 3-hectare scatter of Archaic and Formative materials is shown by the red polygon. Hotspot analysis highlights surface-collected artifact density (blue=projectile points, red=ground stones), with archaeological excavation units shown in yellow. Since M10 is mostly an Inca-period occupation, it is plotted outside the polygon.

3.3.2.1. *Phase 1 (5300-5000 cal BP)*

Several burial contexts were found in SU-7 of M4. The best-preserved was Burial 2, in pit SU-19, consisting only of an adult femur, directly dated to 5294–4963 cal B.P. This pit was filled with clay (SU-20), from which lithic debitage, a green stone bead, and a round-shouldered brown chert foliate projectile point were recovered. Small stones were placed around the pit's circumference (Figure 9a). A human tooth, unearthed in 1997, on the horizontal clay interface with SU-7 produced a nearly identical date of 5294–4994 cal B.P. This surface contained a shallow hearth (SU-9).

Atop these interments, later people laid sand and clay fill (SUs-4, 6, and 18), which formed a mound 1 meter tall. The fill contained several artifacts, such as stone tools, and numerous

fragmentary human remains. A secondary burial in the center of the SU-4 deposit (Figure 9b) was directly dated to 5294–4977 cal BP, suggesting near contemporaneity with the underlying burial.

4.3.2.2. *Phase 2 (4800-4100 cal BP)*

Intrusive into M4's earlier levels, ancient people built a small stone box with a prepared floor of purplish-brown soil and a double wall of angular gray and white rocks placed vertically (Figure 9c). The soil at the base of the box contained fragments of a small human skull, maxilla, and deciduous teeth, suggesting an incomplete child burial. Obsidian flakes and carbon fragments covered the floor. A radiocarbon sample from feature fill is dated 4533–4147 cal BP. Stone slabs and red soil covered this box.

At M6, we recovered charcoal from a hearth dated to 4824–4570 cal BP. This phase includes three more extra-mound dates. At the northern end of Kaillachuro, within our SC unit in Block 3, we found, at a depth of 0.3m, an ashy layer, burned stones, and ground stones with carbon dated 4654–4554 cal BP. Three oval-shaped pits with sparse charcoal remains were recovered in a 2x2m unit #3 in an open area front of M7, dating to 4649–4512 cal BP. Debitage was abundant in ash deposits in a trench between M4-M6, including a camelid bone fragment dated 4827–4576 cal BP.

3.3.2.3. *Phase 3 (3800-3500 cal BP)*

The occupants formed a second 1.2-meter-tall mound at M4, comprising four levels of semi-compact, very dark gray organic soil (SU-3). At the deepest level, we uncovered two stone alignments. SU-3 contains charcoal, an abundance of debitage, flakes, cores, projectile points, bone fragments, and, for the first time, pottery sherds. A human bone recovered from SU-3 dates to 3588–3482 cal BP. The most significant elements of this phase include a reddish-yellow clay surface 2cm thick along the excavated unit (perhaps the mound surface?) with many chipped stone

tools (points and scrapers) and fragments of human bones, one of which dates to 3719–3571 cal BP. A burial pit (B7), a 0.9-m-diameter circular pit filled with highly compact clay soil, medium-sized stones, at least one large, long slab, and fragmentary human bone, was found contemporaneous with this deposit. Some ceramic sherds, four obsidian and chert projectile points (Types 5A, 5B, and 5D), one bead, and several lithic flakes were recovered in this fill. While M6 was also being used, we recovered a human bone from SU-9 dating to 3831–3681 cal BP.

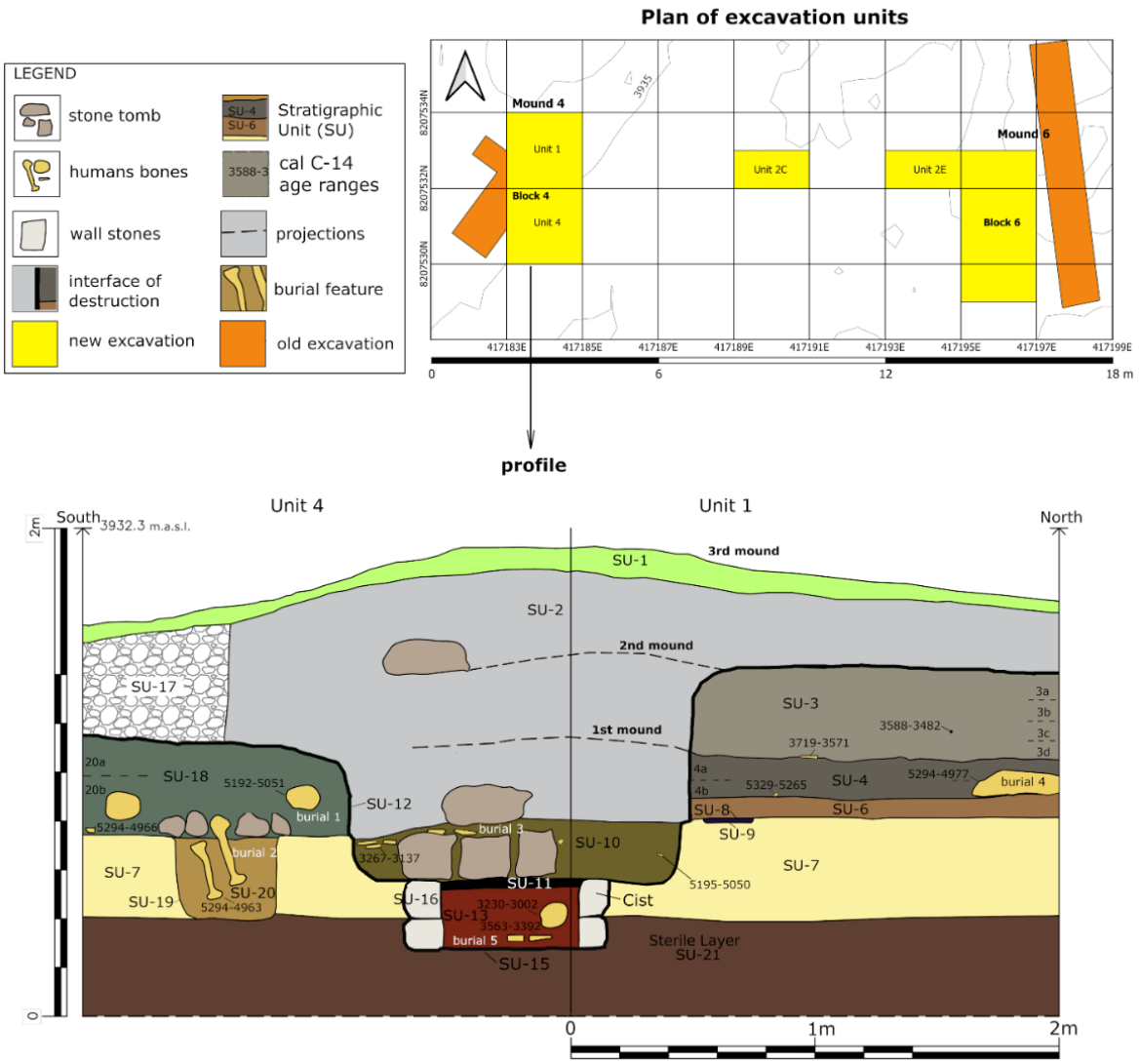


Figure 8. Western stratigraphic section of Mound 4. Radiocarbon dates are shown in calibrated BP age ranges, the stratigraphic units (SU) are indicated, and we show the main features (cist, mounds, burials).

3.3.2.4. *Phase 4 (3500-3000 cal BP)*

Three events happened. First, on the southern side of M4, Kaillachuro inhabitants dug out some of the previous deposits, up to a depth of 1.5 m from the modern surface, to build a semi-subterranean cist measuring 0.8x0.4-m-side and 0.15-m-deep to place a child (Burial 5). The cist wall was built with local volcanic rock, two bright white limestone rocks, and gray mortar as bonding and plastering agents (Figure 9d). The chamber's floor was covered in compact, yellowish-red clay (SU-15). On the floor of the cist, a part of a child's skeleton was found flexed to the right side and covered in red ocher. Two direct dates on bones place the interment between 3466-3132 cal BP. A compact, clayey, ochre-mixed, reddish-brown layer covered the body (SU-13). This infill contained lithic flakes and two Terminal Archaic-Formative Period (5B and 5D) silex and obsidian projectile points (Figure 9.6). A 2cm layer of dark brown ash, charcoal, fine gravel, silex lithic debris, and human bone fragments were later placed as part of a separate burning event (SU-11). Second, four long granodiorite slabs and a clay fill (SU-10), containing the remains of at least three incomplete individuals, sealed the tomb (Figure 9e). Direct dating of two human bones from this fill yielded age estimates of 5185 and 3210 cal BP, respectively. Third, debris covered all these features, containing many thermofractured rocks, ground stones, and few pottery sherds (SU-2), resulting in a renewed M4. In this last fill, two secondary burials (B4 and B5) were reported in the 1990s.

In M6, we observed a rectangular stone platform (Figures 9f and 10). The platform's wall was made of granodiorite rock and gray mortar. We estimate the platform at 0.20m high and almost 3m long. A surface hearth on the floor associated with the platform wall dates to 3385–3172 cal B.P. At circa 3000 BP, both mounds were abandoned. In total, M4 reached a height of at least 1.5m, and M6 1.7m.

3.3.2.5. *Phase 5 (500-400 cal BP)*

Post-abandoning Kaillachuro, other people used some mounds as burial places. In M1 and M6, we discovered intrusive Inca burials (see Appendices 1 and 2).

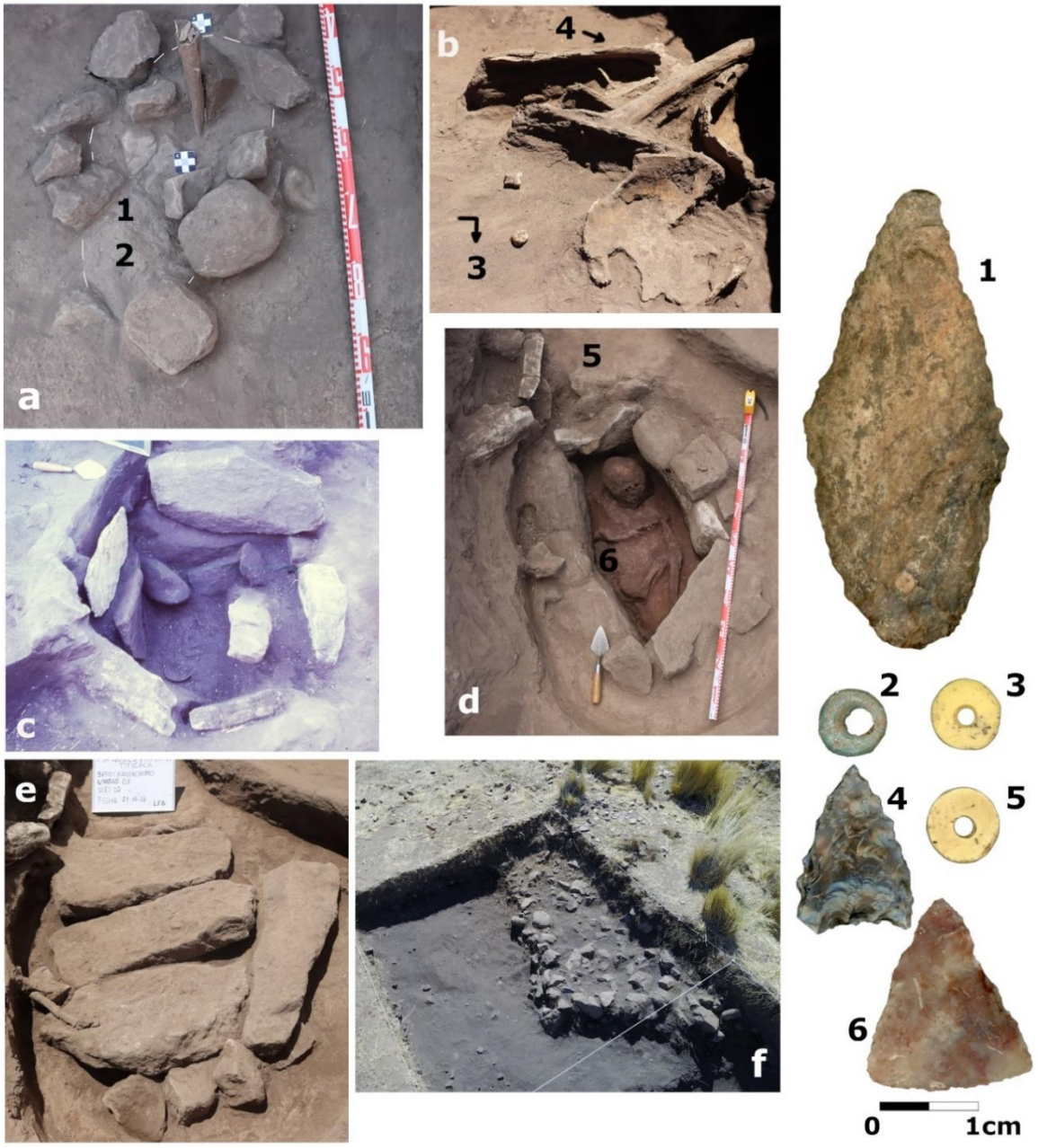


Figure 9. ***a)*** *South view of M4's earliest unexcavated burial pit. Numbers 1 and 2 indicate a green bead and projectile point.* ***b)*** *Burial 2 in M4's initial mound. Three and four indicate a golden stone bead and obsidian point found below the tomb.* ***c)*** *A stone-box at M4 with a child burial.* ***d)*** *Child's cist from above. Both the deposit and the buried person are covered in red ochre. Numbers 5 and 6 represent a stone bead and chert projectile point.* ***e)*** *Fill with bones and stone slabs covers the cist.* ***f)*** *M6 southwest-to-northeast 0.2-m-high stone platform.*

3.3.2.6. *Sequence summary*

Kaillachuro was inhabited between 5300 and 3000 BP. The placement of human remains in graves and the accumulation of deposits over this area formed a low mound about 1 m high in M4 during Phase 1. In the second phase, approximately 4352 cal BP, inhabitants dug into the mound fill and placed at least one stone box that contained the partial remains of a child. M4 apparently returned to its role as a tumulus 300 years later, in Phase 3, when it reached a height of 1.2m (4100–3800 cal BP). During Phase 4, around 3400 cal BP, there were significant transformations at Kaillachuro. A burial cist was built at the base of the M4, cutting it, and a low platform was built at the top of M6. The site was abandoned after 3000 cal BP.

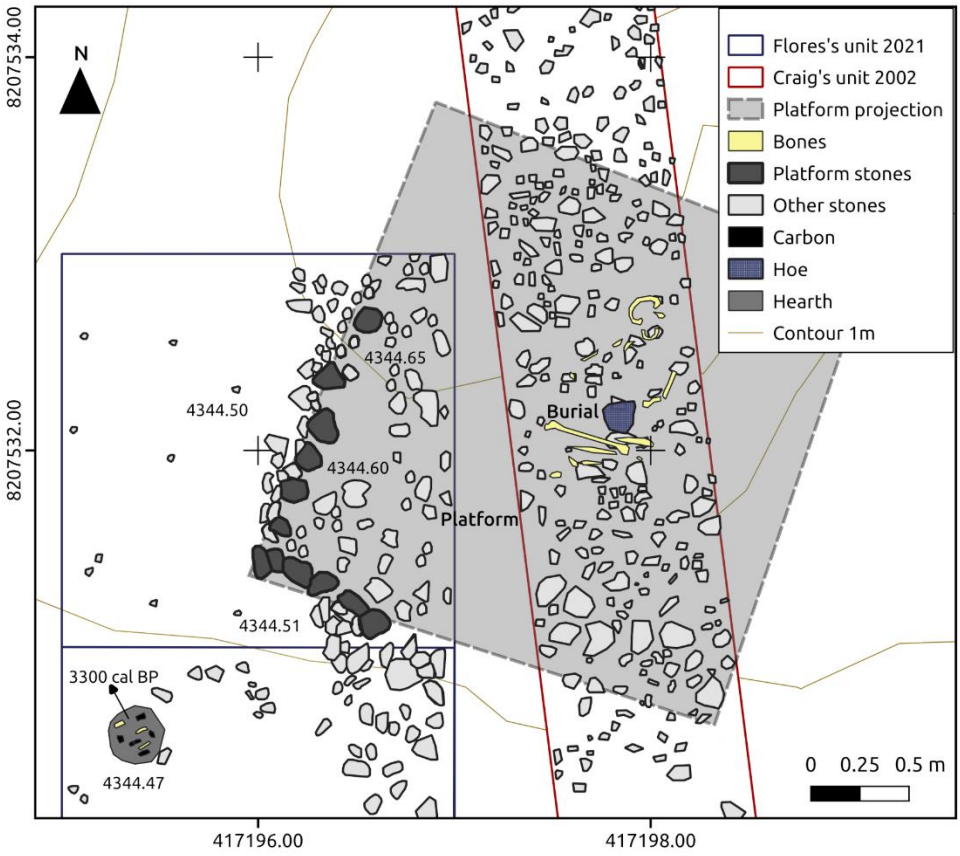


Figure 10. Mound 6 stone platform partially excavated. Craig (2005) excavated the trench outlined in red. We excavated the western units in 2021. Our recent radiocarbon analysis of one of the human remains found by Craig's (2005) shows that this interment is invasive into the platform fill (493 cal BP).

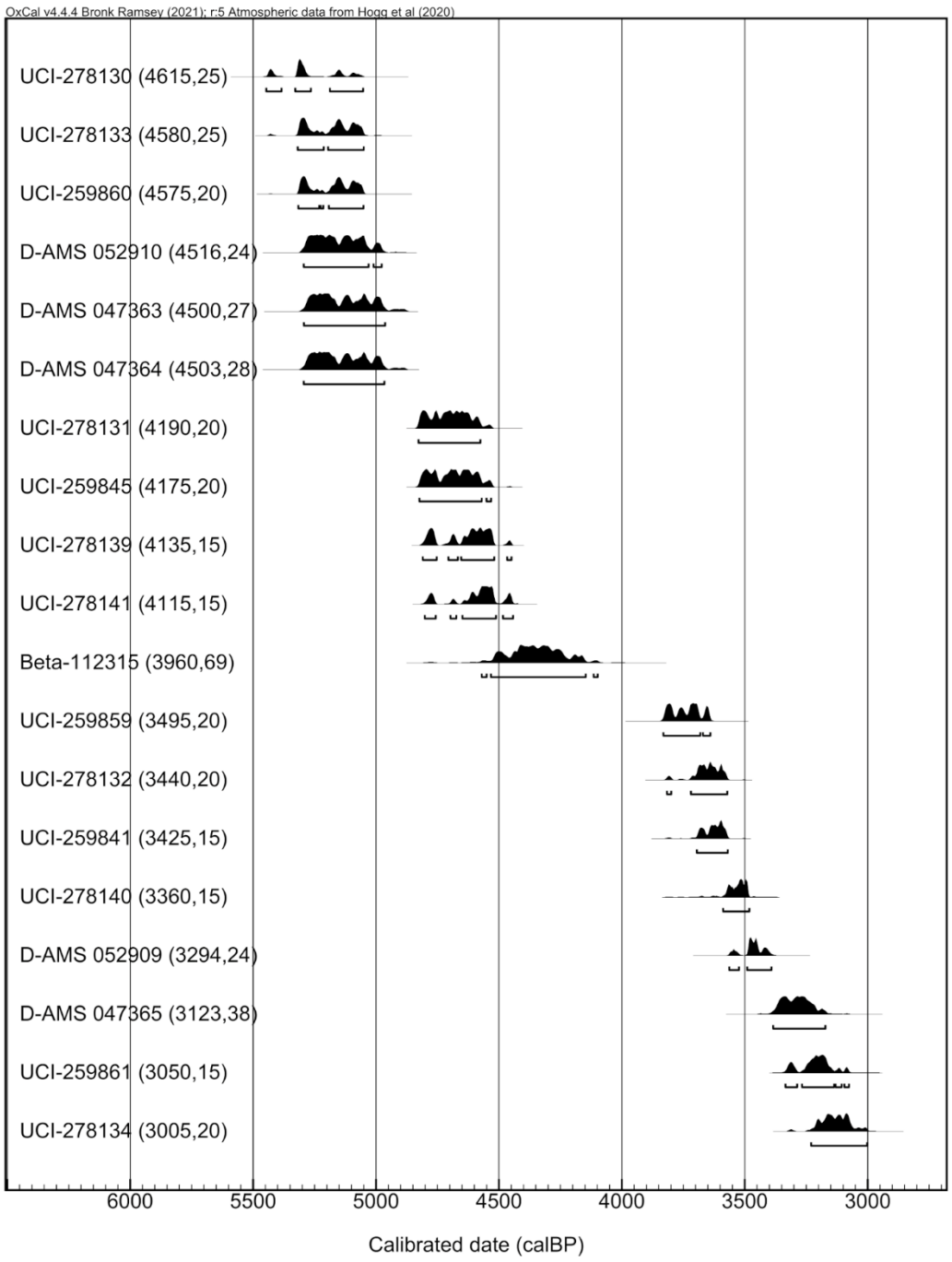


Figure 11. Radiometric dates of Kaillachuro samples by AMS (n = 19). Calibrations employ OxCal v4.4.4 (Bronk Ramsey 2021), r:5 SHCal20 atmospheric curve (Hogg et al., 2020). The dates of the Archaic and Formative periods are included. For the complete list see Supplementary data 1.

3.4. **Discussion**

3.4.1. ***Mound formation.***

The stratigraphic sequence and radiocarbon dates reveal *when* and *how* the mounds at Kaillachuro were formed. It was a slow development that began more than 5000 years ago and persisted for 2000 years. This formation process is consistent with slow and gradual mound growth on the Andean coast (Vega-Centeno, 2007) and Araucanian ethnohistorical data from Chile, where mounds resulted from multi-year postmortem ceremonies (Dillehay, 1995).

Kaillachuro mound formation involved both depositional and renovation events. M4 consists of at least three overlapping mounds of ash sediment, burned stones, secondary human burials, and animal bone fragments from funerary activities and possibly feasting. In the years after the deceased's placement, postmortem actions may have created the first mound. This would explain why radiocarbon evidence cannot distinguish between the burials in this first mound and the burial pits below. Alternatively, some mound fill came from removing prior features and constructing subsequent structures like the stone box and cist. This renovation activity would explain the SU-10 fill's apparent earlier age (5185 cal BP), which contradicts stratigraphic order and other radiocarbon samples that otherwise suggest a robust Early Formative association.

Such processes did not affect the entirety of M4. Figure 8 shows that on the north side of the mound, horizontal deposition in SUs 3 and 4 includes several levels that may have been the result of repeated accumulation, including an in-situ burial in SU-4. On the south side of the mound, SU-19 contained considerable microfragmentation of bone, suggesting ancient people disrupted the fill.

Thus, the first two M4 mounds date to the Late and Terminal Archaic periods, while the third dates to the Early Formative Period. At the end of Phase 4, M4 attained approximately 1.5m in height, while M6 reached approximately 1.8m.

Why mounds were built is difficult to determine. Kaillachuro features are similar in some way to other South-Central Andean hunter-gatherer ceremonial features (Figure 12). Burials and associated features since the beginning of Kaillachuro's use provide the most convincing evidence of the existence of funerary rituals. The earliest interment is a simple pit burial from 5300 cal BP. A projectile point (Type 2A) in the feature fill initially suggested a Middle Archaic Period (9000–7000 cal BP) association. Perhaps the creator of the interment intended to emphasize traditional hunting during an innovative time, or perhaps the artifact entered the tomb incidentally during infilling. These burial pits are not unlike those found near the houses of Jiskairumoko (Aldenderfer, 2012; Craig, 2005) and in Early Archaic period sites up to 9000 cal BP (R. Haas et al., 2020; R. Haas & Viviano, 2015). Regardless, the early burial pits at Kaillachuro represent the beginning of a long and distinct funerary tradition that would later include mound construction.

The repetition of ceremonial practices resulted in the formation of mounds. Burning events are one of these recurring practices throughout Kaillachuro's history. We summarize three illustrative instances. First, a shallow hearth filled with burned plant matter (SUs 8 and 9) appears to have been part of a ceremonial act around the Burial 2. Second, another event in the ocher matrix of the stone box floor turned it a violet color due to the heat of the fire. Third, in Phase 4 of M4, after sealing the burial cist, the creators of the interment burned plant material on top of it. Such burning rituals are common in other Andean societies during the Formative Period (Cohen, 2010; Goodman-Elgar et al., 2023; Hastorf, 2003).

The construction of a masonry cist tomb and platform are distinctive features of Kaillachuro's funerary practice. Cist construction has also been documented at the San Bartolome-Wiskachuni site for the same period, including the choice to build the cist by reconfiguring an ancient site, the tomb form, preference for individual burials, positioning the deceased in a flexed posture on their right side, paucity of inorganic offerings, ocher, and stone-slabs coverings (Herhahn, 2004). Regarding the platform in M6, it is possible that it served as a burial place, as has been documented in Huatacoa (Cohen, 2010). We date a burial, nevertheless, to the Inca Period. Although this result does not rule out the possibility of early burials, further research is essential to determine the function of this architectural feature.

Mounds may have slowly grown in height as waste from funeral and post-funeral ceremonies were left behind. Day of the Dead celebrations in Andean tradition include food preparation and the ritual sacrifice of camelids. Part of the leftovers from the meal are eaten by the attendees, while the other is laid to rest with the deceased (Allen, 2012; Aranguren Paz, 1975). At Kaillachuro, heat-fractured black stones, ashy soils, and some camelid bones covered the last two phases of mound accumulation in M4 and M6. These remains may have been remnants of ceremonies performed around the mounds. Similar deposits have been found at other sites in the South-Central Andes, indicating such mounds served as community gathering places (Bauer, 2007; Cohen, 2010; L. Núñez et al., 2017; L. Núñez & Perlès, 2018; Power et al., 2022).

Thousands of pieces of debitage, hundreds of ground stones, and ash fill at Kaillachuro are indicative of domestic activities. The fact that most of these artifacts come from both the spaces between the mounds and the later fills that formed M4 and M6 is highly interesting, suggesting that nearby domestic areas of the site are still undiscovered. This is not unexpected, as the coexistence of religious and economic activities in the Andes is widely recognized (Allen, 2012).

Where are the Kaillachuro residences? At the nearby Jiskairumoko site, houses and burial pits coexist in the same area (Craig, 2005). No houses have been found at Kaillachuro. However, extensive modern agricultural activity and site reuse/destruction complicate this search. The pit-houses at Jiskairumoko occur at less than 30 cm depth. Thus, it is possible that mechanized plowing destroyed potential houses at Kaillachuro. Our northern unit excavated demonstrates that the plow indeed destroyed a possibly domestic context, featuring a large ashy layer dating to 4634 cal BP. Domestic features might still be preserved below burial locations if Kaillachuro followed Jiskairumoko's pattern. For example, some stone alignments in SU-3 of M4 may have been residential walls. Additional explorations in Kaillachuro may yield preserved houses, and a complete lithic analysis could clarify the role of associated lithic tools.

3.4.2. ***Ritual and South-Central Andean Neolithization***

Our research challenges the assumption that early societies needed to fulfill the criteria traditionally associated with the Andean Neolithic to construct monumental architecture. Instead, we show that the construction of mounds, specifically those of a memorial nature, precedes other domains of socioeconomic complexity. In the South-Central Andes, evidence that hunter-gatherers engaged in complex socioeconomic activities without an agricultural economy, residential sedentism, and institutionalized inequality is also apparent (Aldenderfer, 2004; Aldenderfer et al., 2008; Kitchel et al., 2022; L. Núñez et al., 2017; L. Núñez & Perlès, 2018; Power et al., 2022). Thus, it is crucial to investigate what triggered these social and economic developments.

Kaillachuro illustrates, for the first time, a similar pattern in the Titicaca Basin where the construction of ceremonial architecture emerged part-and-parcel to a corpus of complex socioeconomic behaviors-especially agropastoralism and long-distance exchange-rather than a

product of them. These findings reveal that relationships between the living and dead began to change during the Terminal Archaic Period.

Ceremonial features	Kaillachuro periods					Southern high-Andean sites with ceremonial features		Reference
	I	II	III	IV	V	Terminal Archaic site	Early Formative site	
platform						Asana	Huatacoa	Aldenderfer, 1990; Cohen, 2010
midden fill						Tulan-52	Tulan-54, Huatacoa, Viskachuni	Cohen, 2010; Herhahn, 2004; Núñez et al., 2017; Núñez & Perlès, 2018
burial mounds						Tulan-52	Tulan-54	Núñez et al., 2017; Núñez & Perlès, 2018
box stone / burial cist							Viskachuni	Herhahn, 2004
surface hearths						Asana		Aldenderfer, 1990
clay-surfaced basins						Asana		Aldenderfer, 1990
prepared-clay floors						Asana		Aldenderfer, 1990
horizontal slabs							Tulan-54, Viskachuni	Herhahn, 2004; Núñez et al., 2017
burning events							Chiripa, Huatacoa	Cohen, 2010; Hastorf, 2003
pigments (eg. ocher)						Asana, Jiskairumoko, Tulan-52	Chiripa, Qaluyu, San Bartolome	Craig, 2005; Hastorf, 2003; Herhahn, 2004; Mohr-Chávez, 1977; Núñez & Perlès, 2018
burial pits						Jiskairumoko, Camata, Muruqullu	Tulan-54, Chiripa, Huatacoa, Camata	Cohen, 2010; Craig, 2005; Hastorf, 2003; Juengst et al., 2017; Núñez et al., 2017
walls with vertical slabs and niches						Tulan-52	Tulan-54	Núñez et al., 2017; Núñez & Perlès, 2018
sunken enclosure and walled enclosure							Huatacoa, Chiripa	Cohen, 2010; Hastorf, 2003
ovals, circle of posts and trench						Asana		Aldenderfer, 1990

Figure 12. Ceremonial features at the Kaillachuro site throughout its sequence, and at other contemporary sites.

As in previous archaeological periods, the deceased were buried ceremonially, but for the first time, their presence was rendered visible in the landscape. The burial mounds were monuments that, intentional or not, conveyed signals to the living. This practice was more prevalent during the Formative period, when rites involving human remains were crucial to community development (Hastorf, 2003). Kaillachuro shows that this communal behavior began 5,000 years ago in the Titicaca Basin, 1500 years earlier than previously thought. The finding is consistent with previous Andean studies, where early ceremonial structures either preceded or coincided with emergent complexity, suggesting that ritual was essential to such socioeconomic transformation, perhaps a catalyst for the population's cohesion (Aldenderfer, 1990; Bonnier, 1988; Dillehay, 2011; L. Núñez et al., 2017; L. Núñez & Perlès, 2018; Stanish, 2013). Thus,

ceremonies related to or commemorating the dead inspired the construction of another type of monumental architecture in the Andes that did not necessarily reach massive dimensions or imply the materialization of power, but rather the remembrance of their ancestors. Hunter-gatherer burial practices in the highlands appear to have contributed to neolithization, but the precise mechanism through which these practices facilitated this development is still being examined.

Acknowledgment:

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Chapter 4: **IN THIS MOUND LIES A LEADER? ASSESSING THE STATUS OF KAILLACHURO MOUND BURIALS, TITICACA BASIN, 5.3-3.0 ka**

Paper to be submitted to: *Science Advances or Scientific Report*

Authors: Luis Flores-Blanco, Mark Aldenderfer, James Watson, Gonzalo Irureta, Diana Malarchik, Jelmer Eerkens, Randall Haas

Abstract

The roots of inequality and the extent of leadership in South American Andean Neolithization are unknown. In the Titicaca Basin, signatures of inequality, including burial mounds and exotic-good exchange, first appear during the Terminal Archaic Period, 5.0–3.0 cal. ka, suggesting early forms of social differentiation. The nature and degree of differentiation within Terminal Archaic communities are the subject of this analysis. To determine who was buried in the region's earliest mounds and whether they express social inequality, we explore the age, sex, diets, and funerary assemblages of people buried at the site of Kaillachuro between 5.3–3.0 cal. ka. Results show that the majority of those buried in Kaillachuro were male, both adults and children. Further, prestige goods were preferentially associated with male individuals. Bone collagen stable isotope chemistry demonstrates that diets were plant-dominant, and no subset of individuals exhibits a privileged diet. The Andean Neolithization brought increased gender disparity to Kaillachuro, where men were more likely to have higher status than women. Results also show heavy investment in the burial of children, who were the only individuals interred in stone boxes. However, dietary homogeneity among mound and non-mound burials suggests relatively little differentiation in access to subsistence resources. These findings suggest that the influence of early male leaders was limited to the extent that they did not experience better diets than their female counterparts or than those in non-mound sites. However, there is evidence that suggests the establishment of certain rigid sexual divisions of labor.

Key words: Andes, Titicaca, mound, burials, inequality, leadership

4.1. **Introduction**

The inequality and evolution of leadership have been topics of great interest for archaeologists and anthropologists (Carneiro, 1970; Earle & Earle, 1993; Eerkens et al., 2009; Fried, 1967; J. Haas, 1982; Hayden, 1995; Paynter, 1989; Sahlins, 1963; Service, 1975). Classical neo-evolutionary scholars claimed that inequality is a characteristic commonly found in complex societies with hierarchical differentiation, while simple societies that are politically disintegrated and economically based on hunting and gathering tend to have egalitarian systems (Fried, 1967; Service, 1975).

Following the classic theoretical framework, many archaeologists have searched for empirical evidence of the mechanisms that caused such changes in the past (Paynter, 1989). In general, when archaeologists address the origin of inequality, they are concerned with institutionalized inequality. Consistent with one of these neo-evolutionary models, the *Big Man* and *Chief* proposal by Sahlins (1963), archaeologists have preferred to look for economic entrepreneurs, ambitious leaders, and even dignitaries endowed with power and the capacity to amass wealth. However, some scholars have identified inconsistencies in the statements of the classic neo-evolutionary model (Hayden, 1995; Roscoe, 2012; Stanish, 2017; Wiessner, 2009).

Ethnographic record reveals a wide variety of social organization and leadership, even among egalitarian societies, that are culturally complex and diverse, ranging from the rare but classic entrepreneur *Big Man* to the situational *Headman* (Godelier, 1986; M. Harris, 1993; Sahlins, 1963). Therefore, a society being "egalitarian" does not imply complete equality among all individuals in society. Instead, it refers to a societal structure in which every individual has an equal opportunity to attain a leadership position, primarily based on their personal merits and skills. Thus, it is crucial to recognize that egalitarian societies can have inequalities and social

hierarchies (Flanagan, 1989; Fried, 1960; Kelly, 2013; Paynter, 1989; Roscoe, 2012). But furthermore, egalitarianism should not be conceived as a simple state for a society. Many egalitarian societies have complex institutions for preventing the emergence of chiefs or institutionalized inequality (Wiessner, 2002, 2009). Although it is simply not possible to reconstruct such complex dynamics recorded ethnographically for archaeological cultures, there are some aspects of social complexity that we can know for past societies.

Burial assemblages and the emergence of monumental architecture are commonly used to infer the appearance of status differentials and social inequality in ancient societies (Binford, 1971; Chapman et al., 1981; Hayden, 1995; T. King, 1978; O'Shea, 1984; Pearson, 1999; Peebles & Kus, 1977; Rothschild, 1983; Saxe, 1971; Terlep et al., 2023; Trigger, 1990; Wright, 1978), despite subsequent criticism of such approach identifying inequality (Bradley, 1990; D. Miller & Tilley, 1984). Such studies have tended to focus on highly hierarchical, complex, and agricultural societies, particularly state-organized societies, using primarily ethnographic and ethnohistoric data with broad macroevolution time scales, and region-wide data (Earle & Earle, 1993; J. Haas, 1982).

Similarly, Andean researchers have suggested that the rise of monumental architecture coincided with the development of an elite class. In this view, massive architectural undertakings necessitated a centralization of power. Researchers who have examined this topic in the Andean region have primarily focused on the Formative Period (including its preceramic manifestations about 5.0 ka) from sites such as Caral, Pampa de Llamas-Moxeque, Kuntur Wasi, or Chavin as a starting point for the establishment of power structures (J. Haas et al., 2004; J. Haas & Creamer, 2006; J. Moore, 1996; Pozorski, 1987; Seki et al., 2023; Shady et al., 2001; Tantaleán, 2021).

Researchers in the Lake Titicaca Basin concur that institutionalized authority and centralization of power began during the Upper Formative Period (2.5-1.5 ka), indicated at the sites of Pucara and Tiwanaku. Their arguments are supported by material indicators including a hierarchical settlement pattern, massive public architecture that includes pyramidal structures and sunken quadrangular plazas, enhanced access to precious metals (copper and gold), exotic goods (obsidian) obtained by interregional exchange networks, and the manufacturing of elaborately decorated items, including ceremonial tableware and lithic sculpture—that are regarded as elite indicators (Bandy, 2004; Beck, 2004; Hastorf, 2008; Janusek, 2007, 2015; E. Klarich et al., 2017; Levine et al., 2013; Plourde & Stanish, 2006; Stanish, 2003; Stanish & Levine, 2011). This early hierarchical social structure has been labeled chiefdoms, ranked societies, or even archaic states, while their leaders have been identified as some kind of *chief*.

In addition, stable isotope chemistry presents a valuable method to test expectations for status differentiation given the premise that high-status individuals experienced privileged diets, likely including preferential access to high-ranking foods, especially meat. Such privileged diets should be evident as enriched carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope chemistry of human bones (Ambrose et al., 2003; Kinaston et al., 2013; Le Huray & Schutkowski, 2005; Linderholm et al., 2008; Schutkowski et al., 1999; Somerville et al., 2013). Andean archaeologists have not made much use of isotopic analysis to test possible diet-based status differences, although ethnographic data and Andean zooarchaeological remains indicate that camelid meat is highly valued and only consumed on special occasions (Allen, 2012; deFrance, 2014; Ervynck et al., 2003; Flores-Blanco et al., 2022; Hastorf, 2003; E. Klarich, 2010; Osborn, 2019). This suggests that camelid meat is a high-status food.

As an alternative hypothesis, some Andean archaeologists have suggested that the use of coercive power was unnecessary for the construction of early massive structures and that communal organizations led by religious and temporary leaders may have been sufficient (Burger, 2008, 2019; Burger & Salazar-Burger, 1991; Nesbitt, 2019). While this issue has recently gained attention in Andean archaeology, most Andean archaeologists have not, until recently, begun to look at other forms of social hierarchy; therefore, our understanding of the roots and evolution of leadership remains unclear. The extent of power among leaders potentially ranged from complete to non-existent, with all possibilities in between.

Less attention has been paid to investigating inequality among the so-called "egalitarian" societies, including complex hunter-gatherers and early farmers, that immediately preceded the Formative Period. Yet, many researchers have found archaeological and ethnographic evidence of inequality among such "simple" societies, including hierarchies based on age, sex, and foraging ability, among others (Aldenderfer, 1993, 2004, 2006a; Arnold, 1996; Binford, 1971; Eerkens et al., 2009; Kelly, 2013; Price & Brown, 1985). The scarcity of research on social inequality among hunter-gatherer and early agropastoral societies in the Andes complicates the search for early prestige, authority, and power dynamics. In the South-Central Andes, limited studies suggest that the first signs of social inequality emerged in the Terminal Archaic Period (5.0–3.5 ka), a time when prestigious leaders may have been present, likely with limited authority restricted only to specific domains but without real power. These conclusions follow from the observation of the archaeological contexts of sites such as Asana, Jiskairumoko, and Tulan-52, where early ceremonial features and access to non-local goods support such conclusions (Aldenderfer, 2004; Aldenderfer et al., 2008; L. Núñez & Perlès, 2018).

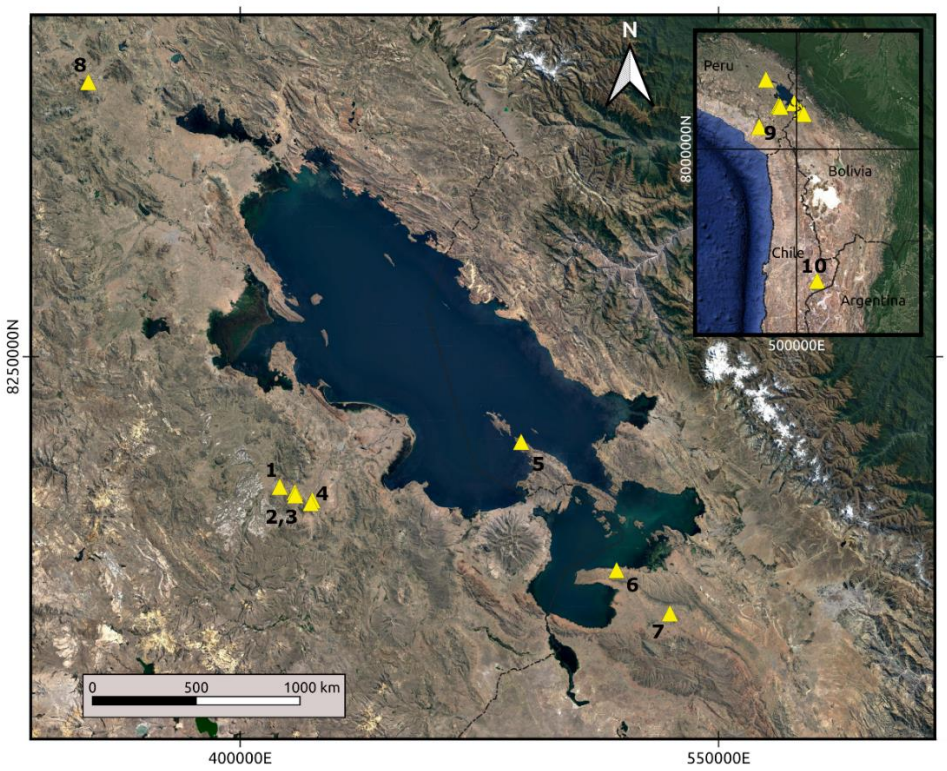
The discovery of mound burials at Kaillachuro in Peru's Lake Titicaca Basin region (Figure 13) (Flores-Blanco & Aldenderfer, 2024) presents new opportunities to evaluate the nature and extent of inequality and the evolution of leadership among the Terminal Archaic Period population. To evaluate the status of those buried at Kaillachuro and then discuss the competing leadership models during the period of Neolithization in the Titicaca Basin, we analyze four distinct facets of the Kaillachuro burial site: First, we evaluate the demographic characteristics, especially age and sex, of those interred in the mounds. Second, we evaluate what types of grave items, if any, were included in the burial context. Third, we examine how similar or unlike their diets were, as expressed in stable isotope signatures. Ultimately, we compare the findings from Kaillachuro, a site characterized by mounds, with the findings from other contemporary and temporally adjacent non-mound sites on the Altiplano, such as Jiskairumoko and Muruqullu, as well as the Early Chiripa phase occupation, which appears to have been a small village during the Early Formative Period I (3500–3000 BP) (Figure 13) (Aldenderfer, 2004; Bandy, 2001; Hastorf, 2003, 2008; Juengst et al., 2017, 2021; M. Miller et al., 2021).

Thus, Kaillachuro provides crucial information that helps fill the empirical void regarding who was responsible for the region’s earliest burial mounds and explores their status and the degree of social inequality. Specifically, we investigate whether individuals buried at Kaillachuro show signs of unequal access to basic goods, such as food resources, and prestige goods, such as non-local raw materials. In the end, we discuss the nature of the buried individual, following ethnographic models of leadership (Godelier, 1986; M. Harris, 1993; Hayden, 1987, 1995; Henrich et al., 2015; Roscoe, 2012; Sahlins, 1963; Wiessner, 2009). Alternatively, we consider the possibility that these individuals may simply have been a random subset of a largely egalitarian community (Table 3).

*Table 3. Summary of archaeological expectations and anthropological models**

Burials expected in the mounds	**Archeological predictions**				**Ethnographic types of leaders**
	sex	**age**	**goods**	**diet**	
1. Leaders of an unequal society	male biased	adult and children	lavish	privileged	Chiefs
2. Leaders of an egalitarian society	male biased	adult biased	moderate	privileged	Big Man
	male biased	adult biased	modest	average	Head Man
3. Members of an equal society	parity, both male and female	adult and children	modest	average	

* Archaeological predictions about burial goods are based on our interpretations of ethnographic data (M. Harris, 1993; Sahlins, 1963; Wiessner, 2009).



years cal B.P.	Chronology: Rowe (Ica sequence)	Chronology: Stanish 2003 / Aldenderfer 2009 (Titicaca sequence)	Sites
	Early Intermediate	Upper Formative	Pucara, Tiwanaku
	Early Horizon	Middle Formative	
3000	Initial Period	Early Formative	Kaillachuro, Jiskairumoko, Muruqullu, ----Chiripa--
3500		Terminal Archaic	
5000	Preceramic	Late Archaic	Soro Mik'aya Patjxa

Figure 13. Geographic and chronological location of the Kaillachuro site, as well as other sites mentioned in the paper. The Kaillachuro occupation is shown by the shaded area on the timeline. Sites: 1=Pirco, 2=Kaillachuro, 3=Jiskairimoko, 4=Soro Mik'aya Patxa, 5=Muruqullu, 6=Chiripa, 7=Tiwanaku, 8=Pucara, 9=Asana, 10=Tulan-52 y Tulan-54.

4.2. **Materials and Methods**

To test the predictions of the competing hypotheses for status and leadership at Kaillachuro, we conduct qualitative and quantitative analysis of the burials, their goods, and diets, all framed in their archaeological context. Following a description of the site, we outline the methods used to collect appropriate data to test the different models.

4.2.1. ***The Kaillachuro site and sample***

The site of Kaillachuro is located at 3,930 masl, 30 km west of Lake Titicaca, in the middle of the Ilave River Valley (Figure 13). It was first recorded in 1995 by Mark Aldenderfer as part of an extensive regional survey. Kaillachuro is a 3-hectare open-air site containing at least twelve small burial mounds. The data examined here have been systematically extracted from these two mounds, M4 and M6, have been excavated, and are well-dated. The stratification of these mounds includes at least five distinct phases containing a variety of burials with distinct mortuary treatments. Almost all of the burials are secondary, with the majority consisting of fragmentary human remains. Radiocarbon dates indicate that the Kaillachuro mounds were used between 5300 and 3000 cal BP, spanning the Late Archaic Period to the Early Formative Periods (Flores-Blanco & Aldenderfer, 2024).

4.2.2. ***Demographic analysis***

Sex and age were estimated using several techniques, including standard osteological and archaeometric methods. Where possible, we examine osteological markers known to vary with sex, such as the sciatic notch and secondary sex indicators including the glabella, mastoid process, and nuchal crest (Buikstra & Ubelaker, 1994). However, due to the fragmentary and disarticulated nature of most remains, we also employed shotgun proteomic analyses of tooth enamel, looking specifically for amelogenin peptides (Buonasera et al., 2020; Parker et al., 2019). In short, proteins

were extracted from approximately 20 mg of enamel powder and analyzed by liquid chromatography mass spectrometry to identify peptides distinctive to the AMELX or AMELY isoforms of amelogenin. While the presence of AMELY identifies the sample as male, samples lacking AMELY could indicate either a poorly preserved male or a female sample. Therefore, we follow the linear logistic regression established by Buonasera and colleagues (2020) to assign a likelihood of female sex for samples containing only AMELX. Because males express AMELY/AMELX within a particular range, for sample with ample AMELX, and no AMELY, the probability of females will be high. Age estimation is based on dental development, dental wear (Lovejoy, 1985), and suture closure (Buikstra & Ubelaker, 1994).

Once the proportion of male:female individuals was determined (Hobbs, 2004), a chi-square test is employed to examine sex bias within the burial population. Finally, we perform a binomial analysis on the obtained ratio to evaluate which theoretical sex ratios might have contributed to the empirically observed sex ratio. In essence, this hypothesis testing is performed to generate credible models of the probability of male burial (R. Haas et al., 2020). Statistical analysis is performed using the R statistical programming language (R Core Team, 2022).

4.2.3. ***Prestige goods***

We evaluate prestige goods associated with burials in both a qualitative and quantitative fashion. We define prestige goods as material goods that indicate a person's skill, knowledge, and wisdom. For example, such items could mark an individual as a skilled craft worker (e.g., flint knapper, bead producer), a trader with social connections that provided access to valuable raw material, a specially productive gatherer or hunter, or a respected shaman (Plourde, 2008; Spikins, 2008). Archaeologists excavating in the Andes, particularly the Titicaca Basin, have identified several costly items that were used as indicators of status. These include monumental architecture, the use

of exotic materials such as obsidian, and ornaments such as bead necklaces made from gold, copper, chrysocolla, and other visually striking raw materials. For example, the obsidian that was brought to Titicaca primarily originated from the Chivay source, which is situated around 200 km distant (Aldenderfer, 2004; Aldenderfer et al., 2008; E. Klarich et al., 2017; Levine et al., 2013; Tripcevich, 2010).

For this analysis, we select only the burials with clear archaeological context, excluding loose bones, to adopt a more conservative approach to grave-good associations, even though these were considered distinct individuals by the MNI principle. We then qualitatively evaluate the presence/absence of prestige goods and assess the quantity of grave goods by sex and age. We use chi-square tests to assess the potential presence of sex or age bias in the acquisition of funerary goods. We anticipate that significant variations in either of these two levels may be a sign of social inequality.

4.2.4. ***Stable isotope analysis***

Light stable isotopes, such as carbon (δ13C) and nitrogen (δ15N), are reliable indicators of ancient diets (DeNiro & Epstein, 1978, 1981; DeNiro & Schoeniger, 1983). The principle of this method is that the isotopic signatures of food consumed by animals, including humans, are embedded in their tissues, and can be detected in isotopic studies. In the case of the carbon stable isotope, photosynthesis is the main vehicle that influences the carbon composition of plants and, by extension, the animals that consume them. Due to their carbon composition, plants are divided into C3, C4, and CAM (Tieszen & Boutton, 1989). In contrast, the study of the stable isotope of nitrogen measures trophic level, or position in the food chain. Therefore, those individuals who preferentially consume plants are expected to have depleted nitrogen values compared to those

who consume more meat (Bartelink et al., 2014; Schoeninger & Moore, 1992; Schwarcz & Schoeninger, 2012).

To extract collagen from bone, we followed a modified Longin procedure (Longin, 1971). Using a hand drill, 1-2 g of cortical bone were cleaned of any surface contamination, removing the entire exposed surface of the bone. We then sonicated each sample in deionized water. The sample was dried for 24 hours, weighed, and placed in a 0.5 M hydrochloric acid (HCl) solution to demineralize it, changing the HCl solution every two days. Each sample was then washed with deionized water and immersed in 0.125 M sodium hydroxide (NaOH) for 24 hours to remove humic acids. Samples were then rinsed again with deionized water and placed in a 70°C oven with acidic pH3 water to solubilize the collagen. Liquid in the vial was then pipetted away from any remaining solids and placed in a lyophilizer to remove water, isolating the collagen fraction. All these procedures were performed at the Archaeometry Laboratory of the UC Davis Department of Anthropology. Afterwards, between 1 and 2 mg of collagen was submitted for the δ13C & δ15N analyses by EA-IRMS in the Stable Isotope Facility at UC Davis.

Due to the isotopic enrichment at the trophic level of carbon and nitrogen, all our raw isotopic results from human archaeological remains have an offset relative to the diet of the individual. For δ13C, enrichment is between 4.5-6.0‰. For δ15N, the offsets range between 3-6‰ (Bocherens & Drucker, 2003; J. Chen et al., 2024; Cheung & Szpak, 2021; Fernandes et al., 2012; O'Connell et al., 2012). We use the rounded mean of this offset, so the δ13C VPDB raw values receive an offset of 5.25‰. The δ15N Air raw values are offset by 4.5‰.

4.2.5. ***Comparative data***

To assess the existence of social inequality, we compare the burial data, grave goods, and dietary patterns of individuals interred in the mounds of Kaillachuro, in comparison to other communities

in the Titicaca Basin. We limit the analysis to the Terminal Archaic and Early Formative Periods, which coincide with the Kaillachuro occupation. We compiled published archaeological, osteological, and isotopic data from graves at both mound and non-mound sites (Aldenderfer et al., 2008; Blom & Bandy, 1999; Craig, 2005; Hastorf, 2003; Juengst et al., 2017, 2021; M. Miller et al., 2021).

To gain more specific insights into the diets of the buried individuals, we compared their isotopic values to those of potential food resources in the region (see Appendix 7). We compiled published isotopic values for foods exclusively from the Titicaca Basin for comparison (Berryman, 2010; DeNiro, 1988; M. Miller et al., 2021; Pezo-Lanfranco et al., 2024; Whittemore et al., 2023). This allowed us to eliminate some environmentally-related isotopic issues related to samples originating from lowlands and regions outside the scope of our study. In addition, 71% are archaeological samples. The remaining 29% are modern samples from the Titicaca Basin; they were adjusted by +1.5‰ for the Suess Effect (Szpak et al., 2013).

For the purpose of comparing the number of burial items of the populations buried at the Kaillachuro and Jiskairumoko sites, we employed the Wilcoxon signed-rank test.

4.3. **Results**

4.3.1. ***Demographics***

The Kaillachuro sample contains an MNI of 24 individuals, with the majority found in M4 (Table 4). Age estimations were possible for 21 individuals. 76% (n=16) of these burials were adults, and 24% (n=5) non-adults (children and adolescents). Chi-square tests suggest a statistically significant difference by age (p-value=0.02). Thus, the data also make clear that children were not precluded from mound burial.

Sex estimates were possible for nine individuals. Of these, seven individuals were evaluated by proteomic means, and two by conventional osteological methods. The overall male-to-female ratio is 7:2 (i.e., 78% male and 22% female). This suggests an excess of males; therefore, males were more likely to receive mound burial, a male bias, but the sample size is small. With the expectation that males should be overrepresented, a one-tailed binomial test is significant (p=0.04). However, a two-tailed test where either sex could be overrepresented is not significant (p=0.09). This indicates that the Kaillachuro burial mounds, specifically M4, were primarily reserved for adult males, while nevertheless allowing individuals of either sex to be buried there (Figure 14). For example, Table 4 shows that there are no non-adult females; The sex of two of the three non-adults has been estimated to be male. Despite this, this statement must be refined through additional research and sample expansion to exclude the possibility of statistical vagary.

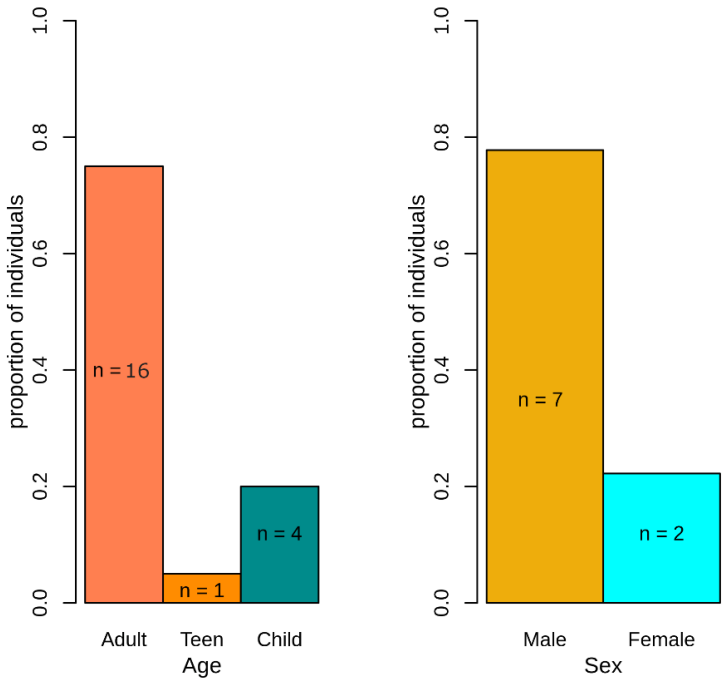


Figure 14. The percentage of individuals who were recovered from Kaillachuro Mound 4. The age-based proportion (n=21) is represented by the bar graph on the left, whereas the sex-based proportion (n=9) displays on the right plot.

Table 4. Osteological information of the burials identified in the mounds M4 and M6 of Kaillachuro.

ID	Context						Osteological data		
	Mound	**Block / Unit**	**Feature**	**# Individual**	**Strata Unit**	**Period**	**Age**	**Age estimated**	**Sex**
1	M4	B3	Burial 1	1	18	Late Archaic	Adult	25-35	Male
2	M4	B3		2	18	Late Archaic	Adult	Indeterminate	Female
3	M4	B3	Burial 2	1	20	Late Archaic	Adult	20-30?	Indeterminate
4	M4	B3		1	7 (surface)	Late Archaic	Indeterminate	Indeterminate	Indeterminate
5	M4	Tr1 (1997)		1	IV/V	Late Archaic	Adult	25-35	Indeterminate
19	M4	U4	Burial 3	1	10	Late Archaic	Adult	Indeterminate	Indeterminate
6	M4	U1	Burial 4	1	4b	Terminal Archaic	Teen	12-15?	Male
7	M4	U1		2	4b	Terminal Archaic	Child	Indeterminate	Indeterminate
8	M4	U1		3	4b	Terminal Archaic	Adult	Indeterminate	Indeterminate
9	M4	U1		1	4a	Terminal Archaic	Adult	Indeterminate	Indeterminate
10	M6	B6		1	9	Terminal Archaic	Indeterminate	Indeterminate	Indeterminate
11	M4	Tr1 (1997)	Stone box	1	V	Terminal Archaic	Child	5-8?	Indeterminate
12	M4	Tr1S (1997)		1	VI clay	Terminal Archaic	Adult	Indeterminate	Male
13	M6?	Tr2	F5	1		Terminal Archaic?	Adult	Indeterminate	Female
14	M4	Tr1S (1997)	B7* R1	1	VII	Terminal Archaic	Adult	Indeterminate	Indeterminate
15	M4	Tr1S (1997)	Quad 1A	1	IX	Terminal Archaic	Child	2.5-4.5	Indeterminate

16	M4	Tr1S (1997)	KCO5	1		Terminal Archaic?	Adult	Indeter-minate	Male
17	M4	B3		1	17	Early Forma-tive?	Indeter-minate	Indeter-minate	Indeter-minate
18	M4	U4	Burial 3	2	10	Early Formative	Adult	18-22?	Male
20	M4	U4		3	10	Early Formative	Adult	Indeter-minate	Indeter-minate
21	M4	U4	Burial 5	1	14	Early Formative	Child	5-8?	Male
22	M4	Tr1 (1997)	B4*	1	I	Early Formative	Adult	25-35	Indeter-minate
23	M4	Tr1 (1997)		2	I	Early Formative	Adult	20-30	Indeter-minate
24	M4	Tr1 (1997)	B5*	1	II	Early Formative	Adult	25-35	Male

* The burials denoted by the letter B were unearthed during the 1997 season.

Statistically, the above assertion has been strengthened by the results of our binomial analysis, given 7 male burials (successes), 9 sexed burials in total (trials), and a given probability of male interment, *p*. The results for *p = 0-100%*, in 10% increments, indicate that there is a male burial bias in one of the possible relationships given our sample (m:f = 90:10) (Figure 15). Although it is extremely unlikely that the empirically observed counts originated from a population in which the proportion is exclusively male. In contrast, we cannot exclude a second possibility, an equal ratio of males to females (50:50). In conclusion, although we cannot exclude the

possibility of a sex-neutral burial practice in the M4 of Kaillachuro, the sum of evidence favors a male-biased burial practice and thus male leadership in any of the models.

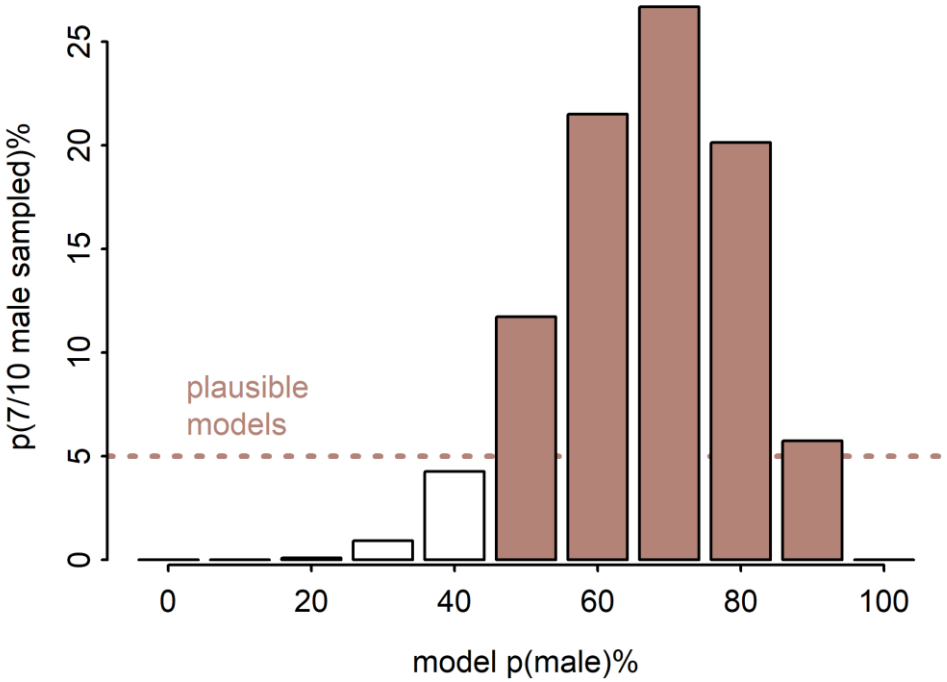


Figure 15. A 50-90% probability of observing 7 males in a random sample of 9 burials given a 0-100% probability that males are buried in Mound 4 at Kaillachuro.

4.3.2. ***Burial treatment***

Burial treatments at Kaillachuro include the placement of obsidian artifacts, beads, red ocher pigment, and non-obsidian chipped tools, as well as the construction of stone boxes. Grave goods were typically few, averaging four artifacts per individual. For instance, we observed two small triangular obsidian and chert projectile points from the ocher fill that covered Burial 5. Above the seal of Burial 5, we observed a secondary and communal burial of at least three adults, one of whom is male (Burial 3), accompanied by obsidian flakes and a stone bead. Another triangular

obsidian point was discovered on the exterior of a stone box, in addition to a significant quantity of obsidian flakes at the base of this feature. Moreover, we observed a fragment of an obsidian projectile point immediately beneath a secondary Burial 3. Meanwhile, funerary architecture was constructed entirely of stone masonry in two structures, which were reserved for children. Overall, Kaillachuro burials exhibit a scarcity of architectural components and notable artifacts such as obsidian, beads, and ocher pigments.

85% of obsidian artifacts are associated with adults, and among those with an estimation for sex, 35% of the obsidian is associated with male adults (Table 5, Figure 16). Red ocher was present among both adults and non-adults. Stone beads were only found with adult burials. While stone funerary structures were built exclusively for children. 67% of the projectile points made of another raw material that is not obsidian are associated with adults, the rest with non-adults. Obsidian, beads, and stone boxes were not associated with female individuals. In summary, quantitative data show that male adults and children were given preferential access to prestige goods.

Table 5. The total number of prestige goods of each type by each type of demographic category (sex and age) of those buried in Kaillachuro. In cases of multiple burials, the total number of artifacts of each type of element has been divided by the number of individuals in the burial, and the result has been rounded. More details in Appendices 3, 5 and 12.

	# individuals (n=17)	Obsidian	Ochre	Bead	Architecture	Non-Obsidian Projectile Point
Adult male	3	8 (35%)	2 (17%)	1 (33%)	0 (0%)	0 (%)
Adult female	2	0 (0%)	1 (8%)	0 (0%)	0 (0%)	0 (0%)
Adult indet	8	12 (50%)	5 (42%)	3 (67%)	0 (0%)	2 (67%)
Subadult	4	4 (15%)	4 (33%)	0 (0%)	2 (100%)	1 (33%)

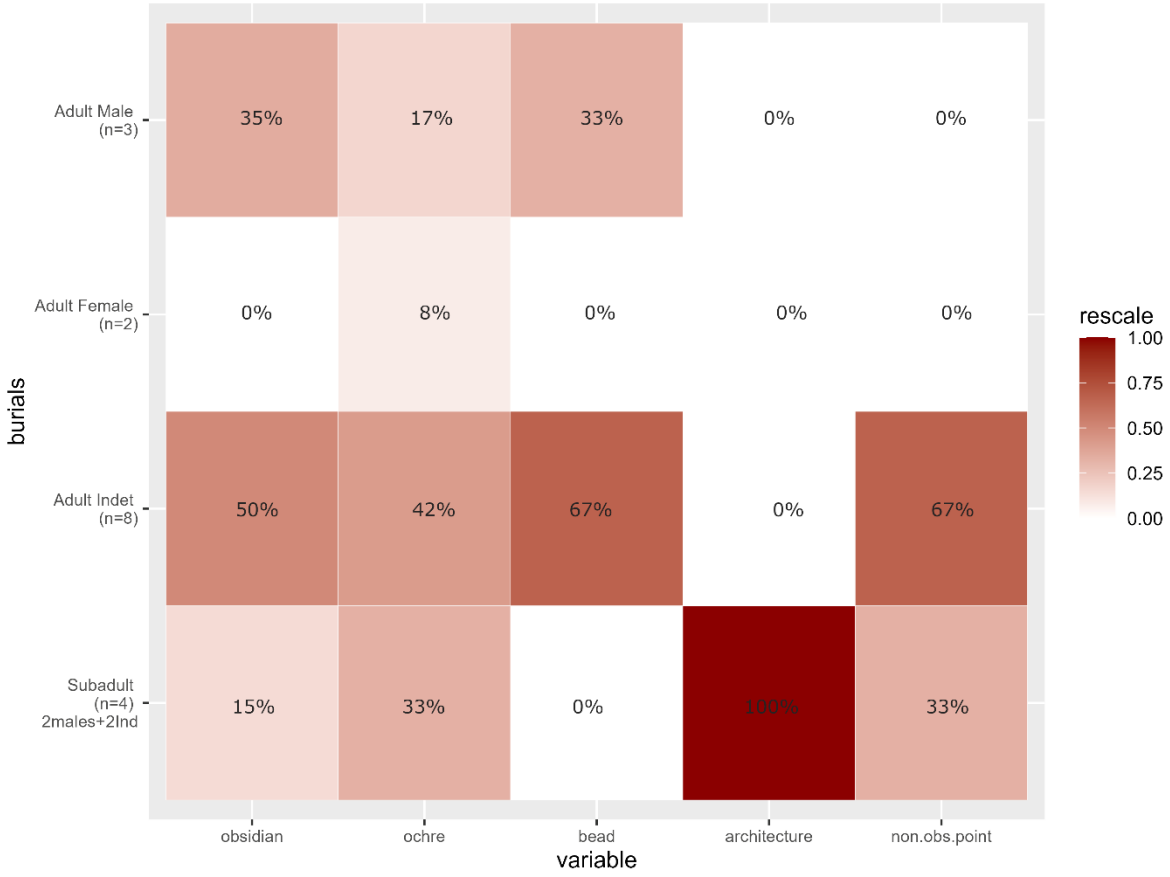


Figure 16. *Quantitative distribution of prestige goods according to the sex and age of 17 buried individuals in Kaillachuro. The decimals in some results are due to the fact that in a few cases there are multiple burials, therefore the number of artifacts has been divided by the number of individuals.*

4.3.3. ***Dietary Assessment***

Our analysis resulted in the isotopic characterization of 17 Kaillachuro samples (Table 6). Overall, the δ13C values exhibit low variation (SD = 0.6‰) around the mean value of -24.2‰, ranging from -22.6‰ to -25.0‰. δ15N exhibits a greater range of variation (mean = 4.4‰; SD = 1.7‰), spanning from 1.5 to 7.1‰. The majority of the individuals (82%) are under 6‰ for δ15N, suggesting that the buried residents of Kaillachuro predominantly consumed plants, with minimal

consumption of meat, including camelids. δ13C values are most consistent with minimal to no consumption of C_4 plants, such as maize and *kiwicha*.

Table 6. Archaeological context and summary of the results of isotopic analysis of samples from the Kaillachuro site (KCO). Corrected isotopic values are shown in the final two columns.

ID		Context					Stable Isotopes data						
#	Lab ID	Site	Mound	Feature / Level	Hard tissue types	Sample type	δ13C$_{VPDB}$ (‰)	Total C (µg)	δ15N$_{Air}$ (‰)	Total N (µg)	C:N	δ13C (5.25)	δ15N (4.5)
1	SIF-1877413	KCO	M4	Burial 1 / 18	Dentin	M3	-19.2	843.6	8.6	309.9	3.2	-24.5	4.1
2	SIF-1877415	KCO	M4		Bone	femur	-19.2	560.3	8.5	202.2	3.2	-24.5	4.0
3	SIF-1895142	KCO	M4	17	Bone	long bone	-19.2	746.4	6.3	275.1	3.2	-24.4	1.8
4	SIF-1877414	KCO	M4	Burial 2 / 20	Bone	femur	-19.1	766.3	8.1	273.5	3.3	-24.4	3.6
5	SIF-1990791	KCO	M4		Dentin	RI1 lower	-18.6	811.6	10.8	285.9	3.3	-23.8	6.3
6	UCI-AMS-278133	KCO	M4	Burial 3 / 10	Bone	tibia	-18.3	42.8	10.4	16.4	3.1	-23.6	5.9
7	UCI-AMS-259861	KCO	M4		Bone	femur	-19.3	40.9	8.6	14.8	3.3	-24.6	4.1
8	SIF-1990787	KCO	M4	Burial 4 / 4b	Dentin	LM2 upper	-18.9	394.9	9.1	140.8	3.3	-24.1	4.6
9	SIF-1990788	KCO	M4	4a	Dentin	RM2 upper	-18.8	625.1	9.2	222.3	3.3	-24.0	4.7
10	SIF-1990792	KCO	M4	Burial 5 / 14	Dentin	RI2 upper	-19.2	515.8	11.6	185.6	3.2	-24.4	7.1
11	SIF-1895185	KCO	M4	7	Bone	bone	-18.9	928.7	9	337.0	3.2	-24.1	4.5
12	SIF-1895159	KCO	M6	9	Bone	long bone	-19.7	307.2	6.9	56.2	6.4	-25.0	2.4

13	SIF-1895130	KCO	M4	B4*	Dentin	RM3	-18.9	284.1	9.6	100.8	3.3	-24.2	5.1
14	SIF-1895156	KCO	M4	IV/V	Dentin	LM3	-17.4	728.1	11.6	269.1	3.2	-22.6	7.1
15	SIF-1990793	KCO	M4	VI clay	Dentin	M3	-18.9	438.5	6.5	154.2	3.3	-24.2	2.0
16	SIF-1990789	KCO	M4	B7* R1 / VII	Dentin	M3	-19.6	240.7	6.0	80.9	3.5	-24.8	1.5
17	SIF-1895136	KCO	M4	KCO 5	Dentin	M3	-18.2	705.98	9.9	261.9	3.1	-23.5	5.4

* The burials denoted by the letter B were unearthed during the 1997 season.

Moreover, our analysis reveals comparable and low δ13C in both adults and non-adults, with a mean ranging between -24.0‰ and -24.3‰ (Table 7). On the other hand, there is some differentiation in δ15N values between adult males and non-adult males. However, the means of these differences (4.6‰ and 5.9‰) do not reach statistical significance (p-value=0.7). This specific isotopic differentiation may be due to the inclusion of a child between 5 and 8 years (Burial 3) whose δ15N (5.9‰) is well above average (Table 6), possibly as a result of delayed weaning, a phenomenon previously identified in archaeological and ethnographic data in the region (De La Rosa-Martinez et al., 2023; Vitzthum, 1992).

The isotopic metrics of a single female (Burial 1) fall within the range of values observed in males (Tables 6 and 7). In summary, these values do not identify sex-based dietary differences, but the small sample is small for females.

While these data are limited, low values, constrained variation, and a lack of internal differentiation are most consistent with the egalitarian model of emergent complexity.

Table 7. Sex and age-categorized statistical summary of the corrected carbon and nitrogen isotope values of human samples from Kaillachuro (n=17).

	n	δ13C ‰				δ15N ‰			
		min	max	mean	std	min	max	mean	std
Adult male	4	-24.5	-23.5	-24.0	0.4	2.0	6.3	4.5	1.9
Adult female	1		-24.5				4.0		
Adult Ind	7	-24.8	-22.6	-24.0	0.7	1.5	7.1	4.6	1.8
Non-adult male	2	-24.4	-24.1	-24.3	0.2	4.6	7.1	5.9	1.8
Isolated bones	3	-25.0	-24.1	-24.5	0.5	1.8	4.5	2.9	1.4

4.3.4. ***Mound sites vs. Non-mound sites***

The individuals interred at locations lacking mounds, such as Jiskairumoko and Muruqullu, exhibit both similarities and differences when compared to those at Kaillachuro. According to Juengst et al. (2017: 435–436), the majority of people, with sex estimation, buried at Muruqullu were men (male=7, female=2). Conversely, despite the relatively small sample size of burials at Jiskairumoko (n=5), all individuals with sex estimates are female (n=2). Significantly, some of those interred at Jiskairumoko were older adult females (Craig, 2005; Watson, 2014).

Grave goods in Jiskairumoko do not show significant variation from those found at Kaillachuro (Figure 17). Two burials are notable for containing most of the prestigious items in Jiskairumoko. Burial 1 is a Late Archaic burial that includes one adult female containing four lapis stone beads and one ground stone. Additionally, a small camelid-shaped effigy was found on a higher level inside the burial pit. Burial 2 dates to the Terminal Archaic Period, including three individuals: one adult found stratigraphically in the lower level, and two subadults in the upper context. That adult is the one associated with nine gold beads, eleven circular greenstone beads, and one ground stone. Additionally, unlike Kaillachuro, the Jiskairumoko burials were found with

ground stone tools (Table 8), and only two of the burials—Burials 3 and 5—used red pigment, while none of the burials were found directly associated with some type of projectile point (Aldenderfer et al., 2008; Craig, 2005).

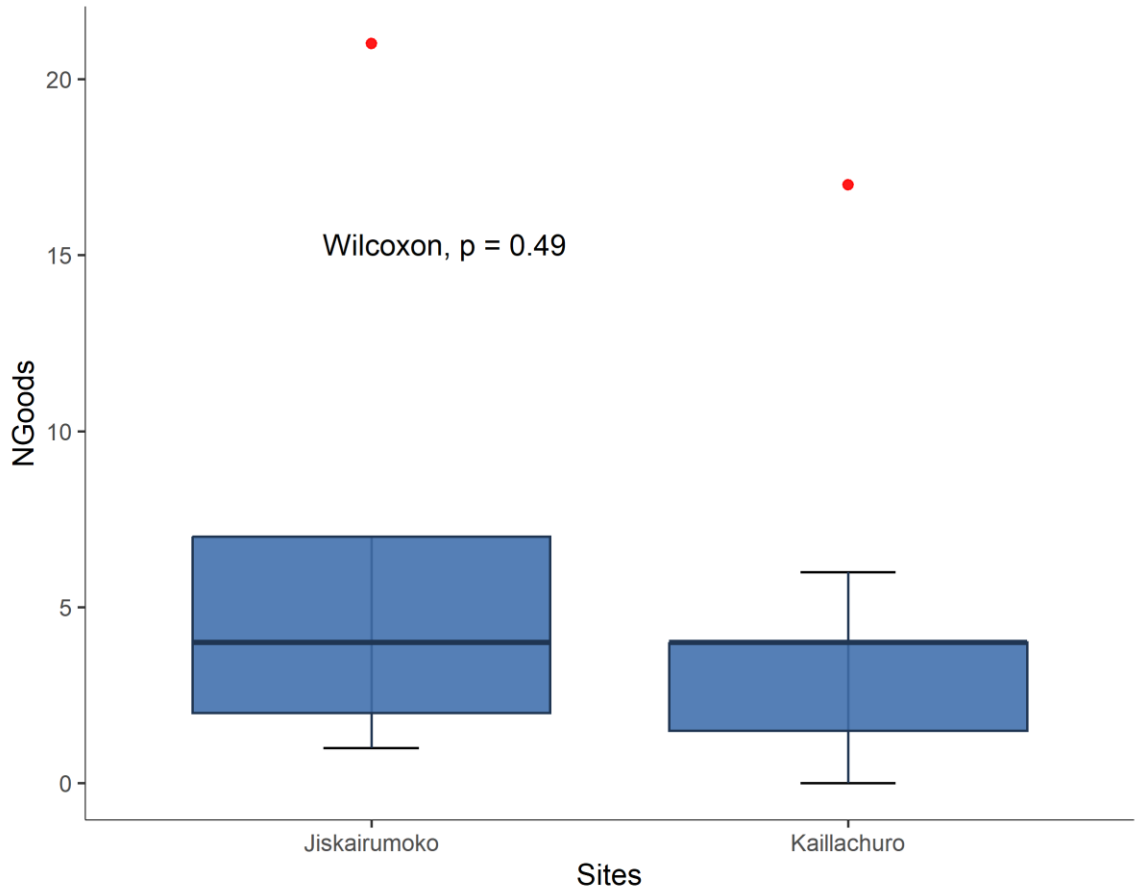


Figure 17. Biplot of the quantity of grave goods per individual from Jiskairumoko (a non-mound site) vs. Kaillachuro (a mound site). The p-value of these two groups is reported (p=0.64) and shows no disparity.

Table 8. The total count of prestige goods from every demographic category (age and sex), among the interred at Jiskairumoko (Aldenderfer, 2004; Aldenderfer et al., 2008; Craig, 2005). (See Appendix 4).

	# individuals	Obsidian	Ochre	Stone Bead	Metal Bead	Architecture	Non-Obsidian Point	Groundstone
Adult indet	2	0 (0%)	0 (0%)	11 (73%)	9 (100%)	0 (0%)	0 (0%)	5 (71%)
Adult female	2	2 (100%)	1 (50%)	4 (27%)	0 (0%)	0 (0%)	0 (0%)	2 (29%)
Indet	1	0 (0%)	1 (50%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Non-adult	2	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Regarding the ancient diet, isotopic values at Kaillachuro are similar to δ13C and δ15N values from other sites (Table 8, Figure 18). The mean δ13C value for both periods of Kaillachuro is like the mean at Jiskairumoko and somewhat lower than Chiripa and Murukullu, but without this being statistically significant. Chiripa (7.0‰) and Murukullu (6.9‰) exhibit the highest mean δ15N values, while the isotope values of Kaillachuro (4‰ and 5.1‰) are almost similar to the Jiskarumoko (5.3‰) values. The majority of data points from Muruqullu overlap with the isotopic values of Kaillachuro; however, there are two atypical values of δ15N (Figure 18, Table 9). However, these results also fall within the intersection of C3 plant-based foods and camelid meat during the Terminal Archaic Period.

Table 9. Statistical summary of corrected carbon and nitrogen isotope values of human samples from mounded and non-mounded sites.

Site type	Site	Period	n	δ 13 C ‰				δ 15 N ‰				References
				min	max	mean	std	min	max	mean	std	
Mound site	Kaillachuro	LA/TA	11	-25.0	-22.7	-24.2	0.6	1.5	7.1	4.0	1.6	Flores-Blanco (see Appendix 6)
		EF	6	-24.6	-23.6	-24.2	0.4	1.8	7.1	5.1	1.9	
Non-mound sites	Jis-kairumoko	LA/TA	4	-24.6	-23.0	-23.8	0.7	4.1	6.8	5.3	1.3	Flores-Blanco (see Appendix 6)
	Muruqullu*	TA	5	-23.9	-20.5	-22.1	1.5	6.3	7.6	6.9	0.6	Juengst et al. (2021: Table 5)
	Chiripa**	EF	8	-24.3	-22.8	-23.6	0.5	5.9	8.3	7.0	0.8	Miller et al. (2021: Dataset_S01)

LA = Late Archaic, TA= Terminal Archaic, EF = Early Formative

* We only gathered the samples dated as Preceramic.

** The human remains samples of Chiripa mostly come from burials associated with domestic features that date back to the Early Chiripa phase (Early Formative I), the village occupancy at the site (Hastorf, 2003, 2008).

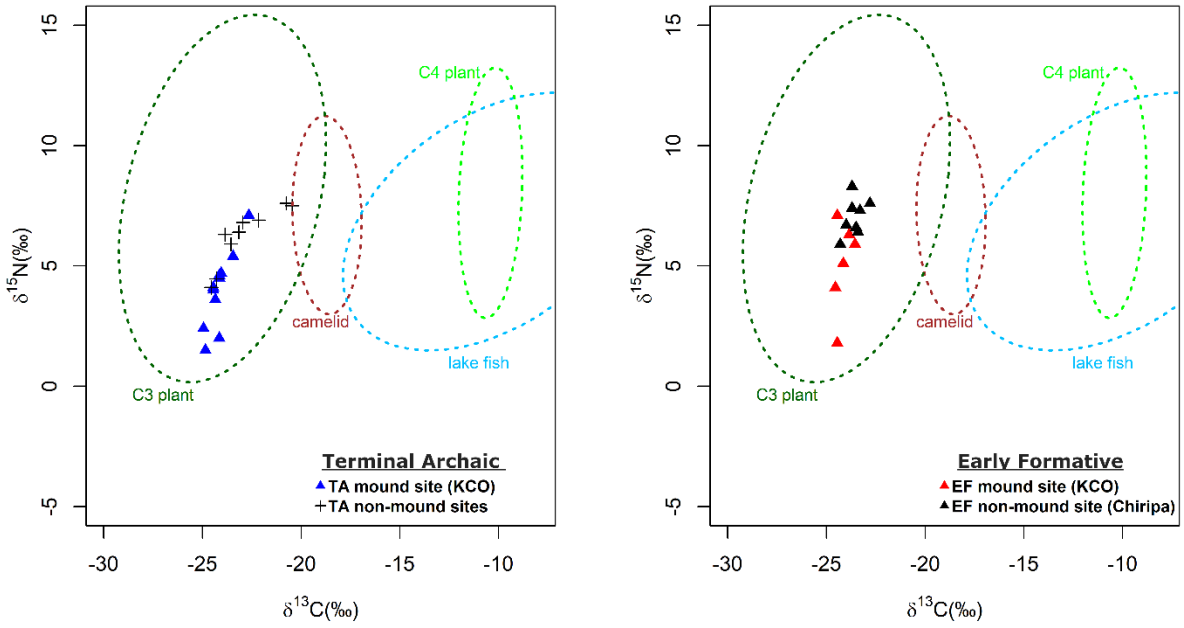


Figure 18. Scatter plot of δ15N and δ13C values of human collagen from mound sites such as Kaillachuro and Chiripa (blue and black triangles) and non-mound sites such as Jiskairumoko, Pirco, and Muruqullu (black crosses) during the Terminal Archaic (TA) and Early Formative (EF) periods in the Titicaca Basin. All values are adjusted. Foodweb developed using both proprietary (Appendix 7) and published data (Berryman 2010; DeNiro, 1988; Miller et al., 2021; Pezo-Lanfranco, et al., 2024; Whittemore et al., 2023).

4.4. **Discussion**

The main objective of this study was to characterize individuals buried in the Kaillachuro mounds and subsequently evaluate the nature and degree of status during the Terminal Archaic and Early Formative Periods in the Titicaca Basin. One of the possibilities we anticipated discovering in these early Titicaca burial mounds was the presence of powerful individuals with abundant, costly items. The association of wealthy burials and monumental architecture has been reported at several sites in the Andes during the Early Formative Period, such as Cardal, Galgada, and Tulan-54, and more clearly later, in Kuntur Wasi and Pacopampa (Burger, 2008; Grieder et al., 1988; L. Núñez et al., 2017; Onuki, 1997; Seki et al., 2023). However, the Kaillachuro burials yielded modest

grave goods assemblages that included beads, red pigment, obsidian projectile points, and a few other objects.

Another way we evaluated inequality was to determine whether there is a substantial difference in the presence and abundance of funerary goods identified at Kaillachuro in comparison to other non-mound sites. Due to the paucity of publications on mortuary contexts in non-mound sites contemporary with Kaillachuro in the Titicaca region, this was more difficult to determine. Our comparative analysis was therefore mostly limited to the nearby site of Jiskairumoko, a village site without mounds. At least two of the five Jiskairumoko burials are female and show a wealth of assets compared to the other three individuals of indeterminate sex. At the same time, the number of costly items displayed in Jiskairumoko is still quite limited in quantity (Aldenderfer, 2004: 29). Comparable data has been documented at the Early Formative site of Chiripa, located on the Taraco Peninsula near Lake Titicaca. Researchers there identified six funerary graves from the Early Chiripa phase. However, sex estimates are only available for two individuals, both females, accompanied by the incomplete remains of other individuals, some non-adults, and grave goods such as beads, ceramics, ground stones, and bone tools (Hastorf, 2003: 315-316). This indicates that individuals buried in Kaillachuro mounds did not receive special funerary objects compared to other contemporary communities. The Kaillachuro grave-good assemblage thus favors an egalitarian model of emergent social complexity.

An intriguing contrast can be observed a burial was discovered in the Huachichocana-III cave in northeastern Argentina. This burial, dating 3600 cal BP, is an adult male buried with more than 50 artifacts, such as various types of necklaces, wood carvings, stone and bone instruments, engraved walking sticks, basketry, turtle shells, and atlatl, among other items. Scholars hypothesize

this person was a shaman (Fernández Distel, 1986). To our knowledge, this is the sole documented instance of a preceramic leader buried with large amounts of wealth in the South-Central Andes.

We next assessed the extent to which the Kaillachuro mound burials privileged certain subsets of society. Most of the individuals encountered at Kaillachuro were male (78%), both adults and children, who tended to receive more grave goods. For instance, ornaments like beads, though limited, were exclusively found with male adults. Likewise, funeral architecture in the form of large-stone boxes was only constructed for the purpose of interring children.

Exotic goods, including potentially costly items like obsidian, were differentially associated with adults, whereas only a small number of such items were found with non-adult burials. It is important to note that within this nucleus, the interment of females was uncommon, and when present, these lack associated artifacts or placement within funerary structures. Instead, female remains were often scattered as loose bones among grave fills. Other mortuary attributes were less exclusive, such as the red ocher pigment, which was equally present in the burials of adults and children of both sexes. We suggest that the more exclusive traits likely serve as indicators of status, although they may also function as signs of identity. The elements widely shared by the majority, such as using red pigment covering, are more likely the byproducts of burial ritual behaviors. The evidence marginally favors a model of male-biased prestige at Kaillachuro. In contrast, in other contemporary non-mound sites (small villages), such as Jiskairumoko and Early Chiripa, a distinct situation arose where costly goods were found alongside the buried females.

The dedication to constructing funerary architecture for the interred children is intriguing in Kaillachuro, and a comparable drive is evident in the burial practices of non-adults in other localities within the Andean region. In Tulan-54, situated in the Atacama Desert of Chile, scholars

documented 27 infant burials within the Early Formative ceremonial edifice. Individuals were interred with exceptionally costly necklaces and various objects produced from materials such as gold, copper, shell, obsidian, and more. In contrast, Tulan-54 adult burials from outside the structure lack prestige items (L. Núñez et al., 2017, 2019). The emphasis on infant burial in Tulán-54 has been associated with foundational ritual acts, as Núñez et al. (2017: 912) indicate, "*infants acting as intermediaries of the Andean pantheon.*"

The aforementioned evidence from the Tulan-54 site, as well as findings at Kaillachuro and other sites mentioned in this paper, could provide evidence for the regional evolution of ascribed status. In chiefdom and state-level societies, children typically inherit positions of status through their parents (Hayden, 1995). Archaeologists hypothesize that such status is expressed in mortuary treatment, for example, through interment with valuable or costly items. However, it's not always like this. It is important to note that possessing valuable items isn't always a sign of affiliation with an elite social group. Ethnographic data from the Amazon region shows that ornaments may function as a means to express an individual's personality, identity, well-being, and essence. In fact, the children of Wanairisu in Amazonia often adorn themselves with an abundance of necklaces as a form of spiritual protection (J. Miller, 2009). The belief that children should adorn themselves with necklaces or bracelets, such as those crafted from red *huayruro* seeds (*Ormosia sp.*), as a protective measure against malignant entities is, in fact, a prevalent custom in the Peruvian Amazon that has spread extensively throughout the Andean region (Gow & Margiotti, 2012). This is in line with findings from archaeological evidence around the world, for example, among Mesolithic societies, which show that some children in societies devoid of powerful rulers were interred beside valuable possessions (Gravel-Miguel et al., 2023; Hodgkins et al., 2021).

In light of this discussion, it becomes challenging to determine whether the presence of children in ancient burial practices signifies the existence of an ascribed status or is a cultural manifestation of other beliefs about death. Regarding Kaillachuro, the available data indicates the absence of buried persons with power, but males seem to have been elevated in social status relative to females, at least in the ceremonial scenario. Consequently, it is improbable that their offspring were interred there due to their inherited social position. However, males seem to possess a higher level of social hierarchy compared to females. Hence, it is plausible that the immense dedication demanded of a prestigious leader motivates followers to perform an unconventional burial of their offspring as a form of compensation. Perhaps this path finally led to society beginning to give more importance to the male lineage, so the deaths of children could have generated social stress due to the interruption of the prestigious leader lineage's continuity. This is consistent with Núñez's argument for Tulan 54 and the role those infant burials played.

If these potential leaders at Kaillachuro did not have the power to accumulate wealth, they also did not have the power to access privileged foods with regularity (i.e., enough to manifest as differences in stable isotope signatures). The characterization of the diet of the highland inhabitants during the Terminal Archaic and Early Formative Periods has been significantly advanced in recent years from isotopic analysis, which has been a great help in our comparative study with Kaillachuro (Capriles et al., 2021; Juengst et al., 2021; M. Miller et al., 2021; Whittemore et al., 2023). The median $\delta^{13}C$ and $\delta^{15}N$ values indicate that the inhabitants of Kaillachuro primarily consumed C3 plants, while camelid meat was scarce. Importantly, our comparative analysis of Kaillachuro and other contemporary sites does not reveal a privileged diet, as might be expected given the various leadership models under consideration. In the earliest phase of Chiripa, another site in the Titicaca Basin during the Early Formative Period I, there are no individuals that stand

out isotopically above the rest. Jiskairumoko and Muruqullu, which lack mounds, exhibit a dietary pattern remarkably similar to that of Kaillachuro throughout the Terminal Archaic Period. Even though the diets of two individuals who were recovered in Muruqullu suggest a degree of variation in meat consumption, this does not negate the likelihood of a substantial consumption of C3 plants.

The findings in Kaillachuro are consistent with an absence of wealthy individuals, a scarcity of grave goods, and a lack of people with distinctive dietary patterns compared to the rest of the population. Therefore, results do not provide evidence to support the existence of powerful leaders of the *Big Man* type, much less a *Chief*, in Kaillachuro, as classic neo-evolutionary models have characterized. But there is also no empirical evidence to substantiate the notion that the Kaillachuro mounds functioned as a cemetery for the whole population. The results of our study indicate a specific selection process, mostly driven by the limited number of individuals interred, as well as a noticeable gender imbalance where women are not proportionally represented. Hence, this confluence of features aligns well with the model that predicted the interment of respected and renowned individuals within society, such as *headmen*, coordinators (as coordinating a religious celebration or *cargo*), or experts of a socially recognized activity. As such, the findings indicate that Kaillachuro was characterized by an egalitarian society with a low-level male-dominated social hierarchy. This conclusion is in line with a cross-cultural evaluation of leadership traits from different ethnographic small-scale societies around the world, which indicates that the majority of leaders are men, and only 2.5% women reach a leadership position, and when occasionally achieved, it is mostly linked to leadership at the residential level, not intercommunal (Garfield et al., 2020).

Results also inform on the relationship between hierarchy, the centralization of power, and the emergence of monumental architecture. While the Kaillachuro mounds may not be the most

iconic instance of massive architecture in the area due to their relatively small size, they serve as an interesting example of early ceremonial architecture. These first mounded forms were designed to accommodate leaders who possessed prestige but lacked power. These leaders likely served as role models for their followers to the extent that they were interred in special locations. As a result, Kaillachuro became a place dedicated to memorializing their deceased, but it was not the initiative of individual entrepreneurs, as a *Big Man*, but rather the emergence of social institutions (Henrich et al., 2010; Wiessner, 2002). We still need to have a more comprehensive understanding of whether this was the seed that planted future institutionalized inequality.

Through the examination of various lines of evidence—including demography, the presence/absence and quantity of grave goods, and a direct evaluation of the diet of individuals interred in some of the earliest documented formal burial structures in the Andes—our findings pave the way for a novel and fascinating avenue of inquiry into the evolution of inequality and the nature of associated leadership. Future research should expand on this in several ways.

First, we suggest that Kaillachuro had situational and prestigious male leaders at the head of a low-level hierarchy of an otherwise egalitarian society. This appears to be held at other contemporary sites in the Titicaca Basin, but with such a small number of sites, additional research at other Terminal Archaic and Early Formative settlements is badly needed. Additionally, archaeologists studying the region should continue searching for evidence of inequality and powerful leaders from multiple lines of evidence, especially from the subsequent Middle or Upper Formative Periods.

Second, we ought to reassess some puzzling and contrasting patterns, such as males at Kaillachuro and females at Jiskairumoko, being interred alongside costly objects. The same discrepancy seems to hold in our comparison of Kaillachuro and the Early Chiripa phase burials,

where most of the individuals buried with grave goods are also female (though only two of five have sex estimates). It is unknown whether this discrepancy results from a temporal difference or from the practice of interring men in public and women in private places. This is in line with much of the Andean ethnographic data from certain communities indicate that traditionally, men have held positions of authority and participated in public life, whereas women are responsible for decision-making but within the house; therefore, women are the power behind the public exposure male (Allen, 2012). Sex inequality has also been observed among the Enga people of New Guinea, where women are confined to the private sphere due to the belief that they bring "contamination." Although this restriction limits their presence in the public sphere, it does not limit their influence on male decision-making (Wiessner, 2002). Another potential explanation is that the Terminal Archaic/Early Formative Periods are characterized by a varied political landscape, wherein certain communities create social structures favoring male access to the special places, as observed in Kaillachuro, while others, such as Jiskairumoko and Early Chiripa occupation, have established a social order that favors females or is devoid of sex bias.

Third, archaeologists investigating the region should continue to inquire about the impact of socioeconomic transformations, such as the appearance of the first cultigens, early ceremonial architecture, the establishment of exchange networks, population concentration, and advancements in weaponry technologies, on the development of distinct sex roles. A diversified scenario has been presented, illustrating a male bias within the Kaillachuro hierarchy as well as contrasting scenarios observed in other settlements throughout the Titicaca Basin.

4.5. **Conclusions**

We conclude that the individuals interred in the Kaillachuro mounds were part of an egalitarian society, they were not elite members of communities. That is, they were not leaders who amassed

considerable wealth. In contrast, our analysis suggests the Kaillachuro mounds served as the last resting place for certain outstanding figures in its community, mostly males. Despite not being a cemetery accessible to all members of the community at large, Kaillachuro likely accommodated prestigious leaders who successfully spearheaded the establishment, progress, and sustenance of novel religious, economic, and technological developments that were advantageous to the people in the community. Put simply, individuals who distinguished themselves through their expertise in symbolic matters, including skill in knapping and the creation of novel weapons like the bow and arrow, successful traders of exotic products like obsidian, or pioneers in camelid care and plant cultivation, were more likely to be buried in mounds. Inhabitants of Kaillachuro may have desired to endow the burial location with symbolism by burying children there as well, an act for which they constructed stone masonry structures.

This form of leadership in Kaillachuro, characterized by a preference for males, symbolic gestures, and an absence of power, originated in the context of an egalitarian society that built early ceremonial architecture. Thus, the findings of Kaillachuro and the contemporary societies examined in this paper invite us to rethink the role of ancient women and men in the Titicaca region. For at least five thousand years, the development of a rigid sexual division of labor—males in the ceremonial sphere and females in the private sphere—was already underway, although this change did not immediately lead to institutionalized social inequality.

CRediT authorship contribution statement.

L. Flores-Blanco: Conceptualization, Methodology, Isotope analysis, Field research, Writing – original draft, Review & editing, Funding acquisition. **M. Aldenderfer**: Field research, Review & editing. **J. Watson**: Osteological analysis. **G. Irureta**: Osteological analysis. **D. Malarchik**:

Proteomic analysis. **J. Eerkens**: Laboratory analysis, Review & editing. **R. Haas**: Conceptualization, Review & editing.

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Chapter 5. DID ARCHERY TECHNOLOGY PRECIPITATE COMPLEXITY IN THE TITICACA BASIN? A METRIC ANALYSIS OF PROJECTILE POINTS, 11-1 ka

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Authors: Luis Flores-Blanco, Lucero Cuellar, Mark Aldenderfer, Charles Stanish, Randall Haas

Abstract

The extent to which archery technology affected social organization in the Andes region of South America remains understudied. To identify the timing and consequences of archery technology in the Lake Titicaca Basin, this analysis examines metric data from 1179 projectile points from the region, 11–1.0 cal. ka. We find that the greatest decrease in projectile point size occurred across the Late/Terminal Archaic and Formative/Tiwanaku period boundaries, 5.0 and 1.5 cal. ka, respectively. We do not find a statistically significant decrease in size during any other transition, including the Terminal Archaic/Formative boundary, which was previously hypothesized to have been the time when archery technology first appeared in the region. These results instead favor the hypothesis that archery technology first entered the region during the Terminal Archaic Period, 5.0–3.5 cal ka. We furthermore observe that this technological transition coincided with the growth of settlements, a surge in the use of exotic goods such as obsidian, a low level of inter-group violence, and incipient agropastoralism—a pattern that intensified during the subsequent Formative period when monumental ceremonial centers emerged. These findings lead us to propose a model for South American archery technology in which its appearance after 5000 years ago contributed to the emergence of new cooperative dynamics that expanded regional exchange networks and community aggregation.

Keywords: Bow and arrow, Archery, Projectile point, Andes, Complexity

5.1. **Introduction**

The introduction of archery technology in the Americas and its effects on social dynamics have generated considerable scholarly debate, especially in North America (Ames et al., 2010; Bettinger, 2013, 2015; Bettinger & Eerkens, 1999; Bingham et al., 2013; Blitz, 1988; Blitz & Porth, 2013; Justice, 2002; Kennett et al., 2013; Marsh et al., 2023; Milner et al., 2013; Vanpool & O'Brien, 2013; Yohe, 1998). The range of perspectives is encapsulated in a 2013 special issue of Evolutionary Anthropology, "Social Complexity and the Bow in the Prehistoric North American Record", which covers eight case studies (Bingham et al., 2013). We identify three general models among the papers, which we refer to as the orderly anarchy, social coercion, and warfare models.

In the orderly anarchy model articulated by Bettinger (2013, 2015), the adoption of archery technology spurred economic autonomy and social fragmentation. In this view, the bow-and-arrow offers greater accuracy than the hand-held spear or the spear-thrower (atlatl), thus expanding the range of animals that could be reliably hunted to include small, fast prey such as lagomorphs and rodents (Blitz, 1988; Hughes, 1998; Tomka, 2013; Whittaker & Kamp, 2006). This enhanced economic opportunity for individuals would have, in turn, reduced the need to share meat and other subsistence resources. This is because expanded diets would have shortened the time between kills, making individuals less dependent on sharing to fill periods of shortfall.

Moreover, the deadliness of archery technology would have enhanced individual capacity to defend resource surpluses, increasing the cost of theft and reducing demand sharing. Not only would such dynamics have reduced meat sharing, but also would have incentivized the collection and storage of plant foods. Bettinger refers to this model as "orderly anarchy" and describes it as "a system without formal authority" and "situational cooperation" (Bettinger, 2013, 2015; Bettinger et al., 2015). This model anticipates a correlation between the arrival of archery

technology and a shift towards a scattered settlement pattern with smaller sites, increasing dietary input from small mammals and plants, and "much more geographically restricted" and uneven access to exotic goods (Bettinger, 2015: 48; Eerkens & Spurling, 2008).

In the social coercion model, Bingham and Souza indicate that the introduction of archery resulted in a greater scale of human cooperation between neighboring non-kin groups via something of a social policing mechanism. In this view, archery technology enabled the enforcement of cooperative norms and reduced "social parasitism" (Bingham et al., 2013: 85). Thus, like Bettinger, Bingham and Souza see the bow-and-arrow as a means of resource defense. However, their model adds a layer of complexity by arguing that such defense resolved conflicts of interest among non-kin groups, which fostered cohesion rather than autonomy. This model anticipates that nucleated settlement patterns, increased sedentism, settlement fusion, the emergence of civic-ceremonial centers, and widespread access to long-distance exchange goods followed the emergence of archery technology. A number of scholars find support for the coercive model across most of the regional case studies in the United States, with the exception of California (Blitz & Porth, 2013; Kennett et al., 2013; Reed & Geib, 2013).

The final model considered here is the warfare model, which considers that archery technology offered a competitive advantage in armed conflicts, driving social coalitions that not only allowed groups to defend resource stores but also to raid neighboring groups, expand control over them, and intensify the production and/or exchange of goods (e.g., Billman et al., 2000; Lambert, 2002). Given this model, archaeologists should be able to recognize significant increases in osteological evidence of interpersonal violence, population concentration at large fortified sites, and occasional evidence of settlement destruction. Competition and control of resources could either expand or limit access to exotic goods. Although several of the Evolutionary Anthropology

papers explore this model, none find clear support for it (e.g., Blitz and Porth, 2013; Reed and Geib, 2013). However, Reed and Geib (2013) and Kennett et al. (2013) observe that although archery did not affect warfare immediately, violence rates eventually increased. Kennett et al. (2013) view this as evidence of a two-stage process in which archery first catalyzed social coercion via "law enforcement" and, subsequently, the combination of archery and social coercion catalyzed warfare. In contrast to all the above models, Milner et al. (2013) suggest that archery technology has a negligible effect on social systems relative to broader economic processes.

The intensive research on the origins of archery technology and its social consequences in North America reveals various socioeconomic outcomes and a set of competing hypotheses that can be evaluated against archaeological observations in other regions. Here, we confront these models with a case study in the South-Central Andes highlands of South America. In the Andes, projectile technology has generally been associated with egalitarian hunter-gatherer societies, and its role in social dynamics has been overlooked, unlike other technologies such as early pottery and architecture (Klink & Aldenderfer, 2005). Projectile technologies are among the oldest and most persistent technologies in the Andes, where various weapon systems (e.g., spear, atlatl, bow and arrow, and sling) were used in various combinations throughout Andean prehistory (Castro et al., 2018, 2021; Castro & Marsh, 2022; Chamussy, 2012, 2014; De Souza, 2004, 2011; Kitchel et al., 2022; A. L. Núñez, 1963; Oliszewski et al., 2018; Owen, 1998; Uhle, 1907).

A central archaeological problem toward understanding the social consequences of archery technology in the South-Central Andes is identifying the age of the technology in the region. Max Uhle (1917: 156) was the first to propose an introduction period for the bow and arrow. Based on several possible bow fragments from Chinchorro contexts (Uhle, 1917, 1922, 1974), small triangular points with concave bases (Uhle, 1922: Fig. 8, b), and small stemmed forms (Uhle, 1922:

Fig. 8, a and c), all of which are associated with preceramic contexts, he proposed an Archaic origin. This evidence has subsequently been used to propose an early, possibly Archaic Period (before 3.5 cal. ka.) introduction of this technology (Bittmann & Munizaga, 1979). Although direct evidence of wooden bows from preceramic contexts was reported from the Chinchorro Morro 1 site on Chile's north coast and the Huachichocana-III cave in northwestern Argentina's puna (Fernández Distel, 1986; Standen, 2003), the lack of direct dates and doubts about the identification of the artifacts prevent conclusive temporal and technological assignments (Fernández Distel, 1986; Focacci, 1974; Llagostera M, 2003; Owen, 1998; Rivera, 1975; Standen, 2003). Thus, the Archaic origin hypothesis was unconfirmed.

The most reliable direct evidence of archery technology has been recovered from Formative (3.5–1.5 cal. ka) and later period sites in northern Chile (Bird, 1943; Focacci, 1974; Latcham, 1928; Muñoz et al., 1991; Rivera, 1975). The clearest examples are found in Arica, where at least three wooden bows and several arrows have been discovered in grave assemblages with Formative Period mummies at the Playa Miller 7 site (Focacci, 1974). Muñoz et al. (1991:10) similarly reported the finding of a wood bow at Camarones 15, an Early Formative Period cemetery. This artifact still had the remains of an attached string made of animal hair and a direct association with arrows, which solidified its identification as a bow.

While the apparent absence of direct evidence for Archaic Period archery technology would seem to indicate a Formative Period origin, it is not yet possible to rule out an Archaic Period origin. The ubiquity of Archaic projectile points (e.g., Klink and Aldenderfer, 2005), depictions of different types of weapons in rock art (Hostnig, 2003), and the find of 4000-year-old atlatls from a single site in the neighboring Argentine puna (Fernández Distel, 1986) demonstrate that projectile weapon systems existed in the South-Central Andean Archaic. However, preservation

biases ensure small sample sizes of perishable artifacts and thus little chance of finding direct evidence of wooden bows or atlatls from the Archaic Period, thus creating a high potential for false negatives. Lacking a sufficient sample of perishable bows and atlatls, archaeologists must rely on indirect evidence gained from the non-perishable component of projectile weapon systems: projectile points.

Andean archaeologists have relied primarily on lithic analysis, including both quantitative and qualitative approaches, to distinguish dart points from arrowheads (Ávalos, 2015; Castro et al., 2018, 2021; Castro & Marsh, 2022; De Souza, 2004, 2011; Hocsman, 2010; Kitchel et al., 2022). Such analyses have suggested the possibility of an early adoption of archery technology during the Terminal Archaic Period somewhere in the northern portion of the South-Central Andes. Like Uhle, Klink and Aldenderfer (2005: 52) noted that 5D-type points, which are small and triangular, appear to be arrow-sized and first occurred in the Terminal Archaic Period, 5.0–3.5 cal. ka. Kitchel et al. (2022) observed a large decrease in projectile point size from two well-dated Titicaca Basin sites, Soro Mik'aya Patjxa and Jiskairumoko, which span the Late-Terminal Archaic boundary, thus supporting Klink and Aldenderfer's (2005) proposal. For instance, at Jiskairumoko, small triangular projectile points have been reported in the Pithouse 1 levels and in Burial 1, with radiocarbon dates of 5.3–4.9 and 4.7–4.6 cal ka, respectively. At Kaillachuro, one of these points was recovered outside a stone box dated to 4.4–4.2 cal ka (Aldenderfer, 2004; Craig, 2005). In the rock shelter of Hakenasa, in the highlands of northern Chile near the Titicaca Basin, miniatures of the 5D points appear for the first time in level 7 dated between 6.0 and 5.7 cal ka, becoming most prevalent in levels 5 and 6 (40% of the points) dated to 5.0-4.0 cal ka (LeFebvre, 2004). This same type of point (typed as S3T6) is reported from the Late-Middle Holocene levels of the Cuncaicha

site (>5.0 ka), but is more popular from the Late Holocene levels (<4.0 ka), especially associated with ceramics (Panczak, 2019: 120).

In the southern Andes, scholars have similarly observed a significant decrease in projectile point size but during the Formative Period, which has led to the conclusion of a Formative Period adoption of this technology in those regions as it spread from the north to south in the South-Central Andes (Ávalos, 2015; Capriles et al., 2011; Castro et al., 2018, 2021; De Souza, 2004, 2011; Hocsman, 2010; L. Núñez, Cartajena, Carrasco, De Souza, et al., 2006; Oliszewski et al., 2018; Santoro, 1989). In sum, the timing of the appearance of archery technology in the South-Central Andes remains unclear, with direct evidence suggesting a Formative Period (3.5–1.5 cal ka.) origin and indirect evidence suggesting a Terminal Archaic (5.0–3.5 cal ka.) origin.

In this analysis, we evaluate the timing of adoption of bow and arrow technology in the Titicaca Basin (Fig. 19) and its relationship with complexity and other social changes. Previous studies in the region have been limited to evaluating direct evidence from bow and arrow contexts (Marsh et al., 2023; Owen, 1998) or semi-quantitative approaches to projectile point size variation (Klink and Aldenderfer, 2005). The few systematic metric analyses are based on limited time frames or a few sites (Ávalos, 2015; Castro et al., 2018; Castro and Marsh, 2022; De Souza, 2004, 2011; Hocsman, 2010; Kitchel et al., 2022). The current study is thus the first diachronic quantitative analysis that considers the complete record (ca. 10,000 years) of projectile point technology using a large dataset recovered by multiple investigators. We suggest that the timing of the introduction of archery technology should be recognizable as a dramatic, statistically significant drop in projectile point size at some point in time. If archery technology first entered the region during the Formative Period, as conservative estimates suggest, then we should observe a sharp decrease in average projectile point size between the Terminal Archaic and Formative

periods around 3.5 cal ka. Alternatively, if archery technology entered the region earlier, as other scholars have proposed, we would expect a sharp size decrease between the Late and Terminal Archaic periods beginning around 5 cal ka. Where such significant size decreases are detected, we should further expect that they span commonly observed size thresholds for dart versus arrow points.

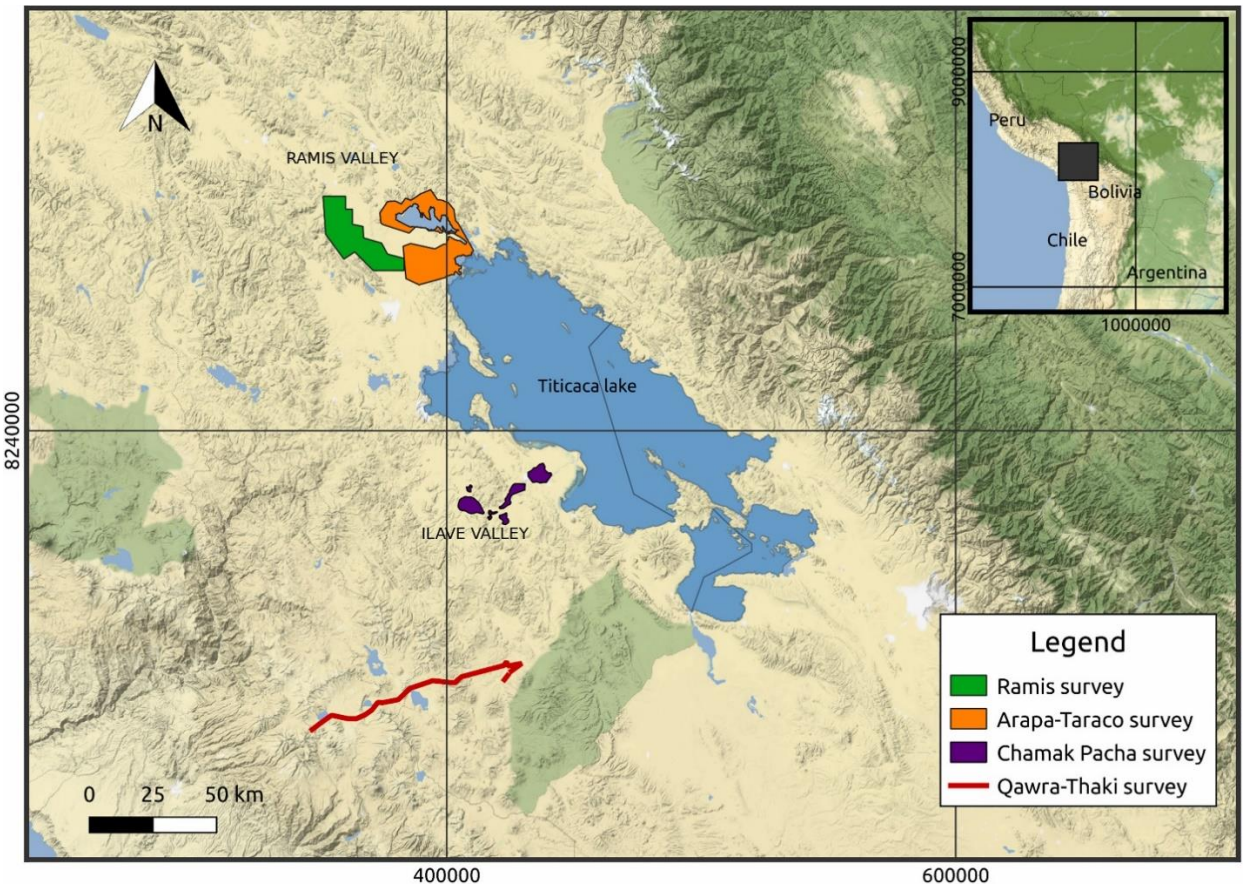


Figure 19. Map of the archaeological surveys in the Lake Titicaca Basin, where the projectile point samples considered in our study come from.

Once we establish the most likely period of archery adoption, we then evaluate the consequences for social organization. Following each model, we indicate that the model of "orderly anarchy" predicts that the appearance of archery technology corresponds to an increase in site frequency, a reduction in site size, and a decreasing access to non-local goods. Alternatively, the social coercion and warfare models predict that the period of archery introduction will correspond to a reduction in site counts, an increase in settlement size, and an increase in access to non-local resources. Finally, the social coercion and warfare models may be distinguished by examining evidence for inter-group violence, with the coercion model anticipating a reduction in rates of skeletal trauma and, conversely, the warfare model anticipating amplification.

5.2. **Materials and methods**

In order to evaluate the competing hypotheses for archery technology, we first conduct a diachronic metric analysis of projectile point size spanning approximately 10,000 years in the Lake Titicaca Basin to identify when archery technology most likely entered the region. We then compare these observations to changing settlement patterns, exotic goods representation, and rates of perimortem trauma in skeletal assemblages. Several analytical methods are outlined below.

5.2.1. ***Projectile points***

To evaluate changes in projectile point size over time in the Andes, we examine projectile points from four surface and subsurface archaeological collections from two different Lake Titicaca Basin locations. The first surface assemblage comes from the Ilave Valley to the southwest of Lake Titicaca (Aldenderfer, 2002; Craig, 2005; R. Haas et al., 2015, 2020; R. Haas & Viviano, 2015; La Favre, 2011), and the second from the Ramis River Valley to the northwest of the Basin (Aldenderfer & Flores-Blanco, 2008; Stanish & Umire, 2004). These two Altiplanic valleys are located more than 100 km apart (Fig. 19).

The sub-surface artifacts from Archaic sites examined in both valleys come from shallow deposits with partially mixed upper layers and radiocarbon-dated features in lower layers (Craig, 2005; Craig et al., 2010; Kitchel et al., 2022). The points from Formative sites are associated with recognized ceramic styles. Twenty-five percent of all projectile points used in this study have been recovered from these archaeological contexts.

Surface-collected points were typologically dated according to the Klink and Aldenderfer (2005) typology. This chronological proposal was based primarily on well-dated artifacts from the Asana open-air site in the Osmore Basin and Quelcatani rock shelter in the headwaters of the Huenque River, Titicaca Basin, but also included chronological information from other sites in the region (Klink and Aldenderfer, 2005). Since this projectile point typology was developed, a number of subsequent investigations have produced observations that independently validate the type assignments and date ranges with paired projectile points and radiocarbon dates from secure feature contexts (Capriles et al., 2018; Craig, 2005; R. Haas et al., 2015, 2020; R. Haas & Viviano, 2015; Herrera et al., 2015; Kitchel et al., 2022; LeFebvre, 2004; Osorio et al., 2011; Panczak, 2019; Rademaker et al., 2014; Sepúlveda et al., 2018). Thus, the projectile point typology offers a strong approach for assigning approximate temporal classifications to lithic artifacts.

A potential limitation of the use of surface-collected projectile points relates to resharpening effects, commonly known as the Frison effect, whereby a given projectile point that has been resharpened can be mistakenly classified, or types thought to be based on cultural variation actually reflect use-life variation within a type (Frison, 1976). Our use of both excavated and surface-collected projectile points mitigates such effects to some extent. If we observe different outcomes between the excavated and surface samples, then we might suspect the analysis has been compromised by such effects. Another way to identify potential resharpening effects is

to consider raw materials as part of the typological process. If projectile point types of similar form are made of different raw materials, then resharpening effects could not have been at play.

In accordance with the projectile point chronology (Klink and Aldenderfer, 2005), the following point types are included in our analysis due to their relatively high degree of temporal resolution, on the order of 2000 years: Early Archaic (11.0–9.0 ka) = 1A, 1B, 4A, 4B; Middle Archaic (9.0–7.0 ka) = 3A, 2A, 2C, 3B; Late Archaic (7.0–5.0 ka) = 4D and 3F; Terminal Archaic (5.0–3.5 ka) = 4F and 5A; Formative Period (3.5–1.5 ka) = 5B—5D; and Tiwanaku Period (1.5–1.0 ka) = 4E (Fig. 20, Table 10). Note that 5B, 5C, and 5D points span the Terminal Archaic and Formative periods. We classify these points as the context allows. Projectile points associated with single-component sites with ceramics are assigned to the Terminal Archaic or Formative Period based on the presence or absence of ceramics. Ambiguous cases are classified as Formative Period to err conservatively (Fig. 20, Table 10).

The projectile points are measured following standard macroscopic lithic analysis procedures (Andrefsky, 2005; Aschero, 1975). The points are measured for length, width, and thickness to two tenths of a millimeter using electronic calipers. Mass is recorded to the nearest tenth of a gram using an electronic balance. Only complete projectile points are examined to avoid erroneous size measurements due to incompleteness.

From this artifact data, we calculate summary statistics for each variable and each time period. Summary statistics are expressed as central tendencies (log mean and median) and dispersion values (95% range). All statistical analysis is performed using the R statistical computing language (R Core Team, 2022).

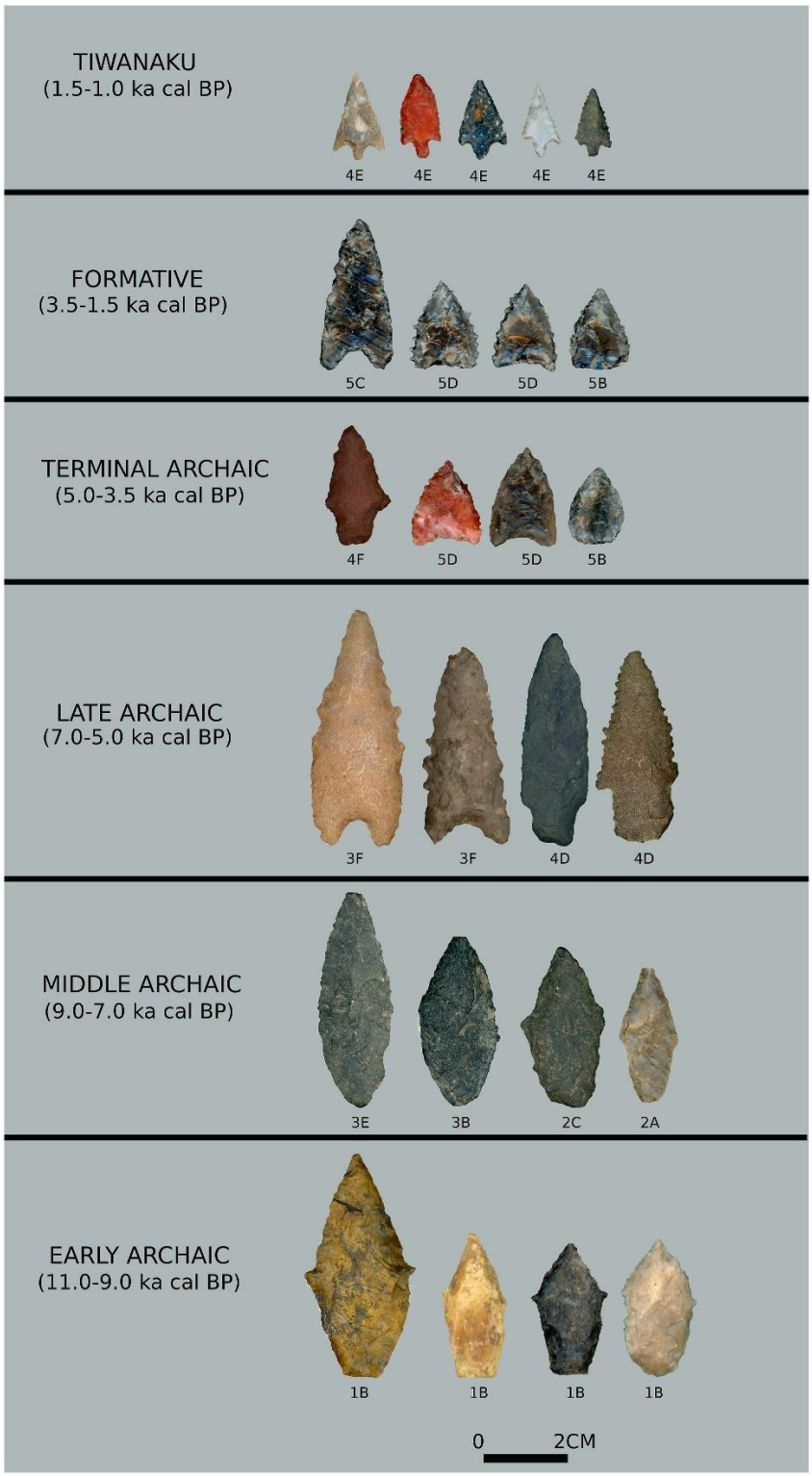


Figure 20. Titicaca Basin projectile point typology (Klink and Aldenderfer, 2005) used in this study. The artifacts shown here come from the Ilave and Ramis valleys from the collections of Aldenderfer (2002, 2012), Aldenderfer and Flores-Blanco (2008), Haas et al. (2020), and (Flores-Blanco, 2021).

Table 10. Frequencies of projectile points examined in this study.

Period	Dates (cal. ka)	Points types[a]	Ilave valley[b]	Ramis valley[b]	Total
Tiwanaku	1.5-1.0	4E	4 (0.6%)	1 (0.1%)	5 (0.7%)
Formative	3.5-1.5	4C, 5B, 5C, 5D	94 (14.4%)	297 (25.2%)	391 (39.6%)
Terminal Archaic	5.0-3.5	4F, 5A, 5B, 5C, 5D	231 (35.4%)	118 (10.0%)	349 (45.4%)
Late Archaic	7.0-5.0	4D, 3F	135 (20.7%)	63 (5.3%)	198 (26.0%)
Middle Archaic	9.0-7.0	3A, 2A, 2B, 2C, 3B, 3E	109 (16.7%)	27 (2.3%)	136 (19%)
Early Archaic	11-9.0	1A, 1B, 4A, 4B	46 (7%)	19 (1.6%)	65 (8.6%)
Archaic	11-3.5	3C, 3D	34 (5.2%)	1 (0.1%)	35 (5.3%)
Total			653 (100%)	526 (100%)	**1179 (100%)**

[a]Klink&Aldenderfer (2005).
[b]counts (column proportions).

5.2.2. ***Differentiating dart vs. arrow points***

Several quantitative approaches have been proposed to discriminate arrows from dart points (Bradbury, 1998; Fenenga, 1953; Hildebrandt & King, 2012; Hughes, 1998; Shott, 1997; Sisk & Shea, 2011; Sitton et al., 2020; Thomas, 1978). These proposals have been grouped into two related methods: the Discriminant Functional Analysis and the Threshold Value method (Okumura & Araujo, 2015). Although these methods are not conclusive for detecting the function of an individual artifact, they are useful for evaluating large populations of points. Consequently, we are concerned here with evaluating broad patterns rather than individual artifacts.

First, the Discriminant Functional Analysis was built on ethnographic and archaeological projectile points that could be confidently assigned to atlatl or archery technologies (Railey, 2010; Shott, 1997; Thomas, 1978). Thomas (1978) evaluated four projectile point attributes, including maximum length, width, thickness, and neck width, finding that width offered the greatest power of discrimination between atlatl and archery systems. Shott (1997) extended the control database and further established four discriminant function equations for assessing dart versus arrow points.

Like Thomas, he found that shoulder width was the most relevant measurement for arrow and dart discrimination in one- and two-attribute equations.

Other researchers have reduced the discriminant function approach to a simplified threshold approach that separates dart and arrow points based on metric threshold values (Fenenga, 1953; Hildebrandt and King, 2012; Hughes, 1998). Fenenga (1953) and Hildebrandt and King (2012) consider weight the threshold measurement most essential to differentiate weapons systems. For Fenenga (1953), small points weighing less than 3.5 g are arrows, while large points weighing more than 4.5 g are darts. For Hughes (1998), there are no dart points below 3 g of weight; therefore, below that threshold, they are likely arrow points.

We use both the discriminate function and threshold approaches to evaluate the introduction of this technology in the Titicaca Basin. The threshold method (Kitchel et al., 2022) and the functional discriminant method (Castro et al., 2018; Castro and Marsh, 2022) have already been used to differentiate dart and arrow point assemblages in the South-Central Andes. Others have analyzed lithic assemblages under morphological, functional, and other metric approaches in general (Ávalos, 2015; De Souza, 2004; Hocsman, 2010). Our approaches consider four measures of projectile point size: maximum width, mass, thickness, and length. We omit stem width measurement because most of the points considered in this study (81%) are unstemmed. These attributes are chosen given the assumptions that the introduction of archery technology introduced a large and statistically significant decrease in projectile point size at some time in the past in the Titicaca Basin and that this decrease should be recognizable in the central tendencies of one or more of these metrics.

It is important to emphasize that the approaches described above are imperfect and must be used with caution. As a number of scholars have pointed out, there is considerable overlap in

the metrics of dart and arrow points, and weapon design specifics could affect point size in ways that could lead to misclassification (Marsh et al., 2023). For instance, an atlatl dart without fletching requires large dart points that are immediately recognizable as such, while a dart with fletching does not (Hughes, 1998), which could lead to their misclassification as arrow points.

Furthermore, resharpening effects can lead to misclassification. Namely, large dart points that have been resharpened could reduce point size below dart/arrow thresholds, leading to misidentification. Our use of multiple projectile point metrics, which are variably sensitive to resharpening effects, is expected to minimize such concerns. Whereas projectile point thickness is the least sensitive dimension to resharpening, projectile point length is the most sensitive. Width exhibits intermediary sensitivity to resharpening effects. If we observe that diachronic size patterns vary across these measurements, then we should take caution in their interpretation. However, if diachronic patterns are consistent across these metrics, we can feel assured that resharpening effects are not confounding the results.

To further reduce ambiguity concerns, we take a long-term comparative approach to projectile point size within the region. Given some weapon types, whether atlatl or bow, we should expect relatively small variations in projectile point size as weapon design and cultural preferences change over time. In contrast, we should expect that the introduction of archery technology induced a significant decrease in average projectile point size that exceeded the smaller within-technology changes throughout the region's 10,000-year history of projectile point use. Although this comparative approach is also imperfect, the advantage is that it controls for regional variation at some level. Lacking direct evidence for the introduction of bow-and-arrow technology, the metric, diachronic approach employed here provides the best estimate of the timing at which archery technology was introduced.

5.2.2.1. Assessing threshold values

We use baseline threshold values for width, mass, thickness, and length calculated from several studies (Kitchel et al., 2022), which derive values from North American ethnographic and archaeological data (Railey, 2010; Shott, 1997; Thomas, 1978). We compare the mean values from each time period to the threshold values to determine whether a given population of points was more likely to have been used with arrows (values below the size thresholds), darts (values above the size thresholds), or some combination of both (values near the size thresholds).

Another limitation of the current approach is that these threshold values are based on North American artifacts, which may not accurately reflect variation in South America (Marsh et al., 2023). However, data provided by Charlin et al. (2016) show that arrow points in Patagonia exhibit very similar dimensions to their North American counterparts. This limited South American sample, which lacks dart measurements, provisionally suggests that North American thresholds are reasonable for South America. We cautiously make the assumption of comparability for the purpose of our study, but note that future investigations are required to evaluate the assumption.

From these previous studies, we expect that a population of arrow points will have an average arrowhead width below 18.0 mm, a mass below 3.2 g, a thickness below 4.3 mm, and a length below 38.7 mm. Conversely, a population of dart points will exhibit average values above those thresholds. Box plots are used to graphically display the results for each archaeological period and for each measured attribute.

5.2.2.2. One-attribute discriminant function analysis

In addition, we evaluate the introduction of the bow and arrow following the discriminant function approach of Shott (1997). We use the one-attribute solution, which uses projectile point width measurements to differentiate projectile technologies. It has the following structure:

Dart: 1.40 × (maximum width) - 16.85

Arrow: 0.89 × (maximum width) - 7.22

For any given projectile point, the width is run through each function, and whichever generates the higher value—the dart or arrow function—is identified as the more likely technology. These results are then aggregated by time period, and the proportion of artifacts assigned to each weapon system is evaluated for each period for the study region in aggregate and for each of the two sub-regions. We assume the introduction of archery technology will be evident when arrow points first become the majority type in the archaeological period.

5.2.3. ***Settlement size***

To evaluate settlement-size change at the time of archery arrival, we use archaeological settlement data from the Ilave and Ramis river basins, between 3820 and 3970 masl, which have occupation spans of approximately 11,000 years. For this paper, we limit the analysis to site-size data from the Early Archaic to Tiwanaku periods (11.0–1.0 cal ka) because our sample lacks lithic projectile points from the subsequent Late Intermediate and Inca periods and the preceding Paleoindian Period. We restrict our analysis to sites dated by radiocarbon or temporally diagnostic artifacts and features, including projectile points, pottery, and architecture.

The first study area is the Ilave River valley and its tributaries, the Huenque and Aguas Calientes. Researchers located and estimated site areas of 74 km^2 (Aldenderfer, 2002, 2012; Craig, 2005; R. Haas et al., 2015; Klink, 2005). The Ilave Basin sample includes 94 open-air sites. The second study area considered is the Ramis River Valley, where our survey covered 400 km^2 (Aldenderfer and Flores-Blanco, 2008). Spatial data come from 71 single-component open-air sites.

Trends in settlement size variation are examined using boxplots, with t-tests used to assess changes between temporally adjacent periods. T-tests are performed on log-transformed site-area data to normalize the data for valid T-testing. The tests were performed as single-tail tests, both greater- and less-than, to assess whether significant size reduction or increase is observed between adjacent pairs of archaeological periods.

5.2.4. *Raw material*

Obsidian is the only well-documented non-local lithic material in the Titicaca Basin. Obtaining it likely entailed exchange networks. Archaeometric analyses show that this raw material came almost exclusively from outside the Basin, mainly from two quarries: Chivay at over 150 km and Alca at over 260 km away (Burger et al., 2000; Levine et al., 2013; Stanish et al., 2002; Tripcevich, 2010). Local geologic sources provide cherts, quartzites, and fine-grained volcanics, but the extent to which non-obsidian materials are non-local is unclear (Kitchel et al., 2022). Much of the chert could have been collected from nearby river gravels, while igneous materials (non-obsidian) may have come from local primary geologic sources (Hastorf et al., 2022; Kitchel et al., 2022; Palacios Moncayo et al., 1993; Protzen & Nair, 2016; Sánchez Fernández et al., 2003). We use a 30x folding pocket magnifying glass and standard lithic material identification criteria (Andrefsky, 2005) to determine the material types of the projectile points examined.

5.2.5. *Violence*

In order to evaluate changes in inter-personal violence rates before and after the introduction of archery technology, we assemble published bioarchaeological data on cranial trauma rates in the Titicaca Basin. Other scholars have compiled the bulk of these cranial trauma data (Arkush, 2022; Arkush & Tung, 2013; R. Haas & Viviano, 2015; Juengst et al., 2017), including 233 individuals from the Altiplano, all of whom come from Late Archaic – Late Intermediate period contexts (7.0–

0.9 cal. ka). We compare these trauma rates for each period to the period of archery introduction in order to assess hypotheses for the effects of archery technology on inter-personal violence rates.

Table 11. Median (with range) and mean (with 95% quantiles) of projectile point size measurements for each archaeological period.

Periods	Metric[a]	width (mm)	mass (g)	thickness (mm)	length (mm)
Tiwanaku	Median (range)	9.7 (9.1 – 12.5)	0.4 (0.2 – 0.6)	2.4 (2.2–3)	19 (16.2–21)
	Mean (95% range)	10.4 (8.1 – 13.4)	0.4 (0.2 – 0.8)	2.5 (2–3)	18.9 (15.9–22.4)
Formative	Median (range)	15.8 (9.5 – 32)	1 (0.3 – 18.1)	5 (2–20)	21 (11–66.1)
	Mean (95% range)	15.8 (11.0 – 22.6)	1.2 (0.3 – 4.7)	4.7 (2.8–7.9)	22.2 (13.2–37.2)
Terminal Archaic	Median (range)	15.9 (7.6 – 33.7)	1.5 (0.2 – 10)	4.8 (1.7–11)	24 (11.1–47)
	Mean (95% range)	15.9 (10 – 25.4)	1.5 (0.4 – 6.2)	4.8 (2.7–8.3)	23.6 (14.1–39.6)
Late Archaic	Median (range)	21 (11.2 – 36.5)	5.2 (0.5 – 20.3)	7.5 (3.7–14.2)	38 (14-68)
	Mean (95% range)	21 (14.0 – 31.5)	5 (1.5 – 16.8)	7.2 (4.6–11.3)	36.8 (21.3–63.6)
Middle Archaic	Median (range)	19.0 (11.7 - 30.6)	5.0 (0.9 – 15.4)	7.4 (4.2–11)	38 (14–75.1)
	Mean (95% range)	18.8 (12.9 – 27.4)	4.9 (1.6 – 15.3)	7.4 (5.0–10.8)	37.9 (22.3–64.4)
Early Archaic	Median (range)	18.6 (13 – 27.2)	3.6 (1 – 12.5)	6.8 (3.5–12)	34.6 (22–73.7)
	Mean (95% range)	18.8 (13.3 – 26.6)	3.6 (1.4 – 9.2)	6.7 (4.6–9.7)	35 (22.7–53.8)

[a]Mean = exponentiated logmean of values

5.3. **Results**

Our first objective is to identify the most likely period of archery introduction in the Titicaca Basin by examining trends in projectile point size over approximately 10,000 years. Our second objective is to evaluate the potential effects of archery technology on social organization by comparing the timing of archery technology to changes in site size, obsidian use, and interpersonal violence rates. These analytical results are used to evaluate expectations of the orderly anarchy, coercion, and warfare models introduced above.

5.3.1. *Introduction of archery technology*

Our efforts resulted in the compilation of data on 1179 projectile points from 288 Titicaca Basin sites. 653 artifacts (55%) from 130 sites come from the Rio Ilave Valley. Three-hundred and ten of these points (47.5%) were recovered from five excavated and well-dated archaeological sites, including Wilamaya Patja, Soro Mik'aya Patjxa, Pirco, Jiskairumoko, and Kaillachuro. These sites cover 6000 years of foraging and agropastoral economies from 9.5 to 3.5 cal ka (Aldenderfer, 2012; Craig, 2005; Flores-Blanco, 2021; Haas et al., 2020; Haas and Viviano, 2015). All other projectile points were recovered from the surfaces of 120 other archaeological sites recorded primarily during the 1990s Chama'q Pacha project led by Mark Aldenderfer and the 2000s Qawra Thaki project led by Charles Stanish (Aldenderfer, 2002; Haas et al., 2015; La Favre, 2011). Although our database includes 1179 artifacts, not all projectile points were always used for all analyses due to artifact incompleteness or because sometimes we could not assign them to a particular archaeological period. Analysis-specific sample sizes are specified with the results.

Of the 1179 artifacts, 526 (45%) come from 158 sites of the Rio Ramis Valley and were recovered during two different surveys around Lake Arapa and Taraco town (Stanish and Umire, 2004) and the lower-middle Pucara River Valley (Aldenderfer and Flores-Blanco, 2008). Moreover, some points were recovered from undated exploratory excavations at five sites (Aldenderfer and Flores-Blanco, 2008).

5.3.1.1. Threshold analysis

Our analysis reveals two periods of statistically significant ($p<0.01$) decreases in projectile point size across all four attributes (width, weight, thickness, and length)—one during the Late-Terminal Archaic transition and the other during the Formative-Tiwanaku period transition (Tables 11 and 12). Importantly, no other inter-period transition shows a statistically significant size change or is

similarly sized. This includes the Terminal Archaic-Formative Period transition, leading us to reject the hypothesis of a Formative Period origin of archery technology. We furthermore observe sustained growth in point size from the Early to Late Archaic periods, as has been previously noted (C. Chen et al., 2021), indicating that archery technology was unlikely to have been introduced during any of those periods. Moreover, the sum of each attribute's projectile point size increase during these three early periods is considerably less than the dramatic decrease in size during the Late-Terminal Archaic and Formative-Tiwanaku transitions, signaling a major technological change at that time. In the following paragraphs, we consider each metric individually.

Table 12. Projectile point size changes over time. Width, mass, thickness, and length all decrease significantly ($p < 0.01$) across the Late/Terminal Archaic and Formative/Tiwanaku boundaries.

Periods	Change in mean (p-value)[a]			
	width (mm)	**mass (g)**	**thickness (mm)**	**length (mm)**
Formative ⟶ Tiwanaku	-5.4 **(**< 0.01**)**	-0.8 **(**< 0.01**)**	-2.2 **(**< 0.01**)**	-3.3 **(**< 0.01**)**
Terminal Archaic ⟶ Formative	-0.1 (0.65)	-0.3 (1.00)	-0.1 (0.66)	-1.4 (1.00)
Late Archaic ⟶ Terminal Archaic	-5.1 **(**< 0.01**)**	-3.5 **(**< 0.01**)**	-2.4 **(**< 0.01**)**	-13.2 **(**< 0.01**)**
Middle Archaic ⟶ Late Archaic	1.9 (1.00)	-0.1 (0.61)	-0.2 (0.23)	-0.9 (0.14)
Early Archaic ⟶ Middle Archaic	0.3 (0.53)	1.5 (1.00)	0.7 (1.00)	2.7 (1.00)

[a]p-values for Welch's two-sample t-test evaluating the hypothesis that the later values are less than the earlier.

For the first size proxy, we observe that mean point width drops 24% from 21 mm in the Late Archaic Period to 15.9 mm in the Terminal Archaic Period ($p < 0.01$; Fig. 21; Tables 11 and 12), crossing below the dart/arrow threshold of 18.0 mm. The Formative Period points exhibit a mean width of 15.8 mm, similar to the Terminal Archaic Period. Finally, the median point widths from the Tiwanaku Period drop 66% from 15.8 to 10.4 mm ($p < 0.01$). These data are consistent with a Terminal Archaic Period introduction of archery technology.

For the second projectile-point size proxy, we observe that mean mass drops significantly ($p < 0.01$) from 5.0 g in the Late Archaic Period across the dart/arrow threshold of 3.2 g–1.5 g

during the Terminal Archaic Period (Fig. 21). Another significant reduction ($p < 0.01$) occurred from 1.2 g in the Formative Period points to 0.4 g in the Tiwanaku Period (Tables 11 and 12). These data are most consistent with a Terminal Archaic Period introduction of archery technology.

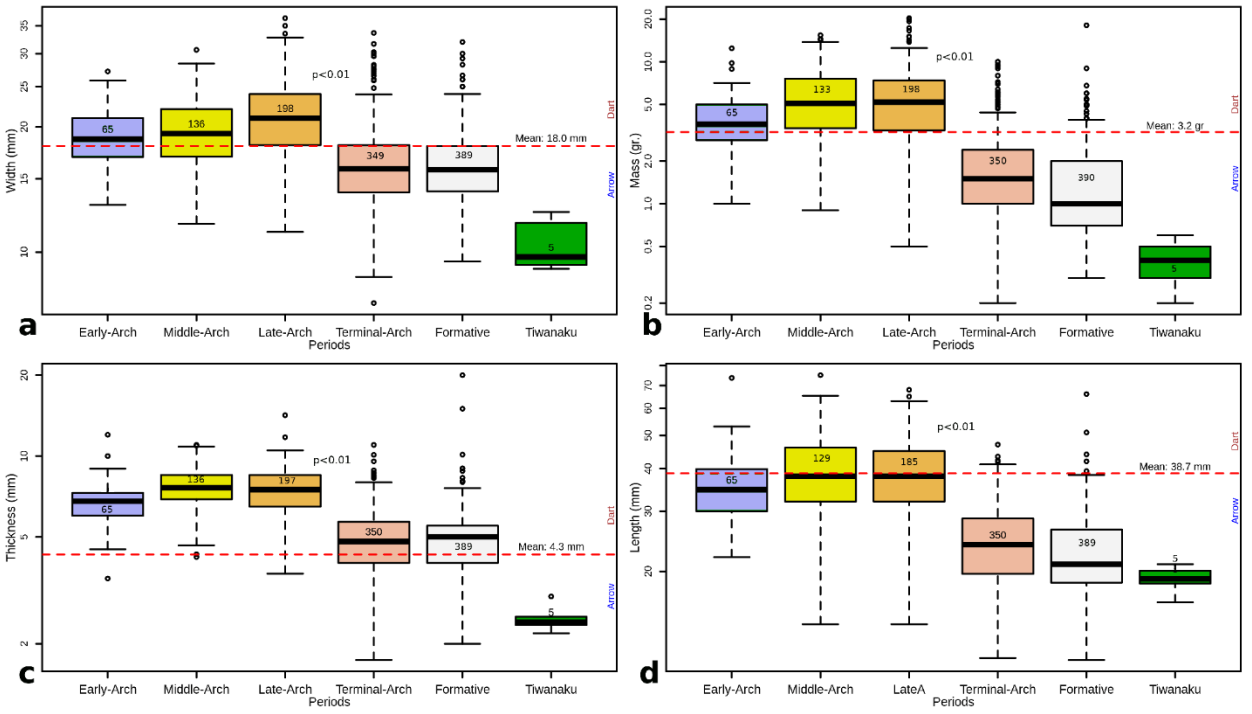


Figure 21. Projectile point size over time in the Lake Titicaca Basin as measured by (a) width, (b) mass, (c) thickness, and (d) length. The red dotted lines represent the threshold above/below which something is likely to be an arrow or a dart. Two significant point size reductions are evident for all four-size metrics—one across the Late-Terminal Archaic transition and the other across the Formative-Tiwanaku Period transition.

For the third proxy, we observe that the mean thickness of the Titicaca points drops dramatically ($p < 0.01$) from 7.2 mm in the Late Archaic to 4.8 mm in the Terminal Archaic Period. Despite this significant size reduction, the mean value does not fall below the dart/arrow threshold of 4.3 mm, which is above the first quartile of values for the Terminal Archaic and Formative periods and covers more than 25% of specimens. Conversely, there are almost no Early-Late Archaic points below the threshold. Concerning the Tiwanaku points, they are well below

dart/arrow reference lines; these finds support the existence of archery technology in the Tiwanaku Period.

Table 13. Dart/arrow classification results according to the Shott (1997) method. Majority arrow point classification is first evident in the Terminal Archaic Period.

	Early Archaic	Middle Archaic	Late Archaic	Terminal Archaic	Formative	Tiwanaku
Dart	31 (48%)	71 (52%)	123 (67%)	66 (19%)	58 (15%)	0 (0%)
Arrow	34 (52%)	65 (48%)	61 (33%)	289 (81%)	332 (85%)	5 (100%)

For the fourth proxy, we observe two significant changes ($p < 0.01$) in point length, one across the Late-Terminal Archaic boundary and another across the Formative-Tiwanaku boundary (Tables 11 and 12). Between the Late Archaic and Terminal Archaic periods, the length decreased by 36%, dropping in the mean from 36.8 mm to 23.6 mm. In subsequent periods, point length decreases to a lesser degree. Although the dart/arrow threshold for point length is poorly defined due to projectile point resharpening effects (e.g., Shott, 1997; Thomas, 1978), we cautiously observe that most projectile point lengths from the Terminal Archaic to the Tiwanaku Period fall below the threshold. Despite potential resharpening effects, the result is consistent with patterns observed among the other metrics, which are less sensitive to such effects. All previous periods' values are more than 50% above the line. These data are consistent with a Terminal Archaic Period introduction of archery technology.

5.3.1.2. *One-attribute solution*

According to the procedure of Shott (1997), we classify the Titicaca projectile points mostly as arrow points (69%), with fewer classifying as dart points (31%). The sample of points from the Ramis Valley contains an even greater proportion of arrows (79%) than those from the Ilave Valley (61%).

The two earliest periods present similar technology percentages (Table 13). 52% of Early Archaic points are classified as arrows and 48% as darts. During the Middle Archaic Period, 48% are arrows and 52% are darts. These results do not allow us to exclude the presence of arrows in these early periods, but archery technology is highly unlikely. Marsh et al. (2023) propose that these early, ambiguously small points are perhaps small darts. Throughout the Late Archaic Period, 67% of the assemblage consists of dart points.

In the Terminal Archaic, 81% (n = 289) of the points are classified as arrowheads (Table 13). Again, the Late/Terminal Archaic boundary reflects an inflection point, with the dart-arrow ratio stabilizing in subsequent periods. 85% (n = 333) are classified as arrows in the Formative Period. All Tiwanaku points are arrows, though the sample includes just 5 artifacts.

Although this method does not clearly distinguish the weapon system during the Early and Middle Archaic periods in the Titicaca Basin, a clear preference for dart technology is evident in the Late Archaic Period, with increasing point size evident from the Early-Late Archaic periods as previously observed (Chen et al., 2021). In the Terminal Archaic Period, average size dropped precipitously and significantly, often below previously identified arrow-point size thresholds, consistent with the introduction of archery technology.

5.3.2. *Settlement size*

Our effort to compile site-size data resulted in area estimates for 165 sites, including 94 from the Ilave Valley and 71 from the Ramis Valley, spanning 11–1.0 cal. ka. In general, we observe sustained growth in the site areas of Titicaca throughout its 10,000-year history (Fig. 22). However, there were two moments in which the change in the site size was greatest. In the Early/Middle Archaic transition, a statistically significant size increase occurred ($p<0.01$) and then again across the Late/Terminal Archaic transition ($p = 0.02$) (Tables 14 and 15, Fig. 22). During the Terminal

Archaic Period, the average settlement size in the Ilave Valley increased by 68%, from 2046 m2 to 6328 m2, but this change is not statistically significant ($p = 0.13$) (Fig. 22, Tables 14 and 15). In the Ramis Valley, we observe a significant 86% growth in the sites from a mean of 407 m2–2888 m2 ($p = 0.01$) during that temporal transition. Settlements continued to grow significantly throughout the Formative Period ($p < 0.01$), averaging 10,419 m2, with the largest covering 83 ha. In the Ilave Valley, during the Formative Period, we observe a slight but statistically insignificant decline in settlement size (Fig. 22).

Table 14. Site-size over time in the Titicaca Basin.

Periods	Metric[a]	Titicaca (m2)	Ilave (m2)	Ramis (m2)
Tiwanaku	Median (range)	4400 (768 – 269556)	3744 (768 – 5400)	22583 (4170 – 269556)
	Mean	5435.0	3117.2	25069.3
Formative	Median (range)	4265 (510 – 8327712)	2860 (510 – 30153)	5269 (510 – 832771)
	Mean	6386.5	2810.2	10418.7
Terminal Archaic	Median (range)	3160 (704 – 30153)	9603 (704 – 30153)	2698.5 (1108 – 11953)
	Mean	3952.5	6327.7	2888.1
Late Archaic	Median (range)	1505 (66 – 13689)	2100 (336 – 13689)	315.5 (66 – 3001)
	Mean	1464.5	2046.0	406.5
Middle Archaic	Median (range)	2275 (30 – 8250)	2400 (30 – 8250)	715 (665 – 765)
	Mean	1435.5	1534.4	713.2
Early Archaic	Median (range)	376 (300 – 774)	419 (300 – 774)	376[b]
	Mean	429.4	443.9	376[b]

[a] Mean = exponentiated logmean of values

[b] There was only one settlement

In conclusion, we identify significant site-size growth in the Titicaca Basin during the Terminal Archaic Period, coinciding with the most probable period of archery introduction, albeit to varying degrees in each valley. In the Ramis Valley, the changes were more pronounced, with two periods of significant site growth, both in the Terminal Archaic Period and the Formative Period (Fig. 22). These data are inconsistent with the orderly anarchy model but consistent with

the coercion and warfare models, which anticipate site growth to coincide with the appearance of archery technology.

Table 15. Settlement sizes change over time. Settlement size increased significantly ($p < 0.01$) in the Middle Archaic, Terminal Archaic, and Formative periods.

	Change in mean (p-value)[a]		
	Titicaca (m2)	**Ilave (m2)**	**Ramis (m2)**
Formative ⟶ Tiwanaku	-1216 (0.64)	307 (0.39)	14015.5 (0.21)
Terminal Archaic ⟶ Formative	2698.5 (0.14)	-642.4 (0.80)	8165.6 (< 0.01)
Late Archaic ⟶ Terminal Archaic	2488 (0.02)	1406.6 (0.13)	2481.6 (0.01)
Middle Archaic ⟶ Late Archaic	-246.9 (0.48)	178 (0.21)	-306.7 (0.80)
Early Archaic ⟶ Middle Archaic	1282 (< 0.01)	1424.1 (< 0.01)	337.2 (–)[b]

[a] p-values for Welch two-sample T test evaluating the hypothesis that the later values are less than the earlier.
[b] Not enough data to obtain the p-value

5.3.3. ***Projectile point raw materials***

Our analysis resulted in the raw material characterization of 1179 projectile points: 653 from the Ilave region and 526 from the Ramis region. In the Early and Middle Archaic periods, chert and basalt were the most commonly used raw materials, while obsidian was scarce (Table 16 and Fig. 23). Local raw materials, such as basalt (47.0%), chert (25.3%), and quartzite (11.6%), remained heavily favored during the Late Archaic Period. The Late/Terminal Archaic boundary reflects a major shift in raw material preference. Obsidian became the second-most popular raw material (31.4%) for making projectile points during the Terminal Archaic Period, behind chert (45.4%). By the Formative Period, obsidian became the dominant raw material (81.5%) for projectile point production. This raw material pattern not only offers insight into changing preferences but also indicates that resharpening effects are unlikely to confound interpretation. In other words, the small 4F points, which tend to be made of fine-grained siliceous materials including chert, chalcedony, and obsidian (57%), are unlikely to be resharpened 4D points, which tend to be made from coarser materials including fine-grained volcanics and quartzites (72%) (see Appendix 9).

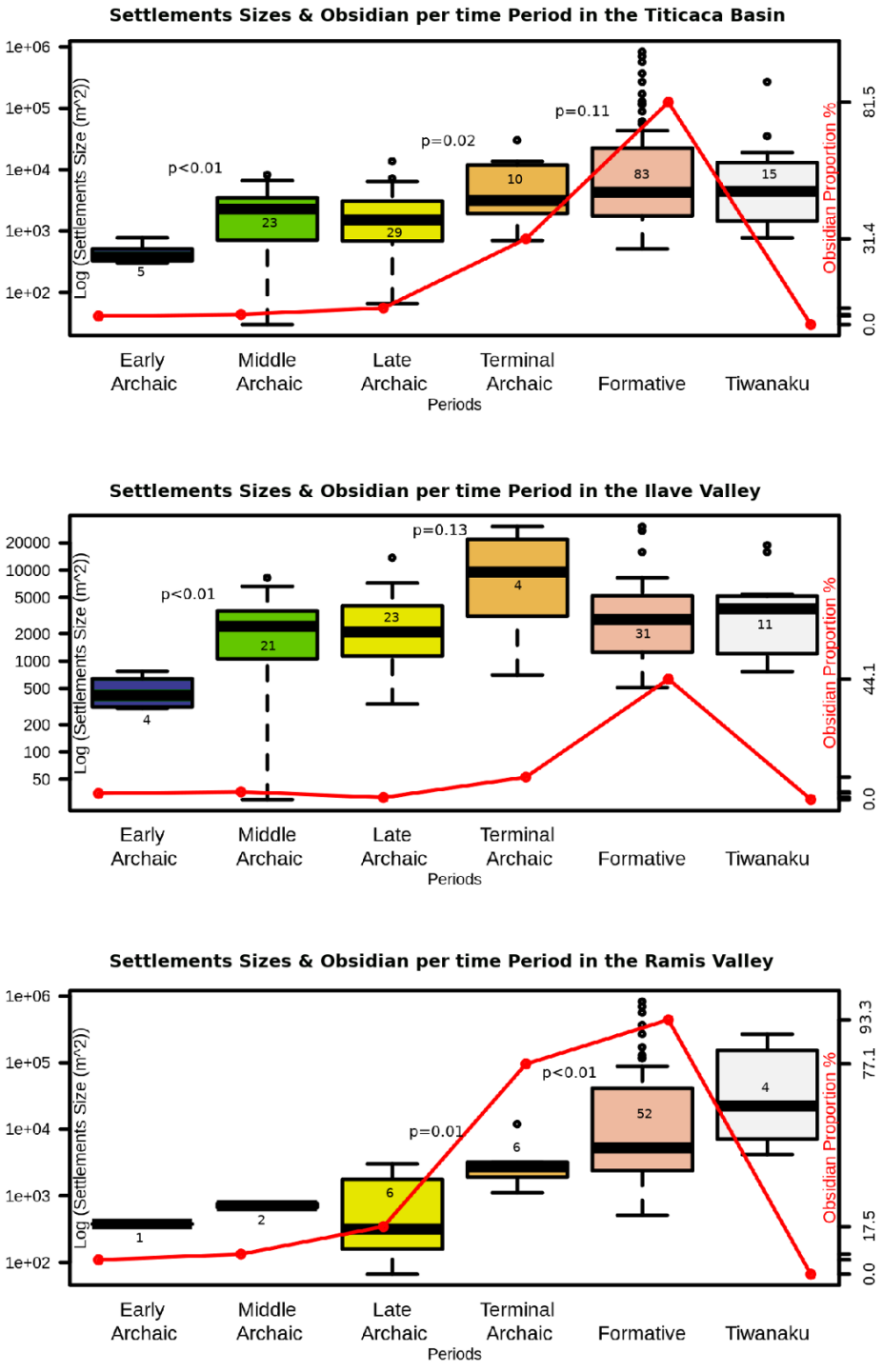


Figure 22. Site size over 10,000 years in the Titicaca Basin, showing a first-order trend of size increase over time. A particularly large increase is observed across the Late/Terminal Archaic boundary, when archery technology most likely appeared in the region.

Table 16. Raw material proportions in the Titicaca Basin, considering together the data from the Ilave and Ramis valleys.

Titicaca Basin	Early Archaic	Middle Archaic	Late Archaic	Terminal Archaic	Indeterminate Archaic	Formative	Tiwanaku
Andesite	0 (0.0%)	3 (2.2%)	11 (5.6%)	1 (0.3%)	0 (0.0%)	2 (0.5%)	0 (0.0%)
Basalt	17 (26.2%)	73 (53.7%)	93 (47.0%)	24 (6.9%)	15 (42.9%)	17 (4.4%)	0 (0.0%)
Chalcedony	4 (6.2%)	5 (3.7%)	2 (1.0%)	32 (9.1%)	1 (2.9%)	7 (1.8%)	0 (0.0%)
Chert	35 (53.8%)	33 (24.3%)	50 (25.3%)	159 (45.4%)	9 (25.7%)	33 (8.5%)	5 (100%)
Obsidian	2 (3.1%)	5 (3.7%)	12 (6.1%)	110 (31.4%)	0 (0.0%)	318 (81.5%)	0 (0.0%)
Quartzite/Quarz	5 (7.7%)	13 (9.6%)	23 (11.6%)	15 (4.3%)	6 (17.1%)	10 (2.6%)	0 (0.0%)
Rhyolite	1 (1.5%)	4 (2.9%)	6 (3.0%)	9 (2.6%)	4 (11.4%)	2 (0.5%)	0 (0.0%)
Indeterminate	1 (1.5%)	0 (0.0%)	1 (0.5%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)
Total	65 (100%)	136 (100%)	198 (100%)	350 (100%)	35 (100%)	390 (100%)	5 (100%)

When we explore our data at the level of each valley, we note regional variation in the raw material preference. In the Ilave valley (Table 17), access to non-local raw materials remains almost nil during the early periods and only significantly increased in the Terminal Archaic Period, although it was far from popular at only 8.2%, surpassed by other raw materials such as chert (62.9%), chalcedony (12.1%), and basalt (9.5%). The transition from the Terminal Archaic to the Formative Period marked a more dramatic shift in raw material preference when obsidian became the most popular raw material (44.1%), although chert remained an important material (31.2%). In general, we observe that the Ilave's inhabitants had difficulty accessing this non-local raw material, which made up only 10% of the valley's projectile point raw material. However, its prominence grew sharply in the Terminal Archaic Period and continued to grow into the Formative Period.

In the Rio Ramis valley (Table 17), our record also shows a near absence of obsidian points for the two earliest periods. Obsidian, despite its increase during the Late Archaic Period, is not the most popular raw material (17.5%), falling behind basalt (39.7%) and chert (27%). Only in the subsequent period, the Terminal Archaic Period, do we observe a statistically significant increase ($p<0.01$) in its representation, when obsidian became the most popular raw material (77.1%). Subsequently, during the Formative Period, nearly all (93.3%) projectile points were made of obsidian. Unlike Ilave, the inhabitants of the Ramis Valley had extensive access to obsidian beginning in the Terminal Archaic Period.

In conclusion, most Archaic period people favored local raw materials. Exotic obsidian became popular during the Terminal Archaic Period, when projectile point size decreased and site size increased (Fig. 23). Arrow makers may favor higher-quality materials like obsidian, which may explain this coincidence (Marsh et al., 2023). Our result fails to align with the orderly anarchy model and instead is consistent with the social coercion model, which predicts increased access to exotic materials with the advent of archery technology, anticipating this change in raw material preferences.

Table 17. Raw material proportions in the Ilave and Ramis River Basins.

Ilave River Basin							
	Early Archaic	**Middle Archaic**	**Late Archaic**	**Terminal Archaic**	**Indeterminate Archaic**	**Formative**	**Tiwanaku**
Andesite	0 (0.0%)	2 (1.8%)	8 (5.9%)	1 (0.4%)	0 (0.0%)	2 (2.2%)	0 (0.0%)
Basalt	11 (23.9%)	65 (59.6%)	68 (50.4%)	22 (9.5%)	15 (44.1%)	10 (10.8%)	0 (0.0%)
Chalcedony	4 (8.7%)	4 (3.7%)	0 (0.0%)	28 (12.1%)	1 (2.9%)	7 (7.5%)	0 (0.0%)
Chert	26 (56.5%)	22 (20.2%)	33 (24.4%)	146 (62.9%)	9 (26.5%)	29 (31.2%)	4 (100.0%)
Obsidian	1 (2.2%)	3 (2.8%)	1 (0.7%)	19 (8.2%)	0 (0.0%)	41 (44.1%)	0 (0.0%)
Quartzite/Quarz	2 (4.3%)	9 (8.3%)	18 (13.3%)	8 (3.4%)	5 (14.7%)	1 (1.1%)	0 (0.0%)
Rhyolite	1 (2.2%)	4 (3.7%)	6 (4.4%)	8 (3.4%)	4 (11.8%)	2 (2.2%)	0 (0.0%)
Indeterminate	1 (2.2%)	0 (0.0%)	1 (0.7%)	0 (0.0%)	0 (0.0%)	1 (1.1%)	0 (0.0%)
Total	46 (100.0%)	109 (100%)	135 (100.0%)	232 (100.0%)	34 (100.0%)	93 (100.0%)	4 (100.0%)

Ramis River Basin							
	Early Archaic	**Middle Archaic**	**Late Archaic**	**Terminal Archaic**	**Indeterminate Archaic**	**Formative**	**Tiwanaku**
Andesite	0 (0.0%)	1 (3.7%)	3 (4.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Basalt	6 (31.6%)	8 (29.6%)	25 (39.7%)	2 (1.7%)	0 (0.0%)	7 (2.4)%)	0 (0.0%)
Chalcedony	0 (0.0%)	1 (3.7%)	2 (3.2%)	4 (3.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Chert	9 (47.4%)	11 (40.7%)	17 (27.0%)	13 (11.0%)	0 (0.0%)	4 (1.3%)	1 (100.0%)
Obsidian	1 (5.3%)	2 (7.4%)	11 (17.5%)	91 (77.1%)	0 (0.0%)	277 (93.3%)	0 (0.0%)
Quartzite/Quarz	3 (15.8%)	4 (14.8%)	5 (7.9%)	7 (5.9%)	1 (100.0%)	9 (3.0%)	0 (0.0%)
Rhyolite	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Indeterminate	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	19 (100.0%)	27 (100.0%)	63 (100.0%)	118 (100.0%)	1 (100.0%)	297 (100.0%)	1 (100.0%)

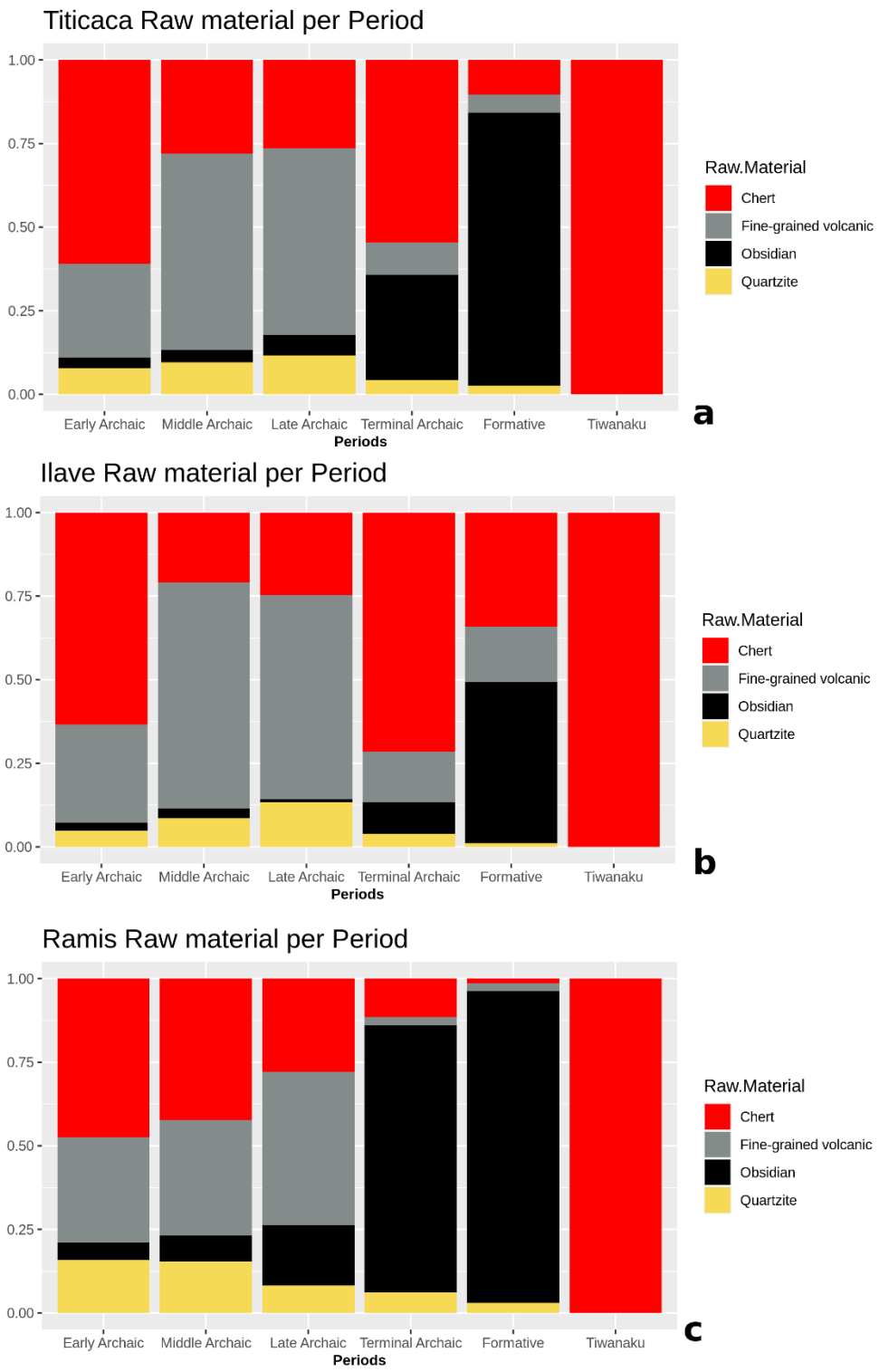


Figure 23. Raw material use for projectile points over time in the Lake Titicaca Basin: (a) The whole sample. (b) Ilave Basin sub-sample. (c) Ramis Valley sub-sample. The Terminal Archaic Period marks an inflection point when use of non-local obsidian was first widely used. Then in the Formative Period the highest level of use of obsidian is reached.

5.3.4. *Violence*

The compilation of cranial trauma data from the South-Central highlands includes 233 individuals distributed among the Late Archaic Period through the Late Intermediate Period (Table 18; Fig. 24). Although the sample is small, inter-personal violence rates appear to have been relatively low during the Late and Terminal Archaic, with only two incidents of cranial trauma (7%) evident among those 28 individuals. This rate of trauma continues into the Formative period. The data reveals no significant change until the Middle Horizon Period, when the rates increase to 12%. The evidence of bone trauma reaches its peak in the Late Intermediate Period, when it reaches 19%. The data suggest that archery technology had little effect on inter-personal violence rates, at least during the early periods of adoption. This observation is inconsistent with the expectations of the warfare model.

Table 18. Cranial trauma rates in the Altiplano.

Period	Individuals	Individuals with trauma	Trauma rate (%)	Sites	Source
Late Intermediate	67	13	19	Molino-Chilacachi, Ch'isi, Kupa Pukio, Ayawiri	Arkush and Tung (2013), Arkush (2022)
Middle Horizon	8	1	12	Chiripa and Jach'uypampa (Fase Tiwanaku)	Arkush and Tung (2013), Arkush (2022)
Formative	130	9	7	Chiripa, Copacabana combined, Kea Kollu Chio (island of Sun), Taraco (Peru)	Arkush and Tung (2013), Arkush (2022)
Terminal Archaic	14	1	7	Muruqullu	Juengst et al. (2017)
Late Archaic	14	1	7	Soro Mik'aya Patjxa	Haas and Viviano (2015)
sum	233	25			

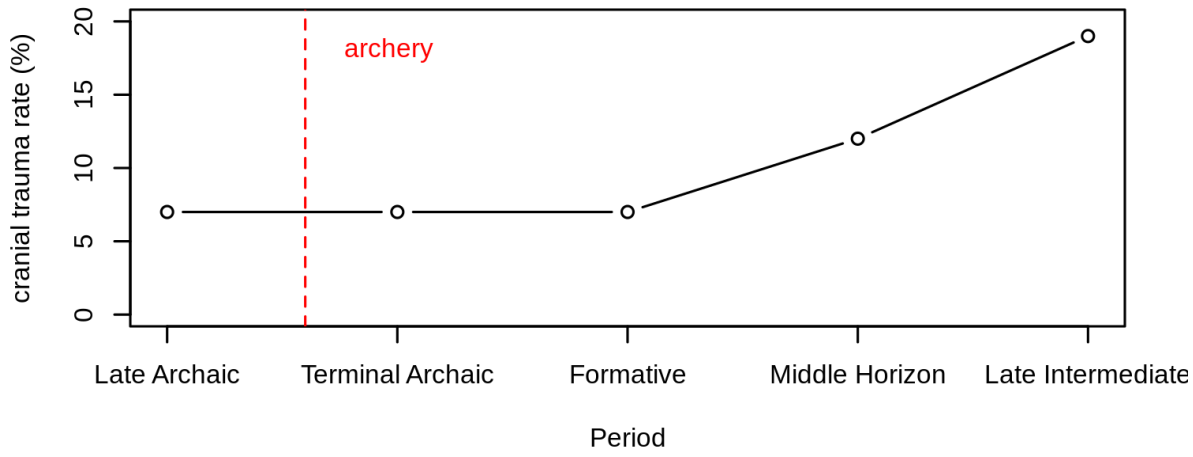


Figure 24. Cranial trauma rates over time in the Altiplano, relative to the suspected period of archery introduction.

5.4. **Summary and discussion**

5.4.1. ***The introduction of bow-and-arrow technology***

The timing and consequences of the introduction of archery technology in the South-Central Andes are the subject of ongoing anthropological research, with potential implications for our understanding of the region's emerging complexity. Our diachronic analysis of projectile point size reveals a dramatic decrease during the Terminal Archaic Period, consistent with the hypothesis that bow and arrow technology first appeared in the regions shortly after 5000 years ago. Importantly, our analysis does not detect any significant size changes between the Terminal Archaic and Formative periods, failing to support the alternative hypothesis of a Formative Period origin of archery technology in the South-Central Andes.

The first ostensible arrow points appear to have been unstemmed, unshouldered, small triangular forms, which have been classified as series 5 (especially types 5A, 5B, and 5D) (Klink and Aldenderfer, 2005). Well-dated features from several sites in the Titicaca Basin and in the northern nearby of the South-Central Andes (Craig, 2005; Kitchel et al., 2022; Klink and

Aldenderfer, 2005; Lefebvre, 2004; Panczak, 2019) indicate that this type of point first appeared as early as 5000 years ago during the Late Archaic Period, but it did not become popular until the Terminal Archaic Period. We also suspect that the small, broad-stemmed 4F points (Klink and Aldenderfer, 2005) were used as arrow points, or perhaps for both dart and arrow points, during the Terminal Archaic Period. These points are miniature versions of Late Archaic 4D points and are encountered at Terminal Archaic sites in the Titicaca Basin like Jiskairumoko and Kaillachuro. Although some have suggested that 4F points are simply resharpened 4D points (Fortin, 2015; La Favre, 2011; Panczak, 2019), this cannot be the case in the Titicaca Basin, where the two types differ by raw material, with 4D points typically made from volcanics and 4F points typically made from cherts. Although misclassification of surface assemblages could compromise this conclusion, we note that Kitchel et al. (2022) made the same observation among a smaller sample of well-dated excavated assemblages spanning the Late/Terminal Archaic boundary. The dramatic size decrease across the Late/Terminal Archaic boundary is therefore clear. Further point-size diminution is not evident until the Tiwanaku Period, which favored highly miniaturized points with narrow stems.

Our results support the hypothesis of early bow and arrow use in the Titicaca Basin, as proposed by previous researchers in the highlands (Klink and Aldenderfer, 2005; Kitchel et al., 2022) as well as on the South-Central coast (Bittmann and Munizaga, 1979; Uhle, 1917). Okumura and Araujo (2015) have proposed an even earlier adoption of this technology in Brazil based on the metric analysis of projectile points. We cannot reject that proposition for the South-Central Andes using Shott's (1997) one-proxy solution discriminant method. In other words, following this method, it is impossible to rule out the possibility that this technology existed during the Early and Middle Archaic periods. However, our threshold analysis supports the conservative hypothesis that

dart technology was the main and likely exclusive projectile technology of the Early Holocene. It is also likely that small early projectile points were small dart points (Castro and Marsh, 2022; Marsh et al., 2023).

We consider that these quantitative methods can be effective in differentiating between two distinct technologies, but they are less useful in differentiating between variations of the same technology (for instance, between large and small darts) based only on mathematical calculations. Indeed, the set of Early Archaic small points is not as small as the Terminal Archaic or later points identified here as arrow points. We further observe that projectile point size changes in the Early—Late Archaic periods are far less dramatic than in the Terminal Archaic Period, suggesting a consistent technological system in the former and a technological change in the latter. The discriminant function and threshold approaches reveal that the first significant change in Titicaca Basin point size—changes that traverse previously identified size thresholds for dart and arrow points—occurred in the Terminal Archaic Period and likely coincides with the introduction and rise in popularity of archery technology.

We emphasize that the hypothetical introduction of archery technology during the Terminal Archaic Period does not entail the abandonment of atlatl technology. To the contrary, atlatl technology persisted well into the Tiwanaku Period. Rather, the metric data presented here support the hypothesis of archery/atlatl coexistence during the Terminal Archaic and subsequent periods, as other authors have previously suggested (Castro et al., 2018, 2021; Castro and Marsh, 2022; De Souza, 2004, 2011; Kitchel et al., 2022; Oliszewski et al., 2018; Owen, 1998). The continued use of the atlatl alongside bow-and-arrow may explain why large points persist into and beyond the Terminal Archaic Period such as with the 5C type and why some portion of projectile points are relatively large despite mean size values favoring arrow points.

Regarding the spread of the bow and arrow technology in the Andes, Silvina Castro and colleagues suggest that this technology moved from north to south, from the Titicaca Basin to Patagonia (Castro et al., 2021; Castro and Marsh, 2022). Archaeological reports of small points at sites such as Asana and Hakenasa, in addition to those reported here from Titicaca, suggest that the original area of this technology was broad, encompassing the entire north of the South-Central Andes, the western sierras, and the Titicaca Basin. In the Chilean and Argentinean Sierra de Atacama, several authors propose archery technology to have originated 3500 years ago (Castro et al., 2018; De Souza, 2004; Hocsman, 2010; Oliszewski et al., 2018). These triangular points with a concave base become common in the Late Period (900–1500 AD) throughout Northwestern Argentina, and interestingly some of them have been found hafted on arrows in Tastil, Salta (Cigliano, 1973; Varde & Muscio, 2018). Meanwhile, in the Southern Andes, archery was reported to have entered as late as 1000 BP (Castro et al., 2018). In the extreme south of Patagonia, this technology was only adopted a few centuries before the arrival of the European conquerors (Charlin et al., 2016; Charlin & González-José, 2018). In this broader geographic and temporal context, it should not be surprising that the earliest evidence of archery technology is found north of the Central-South Andes, in the Lake Titicaca Basin, though further research is needed to determine the cultural mechanisms that led to its transmission. This work has already been done, for instance, in northwest Argentina, where evidence suggests that the technology was transmitted biasedly (Varde and Muscio, 2018).

5.4.2. ***The social impact of archery technology***

Having established the most likely period of archery technology's origin in the South-Central Andes, we can now examine its effects on social organization. During the Terminal Archaic Period, both settlement size and access to non-local resources increased. In the Ilave Valley, researchers

observed an increase in settlement size and a decrease in the total number of sites, which were interpreted as the outcome of a population aggregation process (Aldenderfer, 2002; Craig et al., 2010). Our analysis verifies this observation in the Ilave valley and finds the same pattern in the Ramis valley, albeit to a greater degree. Increased site size indicates that there are more people inhabiting a specific settlement (population aggregation); however, in the Titicaca Basin, researchers have nevertheless documented regional population declines during these times, thus settlement aggregation does not necessarily entail an overall population increase (Albarracin-Jordan & Mathews, 1990; Bandy, 2001; Klink, 2005). In the Ramis Valley, settlements grew even more dramatically during the next Formative Period. This was not the case in the Ilave Valley Formative Period, where we do not detect any significant site-size change. We currently do not have a behavioral explanation for this regional difference, but we cannot rule out sampling effects. Nonetheless, our observation for the Ramis region is consistent with what has been previously reported in the Titicaca Basin (La Favre, 2016; Marsh, 2015; Stanish, 2003).

The growing settlements of the Terminal Archaic and Formative periods were increasingly integrated into obsidian exchange networks that also included gold and copper (Aldenderfer et al., 2008; Craig, 2005). During the Formative Period, these networks were capable of acquiring enormous quantities of obsidian. For example, in the Ramis Valley, north of Titicaca, 93.3% of projectile points were made of obsidian. In contrast, as we move further south of the Titicaca Basin, these networks weaken. In the Ilave Valley, they still acquired obsidian, but it was less than half of what the northern population obtained. Further south, the Formative Period inhabitants of the Tiwanaku valley were unable to acquire non-local raw materials such as obsidian and black basalt (Giesso, 2011). The concentration of obsidian in the north likely reflects a concentration of socioeconomic power in that region (Stanish, 2003; Hastorf, 2003).

Thus, our results support previous models that identify the Terminal Archaic Period (5–3.5 cal ka) as a transitional time of dramatic technological and social change that included the emergence of village life, the domestication of camelids and plants such as potatoes and quinoa, the first burial mounds, the trade of exotic goods and pottery technology, and archery technology (Aldenderfer, 2002, 2004, 2012; Aldenderfer et al., 2008; Craig et al., 2010; Flores-Blanco, 2014; Kitchel et al., 2022; Rumold & Aldenderfer, 2016; Watson & Haas, 2017).

This temporal convergence of events is consistent with the coercion and warfare hypotheses, which envision that archery technology catalyzed aggregation and exchange. The data furthermore contradict Bettinger's (2013, 2015) model of ordered anarchy, which hypothesizes that archery technology fostered greater autonomy and smaller groups with restricted levels of exchange. Moreover, we fail to find support for the warfare model. Interpersonal violence rates in the Titicaca were relatively stable throughout the Titicaca Basin Archaic and Formative periods. The one model that we are unable to exclude is the coercion model, which envisions that archery technology facilitated inter-group cooperation, which led to larger settlements, enhanced trade networks, and unchanging violence rates despite the intensification of inter-personal interactions.

While the evidence favors the Bingham and Souza coercion model, it may also support the two-stage coercion and warfare model proposed by Kennett et al. (2013). The first clear evidence of inter-group violence in the Titicaca Basin appeared during the Upper Formative Period (Stanish and Levine, 2011). The site of Taraco was burned around 2000 BP, ostensibly by the Pukara power center, which cut off obsidian supplies and decorated pottery to Taraco. However, the violence data presented here reveals a slight uptick in rates since the Middle Horizon Period and a continuing upward trend, with 19% of trauma rates occurring during the Late Intermediate Period.

The perimortem trauma data further indicate that violence rates did not increase until the Tiwanaku Period, but the increase relative to the prior periods is small and statistically insignificant ($\chi 2 < 0.01$, $p = 1$). It was only during the Late Intermediate Period that violent trauma levels increased significantly in the South-Central highlands (Arkush, 2022; Arkush and Tung, 2013), when trauma rates increased almost three-fold from 7% prior to the LIP to 19% in the LIP ($\chi 2 = 0.51$, $p = 0.47$). Consistent with this observation, hilltop fortification is not evident until the Late Intermediate Period (Arkush, 2022). Thus, the increase in violence occurred at least several millennia after the introduction of archery technology. It is also instructive that arrowheads are rare from Late Intermediate Period contexts (Arkush, 2022), further suggesting that archery technology did not play a prominent role in structuring violence among South-Central Andean communities.

The militarized state model of Tiwanaku is extensively criticized because there is no clear evidence that violence increased during this period (Goldstein, 2007; Janusek, 2004). Coinciding with this, previous data showed that Tiwanaku Period 4E projectile point frequencies dropped significantly (Klink and Aldenderfer, 2005). Thus, researchers have investigated alternatives to the assumption that the Tiwanaku utilized the points as arrowheads, such as the possibility that they were knives or multipurpose instruments (Fortin, 2015; Hu, 2016). These 4E points are chronological markers for the Tiwanaku Period but occasionally occur in Late Formative Period contexts (Hu, 2016). Researchers have indicated that both 4E points and decorated ceramics and textiles are representative goods of the Tiwanaku elite or local elites acquiring them for a prestige bias, as happened in northern Chile (Klink & Aldenderfer, 2005; Uribe & Aguero, 2001). If this is the case, the widespread presence of this type of point, along with other indicators such as ceramics, would be signs of Tiwanaku presence in the region. However, our analysis found only

five type 4E points, four from the Ilave Valley and one from the Ramis Valley. This is despite the thorough survey of the Ramis region using 5–10 m transects (Aldenderfer & Flores-Blanco, 2008). This is a notably low frequency (0.4%) for an analyzed collection of 1179 complete points, especially considering that this is the period of greatest population size and the most recent period with the least taphonomic effect (Surovell et al., 2009). The scarcity of 4E projectile points can be explained by the fact that the regions where our samples were collected were not under Tiwanaku control. These patterns differ from the heart of Tiwanaku (Giesso, 2011) and the coastal areas into which Tiwanaku expanded (Owen, 1998; Reid et al., 2022).

Although warfare clearly characterizes the Late Intermediate Period, the sparse evidence for violence during all earlier periods indicates that archery technology was unlikely to have elevated warfare. Only the coercion model is left as a viable account of how archery technology could have affected social dynamics in the region. We find that the introduction of the bow and arrow during the Terminal Archaic Period coincided with settlement growth and increasing levels of exchange.

5.5. **Conclusions**

We conclude that the introduction of archery technology in the Titicaca Basin most likely occurred approximately 5000 years ago and coincided with increasing levels of socioeconomic complexity throughout the Terminal Archaic Period (5.0–3.5 cal ka). These changes included the expansion of long-distance exchange networks and settlement size growth. These social changes were more pronounced in the Ramis Valley than in the Ilave Valley.

Furthermore, communities in both valleys, particularly in the Ramis, began to import large quantities of non-local obsidian. When we compare the distribution of obsidian in the Ramis and Ilave valleys, we detect a dramatic increase in obsidian preference during the Terminal Archaic

Period in both regions, with the Ramis region having far higher rates of use. Clearly, Ramis inhabitants were better integrated into long-distance exchange networks of raw materials than those of the Ilave Basin, which may simply reflect the Ramis region's proximity to the Chivay and Alca obsidian sources. Alternatively, the Ilave Valley may have operated more autonomously in a way that limited access to exotic goods, as suggested by Bettinger's orderly anarchy model.

Although a causal link between archery technology and social change has not been demonstrated, the timing of bow-and-arrow introduction, site growth, and obsidian exchange is consistent with hypotheses that identify a causal link between archery technology and social change. The broad agreement between the Titicaca Basin data and Bingham et al.'s (2013) social coercion model suggests that archery technology may indeed have promoted increasing socioeconomic complexity in the region. It may be that the archery technology helped stabilize violence in the face of increasingly dense settlements and inter-community connectivity. There are several ways this could have happened. First, it may be that the bow-and-arrow made a broader range of subsistence activities possible, which alleviated competition, as Bettinger (2013, 2015) has suggested. It's also possible, as Bettinger suggests, that the bow-and-arrow increased the costs of raiding, thus deterring such behavior. Of course, we do not want to give the impression of a mono-causal mechanism. If archery technology had any role in the changes in social organization that appeared in the Terminal Archaic Period, it was likely just one of many factors that are evident in the Terminal Archaic record. Consistent with neoevolutionary models (Aldenderfer, 1993, 2004; Henrich et al., 2010; Stanish, 2017), Terminal Archaic and Formative societies of the Altiplano overcame the challenges of population aggregation and the resulting social tensions by developing new social mechanisms such as incipient trade centers (exchange of non-local goods such as obsidian) and religious beliefs, as evidenced by the emergence of monumental architecture and

ancestor worship (Hastorf, 2003; Levine et al., 213; Stanish et al., 2002). In this view, archery technology may have facilitated social cohesion by alleviating density-dependent stress and deterring non-cooperative behaviors in ways that held violence at bay.

Author contributions

LFB and RH designed the analysis. LFB, MA, CS and RH recovered the materials. LFB, LC, MA, and RH collected the data. LF and RH wrote the manuscript. LFB prepared the plots and tables. LFB performed the statistical analysis, reviewed by RH. LFB, MA and CS edited the manuscript. This paper is a part of the first author's PhD dissertation.

Data availability

All data required to evaluate the conclusions in the paper is either included in the paper itself or is available in the Supplementary Materials.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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6. CONCLUSIONS

The objective of this dissertation was to investigate the social dynamics that accompanied emergent socioeconomic complexity on the Andean Altiplano. To what extent was inequality part of those dynamics? The archaeological site Kaillachuro, in the Titicaca Basin, was the empirical focus of this investigation. As the region's earliest human burial mound site, constructed during the transition from foraging to agropastoral economies, Kaillachuro offers a rare opportunity for empirical evaluation of various models of the relationship between social inequality and complexity. Not only do the mounds seem to signal new social relations in their own right, but their contents also promised to shed new light on community dynamics during a critical time in Andean prehistory.

Establishing the site's chronology was the first critical step. Before conducting my research at Kaillachuro, I anticipated that mound construction commenced approximately 4500 years BP and continued in multiple episodes until approximately 3200 years BP, extending into the Early Formative Period. These expectations followed from radiocarbon dates recovered from Kaillachuro Mound 4 during a limited testing effort in 1997. The examination of the projectile points identified on the surface suggested Terminal Archaic and Formative Period components (Craig, 2005). Such findings are furthermore consistent with prior research at other Andean sites, which demonstrates that monumental architecture was widespread during the Formative Period (Cohen, 2010; Hastorf, 2003, 2008).

The investigations reported here expanded on the previous testing effort, integrate that unpublished field data, and found that Kaillachuro mounds formed in multiple construction episodes between at least 5300 to 3000 cal BP. The finding of funerary features in the mounds

establishes their ceremonial purpose. Moreover, the abundance of chipped stones and groundstone artifacts in the vicinity of the mounds also indicates domestic activities.

Although Andean archaeologists have documented signs of ceremonial activities in the form of burial pits since the beginning of human occupation in the Titicaca Basin (R. Haas et al., 2020; R. Haas & Viviano, 2015), our research has demonstrated that Kaillachuro shows the earliest ceremonial architecture that is visible on the landscape, in the form of small burial mounds, from at least 5000 years ago (Chapter 3).

Having secured the site's chronology, I then sought to evaluate the nature and extent of status among the interred individuals. Who was buried in the mounds, and how elaborate were their burials? We have shown from several lines of evidence—contextual, radiocarbon dating, osteological, and isotopic—that mound-building behavior did not originate in a society characterized by a rigid social hierarchy and powerful leaders. Instead, this behavior arose from the establishment of ceremonies around death.

Consequently, I conclude that the purpose of constructing burial mounds is to function as ceremonial/ritual structures that memorialize the death and thus serve as a focal point for communities, establishing norms, customs, and punishments that promote orderly community life. This conclusion is consistent with the opinions of other Andean scholars, who emphasize the significance of ceremonial centers as points of attraction for local communities. Kaillachuro may have started out as a place for family member burials, but repeated burials—for instance, over twenty individuals in Mound 4—and the site's use for funerary purposes for more than two thousand years gave Kaillachuro a sense of place that extended beyond kinship relations. This ensured that the site has long-term continuity because became a place of community commemoration. Thus, Kaillachuro housed different members important to the history of the

community. For other cases in the Andes, we do not find that the emergence of ceremonial and monumental architecture in places like Caral or Kotosh, or later Chavin and Pucara, is based on burial mounds, but rather on public architecture to receive people (Bonnier et al., 1988; E. A. Klarich, 2005; Rick, 2004; Shady & Leyva, 2003). These differences also raise some questions, why in places like Caral, were massive pyramid-level buildings managed to be built, which were not achieved in places like Kaillachuro? Could variations in the accessibility of natural resources have contributed to these variations? What role did leaders play in this path towards social differentiation and complexity? Do we have different paths of social formation in the Andes?

Another remarkable aspect is that such big changes in the Titicaca Basin appear to have been initiated by hunter-gatherer societies, maybe in transition to agropastoral. As we extensively explored in Chapter 1, numerous ethnographic and archeological studies have demonstrated that hunter-gatherer societies may not always possess simple social structures and are not even necessarily egalitarian, as Wiessner argues (2002: 251) "*egalitarianism is not the product of simplicity*". In the case of Kaillachuro, we have demonstrated that a society can achieve forms of social complexity while maintaining low levels of inequality. The level of complexity in the Kaillachuro case has been demonstrated by empirical data, including the presence of burial mounds, the use of non-local raw materials, differences in sex in access to burial in the mounds vs no-mounds, and the introduction of new technologies such as the bow and arrow, pottery, and metals. The archeological evidence suggests that the Kaillachuro society was in the process of establishing socioeconomic institutions that were connected to religious beliefs, specialized spheres based on gender, and interregional exchange networks.

In Chapter 5, I examined the extent to which archery technology could have been causal or consequential to the other socioeconomic developments during the Terminal Archaic Period. To

do this, I first examined the timing of arrow-point technology in the region and second compared that timing to other socioeconomic changes in the region. We found that the people of Kaillachuro, as well as the Titicaca Basin as entirety, most likely started producing small triangular lithic points that were utilized as arrowheads beginning around 5 cal. ka. This finding demonstrates that this introduction of this novel weapon system could not have been a consequence of the growing social complexity, but rather may have contributed to the development of this new social dynamic. Moreover, this finding establishes the South-Central Andes as the earliest locus of archery technology utilization in the Americas and demonstrates that it likely took place alongside other technological advancements, including monumental architecture, the first crops, the domestication of camelids, and the use of ceramics and metals.

Therefore, the discoveries made at Kaillachuro have surpassed our expectations by an exponential margin, not only in terms of the site's age but also in its significance in elucidating the neolithization process in the South-Central Andes from various perspectives and lines of evidence, as we developed in this dissertation. In the forthcoming years, it is essential to further develop this approach, while simultaneously increasing the empirical data on both spatial and temporal dimensions. To have a comprehensive understanding of this process, it is necessary to conduct additional archaeological investigations at sites dating back to the Late Archaic, Terminal Archaic, and Early Formative periods in the Andean Altiplano. Additionally, we necessitate digging into the collections of previous excavations. For example, as seen in Chapter 2, a substantial amount of information is predominantly contained within dissertations. Therefore, a systematization of said data is required, and specialized analysis is carried out.

6.1. **Next Steps**

Although the archaeological efforts reported here were problem-oriented, the excavations at Kaillachuro generated new questions and additional data that ought to propel further research, whether by myself or by other investigators. Here, I present a few potential directions.

While scholars have recognized the significance of an emerging agropastoral economy in the Altiplano (Capriles, 2014a, 2014b; Marsh, 2015), there is a general lack of empirical research on materials from the suspected period of economic transition. To date, systematic investigation of Terminal Archaic faunal or archaeobotanical assemblages are entirely lacking in the Titicaca Basin. Yet, such analyses are necessary to validate current models of economic transformation in the region. Our research team has identified a substantial quantity of faunal remains, which we suspect are primarily camelids. However, we have not yet conducted a comprehensive investigation of these remains. Along with the Jiskairumoko fauna collection, the Kaillachuro collection can provide insights into the domestication of camelids and their subsequent uses.

The isotope findings presented in Chapter 4 indicate that the Kaillachuro inhabitants primarily consumed C3 plants. Camelid meat must also have been a component of the diet, as revealed by the presence of bone remains that we have recovered (Chapter 3). However, we do not know if they were a daily meal or for special events around death ceremonies. I predict that camelids were also consumed in rituals such as those associated with the Kaillachuro dead and played a fundamental role in the establishment of obsidian exchange networks during the Terminal Archaic Period. Consequently, researchers should pay attention to certain clues in animal bones that could potentially falsify this suggestion.

Recent isotopic investigations have highlighted the importance of plants during the diets of the Archaic and Formative periods (Capriles et al., 2021; J. Chen et al., 2024; Juengst et al.,

2021; M. Miller et al., 2021). Plant taxa contributed to Archaic diets has been the subject of archaeobotanical investigation more extensively than zooarchaeological study. Although a systematic investigation of Terminal Archaic archaeobotanical remains lacking, researchers have conducted more extensive research (Chapter 2). *Chenopodium* appears to have been essential to this ancient Altiplano diet (Bruno et al., 2018; Bruno & Whitehead, 2003; Langlie et al., 2011; Murray, 2005). Tubers also appear to have played a prominent role in Archaic diets of the region (J. Chen et al., 2024; Rumold, 2010; Rumold & Aldenderfer, 2016; Watson & Haas, 2017). However, the consumption of tubers brings with it an issue that has not been sufficiently addressed by archaeologists. Detoxification is necessary. Unlike other plant species, wild potatoes have high quantities of toxic phytochemicals, requiring mechanisms to reduce them. Merely preparing the potatoes through cooking or peeling is insufficient. Detecting this detoxification will subsequently provide insight into the domestication process of potatoes. The domestication of potatoes would have been facilitated by the consumption of larger tubers with clays (geophagy), according to an ecological-chemical model (Johns, 1989). This is because larger tubers contain lower concentrations of glycoalkaloids than smaller ones. Paleobotanists will, nevertheless, be compelled to seek out more microscopic techniques in order to detect the presence of micro residues of tubers in starches and phytoliths (Rumold & Aldenderfer, 2016). The Kaillachuro botanical collection has been obtained by flotation and analysis is currently underway. I anticipate the discovery of quinoa and potato seeds with signs of transition to domestication.

These pieces of information possess the potential to improve our comprehension of the roots of social inequality and the assignment of roles according to sex. Numerous scholars have posited that these two significant transformations were precipitated by agriculture and sedentary lifestyles (Aldenderfer, 2006b; Hansen et al., 2015; Kelly, 2013; Kohler et al., 2017). Although the

data gathered from Kaillachuro is insufficient to provide conclusive answers to these major questions, it has yielded novel evidence that has provided an insight into this period of transition. In the context of a society that was relatively egalitarian, Kaillachuro was a community that initiated the construction and utilization of ceremonial architecture for its deceased. This recurring ritual practice resulted in a modest form of monumental architecture, and these mounds served as the final resting places for situational leaders. A low-level hierarchy appears to have existed, with a preference in the burial of male adults and significant investment in funerary architecture for male children. This observation is consistent with observations in other parts of the world where egalitarian societies were not without inequalities and were in transit to agricultural economies (Arnold, 1993, 1996; Kelly, 2013; Roscoe, 2012). However, we have also found that burial practices were diverse, with leadership being limited during this time period. By examining adjacent sites with non-mound burials, including Jiskairumoko and, later, the Early Chiripa phase, we observe that females featured more prominently.

Kaillachuro holds significant potential for further investigation. We have investigated only four of the eleven mounds, of which only two show clear evidence of funerary use (M4 and M6). One of them (M1) was dismantled by an Inca occupation, and in another (M5), we have found holes with burning remains dating from the Terminal Archaic Period but no burials. It would be advisable to excavate additional mounds to clarify the formation process of these complicated mounds.

The extent to which the mounds were associated with domestic activities also remains unverified. The presence of ground stone and abundant lithic tools and debitage suggest domestic evidence at Kaillachuro, but we have not found direct evidence, such as habitation units like those reported at Jiskairumoko. This may be explained by a long history of deep, mechanical plowing.

Such activities likely disturbed any intact houses if they were present at Kaillachuro. Systemaitic analysis of artifact distributions could offer insight into residential locations. We wonder if they lived as close as around the mounds, or perhaps they lived in nearby villages like Jiskairumoko?

Finally, this dissertation does not cover themes such as mobility and the process of a sedentary lifestyle. However, Kaillachuro can provide valuable insights into these issues through isotopic analyses, specifically focusing on O and Sr. Furthermore, the ancient DNA analysis could provide insight into whether the population responsible for constructing the mounds of Kaillachuro are locals or not to the Titicaca Basin.

The evidence presented in this dissertation shows that the emergence of social complexity in Kaillachuro did not depend on powerful chiefs or institutionalized inequality. Nonetheless, the emergence of a ceremonial place around the dead appears to have catalyzed low-level hierarchy along gender lines, a sexual division of the social spheres, ceremonial/male (at Kaillachuro) and domestic/female (at Jiskairumoko), but without causing unequal access to food and mortuary goods. Thus, Kaillachuro's research has answered several anthropological questions while also highlighting areas in need of additional investigation. In fact, I will be conducting a more extensive excavation at Kaillachuro during the summer of 2024. This endeavor holds tremendous potential for yielding archaeological features as well as a more substantial sample of organic and inorganic remains, where we expect to address some of the outstanding questions about the emergence of complexity at Kaillachuro and among early Altiplano communities more generally.

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8. **APPENDICES**

Appendix 1. Kaillachuro Radiocarbon Dating Table

ID	Laboratory ID	Provenance						Radiocarbon BP		Radiocarbon cal BP	
		Material	Block	Unit / Grid	SU*	Level	Context	Age	Error	cal BP (95.4%)	Mean cal BP
1	UCIAMS-278130	Human tooth	3	1	4		bone in fill	4615	25	5329-5265	5262
2	UCIAMS-278133	Human bone	3	4	10		bone in basin	4580	25	5195-5050	5185
3	UCIAMS-259860	Human tooth	3	CE	18**	b	Burial 1	4575	20	5192-5051	5180
4	D-AMS 052910	Human bone	3	1	4	b	Burial 4	4516	24	5294-4977	5150
5	D-AMS 047363	Human bone	3		20**		Burial 2	4500	27	5294-4963	5131
6	D-AMS 047364	Human tooth	3	T1S***			Loose tooth near a metal disc	4503	28	5294-4966	5134
7	UCIAMS-278131	Animal bone		2E	4		camelid in trench	4190	20	4827-4576	4699
8	UCIAMS-259845	charcoal	6	SE	4		hearth in the fill	4175	20	4824-4570	4686
9	UCIAMS-278139	charcoal	4	SC	6		ash level	4135	15	4654-4519	4634
10	UCIAMS-278141	charcoal		3	6		charcoal in pit	4115	15	4649-4512	4591
11	BETA-112315[+]	charcoal	3		V		Stone box	3960	50	4533-4147	4352
12	UCIAMS-259859	Human bone	6	CE	9		Bone in fill	3495	20	3831-3681	3738
13	UCIAMS-278132	Human bone	3	T1S	N6-R1		Loose bone in fill 10-cm from a B7	3440	20	3719-3571	3651
14	UCIAMS-259841	charcoal	5	CC	11		midden pit	3425	15	3695-3569	3630
15	UCIAMS-278140	charcoal	3	1	3	c	Occupation level	3360	15	3588-3482	3532
16	D-AMS 052909	Human bone	3	4	13/14		Burial 5	3294	24	3392-3563	3466

17	D-AMS 047365	Human bone	6		9	stone platform	3123	38	3385-3172	3288
18	UCIAMS-259861	Human bone	3	CE	10**	Burial 3	3050	15	3267-3137	3210
19	UCIAMS-278134	Human tooth	3	4	13/14	Burial 5	3005	20	3230-3002	3132
20	D-AMS 047367	Animal bone	1		10	Intrusive burial	340	24	448-355	383
21	D-AMS 052911	Human bone	6	Trench 2[++]	VI	Intrusive burial	472	20	520-462	493

* Stratigraphic Unit (SU)

** We renamed 2021 and 2022 SUs to provide the recording unique strata numbering. For the 2021 season, SU-18 instead of 3, SU-20 instead of 4 and SU-10 instead of 7. Other changes: SU-7 instead of 6, SU-19 instead of 5, and SU-17 instead of 2. For the 2022 season, just a few changes, SU-16 instead of 17, SU-21 instead of 18, and SU-16 is within 10.

*** Trench 1 South (T1S).

[+] Old radiocarbon date from Kaillachuro (Craig 2005).

[++] Excavation 2002 (Craig 2005)

Appendix 2. Periodization of the Kaillachuro stratigraphic sequence.

Periods	**Phases**	**Events**	**SU (Stratigraphic Unit)**	**Features**	**# Radio-carbon dates**	**Date (Cal BP)**
Inca?	5	Intru-sive	SU-1	burials in M1 and M6	2	520-400
Early Formative	4	C	SU-2	Third M4, Last M6	4	3500-3000
		B	SU-10	Burial 3, slabs		
		A	SU-11, SU-12, SU-13, SU-14 (Burial 5), SU-15, SU-16 (Cist)	Burial 5, Cist, Platform		
	3		SU-3	Second M4	4	3800-3500
Terminal Archaic / Late Archaic	2			Box Stone	5	4800-4100
	1	B	SU-4, SU-6, SU-18	Burial 4, First M4	6	5300-5000
		A	SU-7, SU-8, SU-9, SU-19, SU-20	Burial 1, Burial 2		
			SU-21 (sterile layer)		Total: 21	

* M4 = Mound 4 / M6 = Mound 6

Appendix 3. Detailed data on the presence and quantity of burial elements from the Kaillachuro burials (n=17).[1]

ID	Location						Goods						
	Burial	# indiv	Sex	Age	Context	Period	Obsidian	Metal	Bead	Ochre	Ceramic	Other	Architecture
1	Burial 1	2	Male & female	adult	mound fill	Late Archaic							
2	Burial 2	1	unidentified	adult	burial pit	Late Archaic	1 debris		1 green stone			1 point, silex knife, silex debris	
3	Burial 3	3	male	adult	mound fill	Early Formative	12 flakes and debris		1 stone	1 fragment		2 silex scrapers, debris	
4	Burial 4	3	male	adult	mound fill	Terminal Archaic	1 flake			1 fragment			
5	Burial 5	1	male	child	cist	Early Formative	projectile point			deposit		silex projectile point	1
6	B4	2	unidentified	adult			debris			1		1 silex point, 1 nucleo cuarcita, lascas	
7	B5	1	male	adult			3 points + debris		1	1			
8	B6	1	unidentified	adult								silex flakes	
9	B7	1	unidentified	adult		Terminal Archaic	debris		1 silex		5	1 raspador silex,	

[1] The burials labeled as B (e.g., B4) are from the collection of the Mark Aldenderfer project. Aldenderfer authorized the use of his field notebook data.

											perforador silex, 1 raedera calcedonia, 1 preforma silex, 11 nucleos	
10	Box burial	1	unidentified	child	stone box	Terminal Archaic	projectile point and debris		deposit			1
11	T2/F5	1	female	adult	M6?	Terminal Archaic?			1	7		

Appendix 4. Data on the presence and quantity of burial elements from the Jiskairumoko burials (Aldenderfer, 2004; Aldenderfer et al., 2008; Craig, 2005, 2012).[2]

ID	Location							
	Burial	# individuals	Type of burial	Sex	Age	Cranial deformation	Context	Period
1	Burial 1	1	Primary	female	older adult	bilobate	pit burial	Late Archaic (4275 ± 46 B.P.)
2	Burial 2	3	Secondary	NA	adult + 2 non-adults	No	pit burial	Terminal Archaic (3733 ± 43 B.P)
3	Burial 3	1	Secondary	female	older adult	bilobate	pit burial	Terminal Archaic (3450 ± 45 B.P. & 3341 ± 45 B.P.)
4	Burial 4	1	Secondary	NA	adult	No	pit burial	Terminal Archaic?
5	Burial 5	1	Secondary	NA				Terminal Archaic?

→ Continuation

ID	Goods						
	Obsidian	Metal	Stone Bead	Ochre	Ceramic	Groundstone	Other
1	2	0	4 lapislazuli	0	0	1	1 Camelid effigy in level IIIe, above the context of burial 1. It is not an offering but is associated + 6 non-obsidian artifacts
2	0	9 gold beads	11 circular greenstone beads	0	0	1 (immediately above Burial 2)	1 unifacial scraper made of orange quartzite
3	0	0		Ground ochre dust		1	2 chipped stone tools
4	0	0	0	1	0	4	some of the bones in the burial are large mammal
5				Ground ochre dust			

[2] Most of the information was collected from Craig (2005).

Appendix 5. Quantified and distributed data on the funerary elements from the Kaillachuro burials.

ID	Burial	Age	Sex	Obsidian	Ochre	Bead	Architecture	Non-obs point	Subtotal	Total x burial
1	Burial 1	Adult	Male	0	0	0	0	0	0.00	0
2		Adult	Female	0	0	0	0	0	0.00	
3	Burial 2	Adult	Indet	1	0	1	0	1	3.00	3
4	Burial 3	Adult	Male	4.3	1	0.33	0	0	5.63	17
5		Adult	Indet	4.3	1	0.33	0	0	5.63	
6		Adult	Indet	4.3	1	0.33	0	0	5.63	
7	Burial 4	Teen	Male	0.33	1	0	0	0	1.33	4
8		Child	Indet	0.33	1	0	0	0	1.33	
9		Adult	Indet	0.33	1	0	0	0	1.33	
10	Burial 5	Child	Male	1	1	0	1	1	4.00	4
11	B4	Adult	Indet	0.5	1	0	0	0.5	2.00	4
12		Adult	Indet	0.5	1	0	0	0.5	2.00	
13	B5	Adult	Male	4	1	1	0	0	6.00	6
14	B6	Adult	Indet	0	0	0	0	0	0.00	0
15	B7	Adult	Indet	1	0	1	0	0	2.00	2
16	Box	Child	Indet	2	1	0	1	0	4.00	4
17	T1/F5	Adult	Female	0	1	0	0	0	1.00	1

References: The date information comes from my own research (Burials 1, 2, 3, 4, 5), but data from the Mark Aldenderfer excavations of the 1990s is also incorporated. He authorized the use of his field notebook data.

Appendix 6. The results of isotopic analysis of samples from several archaeological sites in the Titicaca Basin. Raw and adjusted isotopic values are shown.

Sites	Period	Class	d13C	d15N	C/N	Adjusted_d13C (-5.25)	Adjusted_d15N (-4.5)	Reference
Kail-lachuro	Late Archaic	mound	-19.2	8.6	2.6	-24.45	4.1	Flores-Blanco
Kail-lachuro	Late Archaic	mound	-19.2	8.5	2.6	-24.45	4	Flores-Blanco
Kail-lachuro	Late Archaic	mound	-19.1	8.1	2.8	-24.35	3.6	Flores-Blanco
Kail-lachuro	Late Archaic	mound	-18.9	9.1	2.4	-24.15	4.6	Flores-Blanco
Kail-lachuro	Late Archaic	mound	-18.8	9.2	2.4	-24.05	4.7	Flores-Blanco
Kail-lachuro	Late Archaic	mound	-18.9	9	2.5	-24.15	4.5	Flores-Blanco
Kail-lachuro	Terminal Archaic	mound	-19.7	6.9	3.3	-24.95	2.4	Flores-Blanco
Kail-lachuro	Terminal Archaic	mound	-17.4	11.6	1.8	-22.65	7.1	Flores-Blanco
Kail-lachuro	Terminal Archaic	mound	-18.9	6.5	3.4	-24.15	2	Flores-Blanco
Kail-lachuro	Terminal Archaic	mound	-19.6	6	3.8	-24.85	1.5	Flores-Blanco
Kail-lachuro	Terminal Archaic	mound	-18.2	9.9	2.1	-23.45	5.4	Flores-Blanco
Jis-kairumoko	Terminal Archaic	non-mound	-18.3	10.4	2.7	-23.55	5.9	Flores-Blanco
Jis-kairumoko	Terminal Archaic	non-mound	-19.3	8.6	2.7	-24.55	4.1	Flores-Blanco
Jis-kairumoko	Terminal Archaic	non-mound	-19.03	8.96	2.7	-24.28	4.46	Flores-Blanco
Jis-kairumoko	Terminal Archaic	non-mound	-17.7	11.3	2.7	-22.95	6.8	Flores-Blanco
Muruqullu	Terminal Archaic	non-mound	-17.9	10.9		-23.15	6.4	Juengst et al. 2021: Table 5
Muruqullu	Terminal Archaic	non-mound	-15.2	12		-20.45	7.5	Juengst et al. 2021: Table 5
Muruqullu	Terminal Archaic	non-mound	-16.9	11.4		-22.15	6.9	Juengst et al. 2021: Table 5
Muruqullu	Terminal Archaic	non-mound	-15.5	12.1		-20.75	7.6	Juengst et al. 2021: Table 5
Muruqullu	Terminal Archaic	non-mound	-18.6	10.8		-23.85	6.3	Juengst et al. 2021: Table 5

Kail-lachuro	Early Formative	mound	-19.2	6.3	3.6	-24.45	1.8	Flores-Blanco
Kail-lachuro	Early Formative	mound	-18.6	10.8	2	-23.85	6.3	Flores-Blanco
Kail-lachuro	Early Formative	mound	-18.3	10.4	2.1	-23.55	5.9	Flores-Blanco
Kail-lachuro	Early Formative	mound	-19.3	8.6	2.6	-24.55	4.1	Flores-Blanco
Kail-lachuro	Early Formative	mound	-19.2	11.6	1.9	-24.45	7.1	Flores-Blanco
Kail-lachuro	Early Formative	mound	-18.9	9.6	2.3	-24.15	5.1	Flores-Blanco
Chiripa	Early Formative	non-mound	-18.2	11.1		-23.5	6.6	Miller et al. 2021
Chiripa	Early Formative	non-mound	-19	10.4		-24.3	5.9	Miller et al. 2021
Chiripa	Early Formative	non-mound	-18.7	11.2		-24.0	6.7	Miller et al. 2021
Chiripa	Early Formative	non-mound	-18	11.8		-23.3	7.3	Miller et al. 2021
Chiripa	Early Formative	non-mound	-17.5	12.1		-22.8	7.6	Miller et al. 2021
Chiripa	Early Formative	non-mound	-18.4	12.8		-23.7	8.3	Miller et al. 2021
Chiripa	Early Formative	non-mound	-18.1	10.9		-23.4	6.4	Miller et al. 2021
Chiripa	Early Formative	non-mound	-18.4	11.9		-23.7	7.4	Miller et al. 2021

Appendix 7. The foodweb used as a database in isotopic analysis.

Site	Region	Altitude	Period	Time	Taxa	Tissue type	Type	d13C	d15N	C/N	Suess eff	d13C_adjsuted	d115N_adjsuted	Reference
Khonkho Wankane	Titicaca	3884	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-18.6	7.4	3.0		-18.6	7.4	Berryman 2010: Appendix A
Khonkho Wankane	Titicaca	3884	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-17.3	7.1	3.0		-17.3	7.1	Berryman 2010: Appendix A
Khonkho Wankane	Titicaca	3884	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-18.8	4.8	3.0		-18.8	4.8	Berryman 2010: Appendix A
Tiwanaku/Mollo Kontu	Titicaca	3865	Tiwanaku/ Late Intermediate Period	Archaeological	Camelidae	Bone	Camelid	-18.6	6.2	3.0		-18.6	6.2	Berryman 2010: Appendix A
Tiwanaku/Mollo Kontu	Titicaca	3865	Tiwanaku/ Late Intermediate Period	Archaeological	Camelidae	Bone	Camelid	-18.4	6.1	3.0		-18.4	6.1	Berryman 2010: Appendix A
L8516_1	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.2	8.6	3.4		-19.2	8.6	Miller et al. 2021: Dataset_S01
L8516_2	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.4	6.5	3.6		-19.4	6.5	Miller et al. 2021: Dataset_S01

L8516_3	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.2	8.9	3.5		-19.2	8.9	Miller et al. 2021: Dataset_S01
L8516_4	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.5	6.3	3.6		-19.5	6.3	Miller et al. 2021: Dataset_S01
JC099	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.7	6.7	3.2		-19.7	6.7	Miller et al. 2021: Dataset_S01
JC100b	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-18.8	10.7	3.3		-18.8	10.7	Miller et al. 2021: Dataset_S01
JC101	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.2	9.6	3.3		-19.2	9.6	Miller et al. 2021: Dataset_S01
JC102	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.9	10.7	3.2		-19.9	10.7	Miller et al. 2021: Dataset_S01
JC103B	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.8	7.4	3.3		-19.8	7.4	Miller et al. 2021: Dataset_S01
JC105	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-18.5	7.2	3.2		-18.5	7.2	Miller et al. 2021: Dataset_S01

JC106	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.3	9.2	3.2	-19.3	9.2	Miller et al. 2021: Dataset_S01
JC107	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-20.1	6.4	3.3	-20.1	6.4	Miller et al. 2021: Dataset_S01
JC108	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-19.2	8.7	3.2	-19.2	8.7	Miller et al. 2021: Dataset_S01
JC109	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-20.3	10.2	3.3	-20.3	10.2	Miller et al. 2021: Dataset_S01
JC110	Titicaca	3800	Formative-Tiwanaku	Archaeological	Camelidae	Bone	Camelid	-18.6	10.8		-18.6	10.8	Miller et al. 2021: Dataset_S01
Kaillachuro	Titicaca	3930	Terminal Archaic	Archaeological	Camelidae	Bone	Camelid	-18.7	7.1	3.3	-18.7	7.1	Flores-Blanco, Luis
Kaillachuro	Titicaca	3930	Terminal Archaic	Archaeological	Camelidae	Bone	Camelid	-19.6	6.3	3.3	-19.6	6.3	Flores-Blanco, Luis
Kaillachuro	Titicaca	3930	Inca	Archaeological	Camelidae	Bone	Camelid	-17.2	6.6	3.1	-17.2	6.6	Flores-Blanco, Luis
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-18.6	8.4		-18.6	8.4	DeNiro, 1988; Pezo, et al. 2024

Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-18.5	7.3		-18.5	7.3	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-18.3	6.9		-18.3	6.9	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-18.6	6.8		-18.6	6.8	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-18.2	7.2		-18.2	7.2	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-19.2	7.2		-19.2	7.2	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-18.8	6.4		-18.8	6.4	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-19.2	6.4		-19.2	6.4	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-18.8	5.6		-18.8	5.6	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-19.1	5.4		-19.1	5.4	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-18.8	5.3		-18.8	5.3	DeNiro, 1988; Pezo,

													et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-19.1	5.1		-19.1	5.1	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-19.5	4.4		-19.5	4.4	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-16.8	4.7		-16.8	4.7	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-17	5.7		-17	5.7	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-17.2	5.9		-17.2	5.9	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-16.3	6.5		-16.3	6.5	DeNiro, 1988; Pezo, et al. 2024
Pukara	Titicaca	3904	Formative	Archaeological	Camelidae	Bone	Camelid	-16.5	7		-16.5	7	DeNiro, 1988; Pezo, et al. 2024
Tiwanaku/Mollo Kontu	Titicaca	3865	Middle Formative	Archaeological	Unknow	Bone	Titicaca fish	-16.9	6.1	3.5	-16.9	6.1	Berryman 2010
KU-AQ	Titicaca	3800	Middle Formative	Archaeological	Trichomycterus sp.	Bone	Titicaca fish	-6.72	7.05		-6.72	7.05	Miller et al. 2010: Table 3

KU-AQ	Titicaca	3800	Middle Formative	Archaeological	Orestias sp.	Bone	Titicaca fish	-8.49	7.29		-8.49	7.29	Miller et al. 2010: Table 3
KU-AQ	Titicaca	3800	Middle Formative	Archaeological	Orestias sp.	Bone	Titicaca fish	-6.51	5.39		-6.51	5.39	Miller et al. 2010: Table 3
KU-AQ	Titicaca	3800	Middle Formative	Archaeological	Orestias agassii	Scales	Titicaca fish	-9.55	5.88		-9.55	5.88	Miller et al. 2010: Table 3
KU-AQ	Titicaca	3800	Middle Formative	Archaeological	Orestias luteus	Scales	Titicaca fish	-11.3	7.43		-11.3	7.43	Miller et al. 2010: Table 3
KU-AQ	Titicaca	3800	Middle Formative	Archaeological	Orestias sp.	Bone	Titicaca fish	-17.2	5.81		-17.2	5.81	Miller et al. 2010: Table 3
Chiripa-Santiago	Titicaca	3852	Middle Formative	Archaeological	Orestias sp.	Scales	Titicaca fish	-10.1	7.66		-10.1	7.66	Miller et al. 2010: Table 3
Chiripa-Monticulo 1	Titicaca	3852	Middle Formative	Archaeological	Orestias sp.	Scales	Titicaca fish	-6.1	12.82		-6.1	12.8	Miller et al. 2010: Table 3
Chiripa-Llusco	Titicaca	3852	Middle Formative	Archaeological	Orestias sp.	Scales	Titicaca fish	-10.2	4.95		-10.2	4.95	Miller et al. 2010: Table 3
Chiripa-Monticulo 1	Titicaca	3852	Middle Formative	Archaeological	Orestias sp.	Scales	Titicaca fish	-9.64	6.72		-9.64	6.72	Miller et al. 2010: Table 3
Chiripa-Santiago	Titicaca	3852	Middle Formative	Archaeological	Orestias sp.	Scales	Titicaca fish	-11.4	5.05		-11.4	5.05	Miller et al. 2010:

													Table 3
Lake Poopo	Titicaca	3700		Modern	Zea mays	Seeds	C4 plant	-12.7	7.1		1.5	-14.2	8.6	Miller et al. 2021: Dataset_S01
Lake Poopo	Titicaca	3700		Modern	Zea mays	Seeds	C4 plant	-12.5	8.4		1.5	-14	9.9	Miller et al. 2021: Dataset_S01
Lake Poopo	Titicaca	3700		Modern	Zea mays	Seeds	C4 plant	-11.5	8.7		1.5	-13	10.2	Miller et al. 2021: Dataset_S01
Lake Poopo	Titicaca	3700		Modern	Zea mays	Seeds	C4 plant	-12.3	10		1.5	-13.8	11.5	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Zea mays_Taraco Peninsula	Seeds	C4 plant	-11.1	5.1		1.5	-12.6	6.6	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Zea mays_var_Altiplano	Seeds	C4 plant	-11.4	8.9		1.5	-12.9	10.4	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Solanum tuberosum_2	Skin + Starch	C3 plant	-24.7	7.2		1.5	-26.2	8.7	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Solanum tuberosum_3	Skin + Starch	C3 plant	-27.9	6.8		1.5	-29.4	8.3	Miller et al. 2021: Dataset_S01

Taraco Peninsula	Titicaca	3852		Modern	Solanum tuberosum_4	Starch	C3 plant	-25.5	6		1.5	-27	7.5	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Solanum tuberosum_4	Skin	C3 plant	-25.4	6.9		1.5	-26.9	8.4	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Solanum tuberosum_5	Skin	C3 plant	-26.8	6.4		1.5	-28.3	7.9	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Solanum tuberosum_5	Skin + Starch	C3 plant	-26.6	7.3		1.5	-28.1	8.8	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Solanum tuberosum_6	Skin + Starch	C3 plant	-27.9	8.6		1.5	-29.4	10.1	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Solanum tuberosum		C3 plant	-27	7.3		1.5	-28.5	8.8	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Solanum tuberosum		C3 plant	-27.1	9.3		1.5	-28.6	10.8	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852	Formative-Tiwanaku	Archaeological		Seeds	C3 plant	-22.8	11			-22.8	11	Miller et al. 2021: Dataset_S01

TAP L1198/6/F11077	Titicaca	3852	Formative-Tiwanaku	Archaeological		Seeds	C3 plant	-22.5	9.4			-22.5	9.4	Miller et al. 2021: Dataset_S01
TAP L799/1/F10278	Titicaca	3852	Formative-Tiwanaku	Archaeological		Seeds	C3 plant	-23.5	12.9			-23.5	12.9	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852	Formative-Tiwanaku	Archaeological		Seeds	C3 plant	-22.6	8.8			-22.6	8.8	Miller et al. 2021: Dataset_S01
TAP L7671/1/F15382	Titicaca	3852	Formative-Tiwanaku	Archaeological		Parenchyma	C3 plant	-21.8	9.7			-21.8	9.7	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Chenopodium ambrosioides	Seeds	C3 plant	-23.9	7.7		1.5	-25.4	9.2	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Chenopodium quinoa_1		C3 plant	-24.3	5.7		1.5	-25.8	7.2	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Chenopodium quinoa_2	Leaf	C3 plant	-24.4	7.2		1.5	-25.9	8.7	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Chenopodium quinoa_2	Seeds	C3 plant	-22.9	8.1		1.5	-24.4	9.6	Miller et al. 2021: Dataset_S01

Lake Poopo	Titicaca	3700	Modern	Chenopodium quinoa	Seeds	C3 plant	-25.2	6.4	1.5	-26.7	7.9	Miller et al. 2021: Dataset_S01
Lake Poopo	Titicaca	3700	Modern	Chenopodium quinoa	Seeds	C3 plant	-24.7	7.2	1.5	-26.2	8.7	Miller et al. 2021: Dataset_S01
Lake Poopo	Titicaca	3700	Modern	Chenopodium quinoa	Seeds	C3 plant	-26.9	10.7	1.5	-28.4	12.2	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852	Modern		Fruit + Casing	C3 plant	-26	0.4	1.5	-27.5	1.9	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852	Modern		Flower	C3 plant	-27.8	0.3	1.5	-29.3	1.8	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852	Modern	Juncaceae		C3 plant	-27	4.5	1.5	-28.5	6	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852	Modern	Juncaceae		C3 plant	-26.8	8	1.5	-28.3	9.5	Miller et al. 2021: Dataset_S01
Lake Wiñyamarka	Titicaca	3800	Modern	Schoenoplectus tatora		C3 plant	-26.9	5.9	1.5	-28.4	7.4	Miller et al. 2021: Dataset_S01

Lake Wiñyamarka	Titicaca	3800		Modern	Schoenoplectus tatora		C3 plant	-26.7	2.1		1.5	-28.2	3.6	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Oxalis tuberosa_1		C3 plant	-25.9	10.3		1.5	-27.4	11.8	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Oxalis tuberosa_2		C3 plant	-25.5	9.8		1.5	-27	11.3	Miller et al. 2021: Dataset_S01
Taraco Peninsula	Titicaca	3852		Modern	Oxalis tuberosa_3		C3 plant	-24.5	7.1		1.5	-26	8.6	Miller et al. 2021: Dataset_S01
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-25.1	8.8	17.87		-25.1	8.8	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.2	6.1	11.01		-23.2	6.1	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.4	7.6	17.41		-24.4	7.6	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.2	8.7	16.18		-24.2	8.7	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.8	5.1	18.96		-23.8	5.1	Whittemore et al. 2023: SM 2

Ayawiri	Titicaca	4000	Formative	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.1	2.8	23.70	-23.1	2.8	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.9	9.3	18.10	-23.9	9.3	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-10.7	7.9	31.98	-10.7	7.9	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Solanum tuberosum	Root	C3 plant	-24.9	5.5	42.29	-24.9	5.5	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Fabacea	Seed	C3 plant	-24.3	4	11.27	-24.3	4	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.3	9	19.94	-24.3	9	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.2	11.8	19.67	-24.2	11.8	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.3	8.3	16.78	-24.3	8.3	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.6	11.1	20.19	-24.6	11.1	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.5	8.5	19.40	-23.5	8.5	Whittemore et al.

													2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.3	8.2	20.03	-24.3	8.2	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24	13.5	18.79	-24	13.5	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24	9.5	21.36	-24	9.5	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.5	9.1	11.28	-23.5	9.1	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.6	4.7	11.73	-23.6	4.7	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.4	4.9	7.92	-23.4	4.9	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.4	10.2	23.41	-24.4	10.2	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.7	8.1	17.49	-23.7	8.1	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.2	9.8	14.60	-23.2	9.8	Whittemore et al. 2023: SM 2

Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.7	11.4	15.71	-23.7	11.4	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.7	10.3	23.18	-24.7	10.3	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.8	12	20.41	-24.8	12	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-25.1	13.6	24.41	-25.1	13.6	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.8	11.3	17.97	-24.8	11.3	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.5	7.1	13.78	-23.5	7.1	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23	8.2	14.99	-23	8.2	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.7	9.3	15.93	-23.7	9.3	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	Formative	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.4	9.4	20.48	-23.4	9.4	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	Formative	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.6	9	18.62	-23.6	9	Whittemore et al.

														2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.1	6.3	16.44		-24.1	6.3	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-25.2	9.6	18.37		-25.2	9.6	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24	10.3	21.65		-24	10.3	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.8	11.5	12.33		-23.8	11.5	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-25.3	9.6	22.60		-25.3	9.6	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.4	9.5	21.99		-24.4	9.5	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.9	8.7	19.90		-23.9	8.7	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.4	5.6	13.06		-24.4	5.6	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.2	8.6	19.55		-23.2	8.6	Whittemore et al. 2023: SM 2

Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.4	7.2	18.42		-24.4	7.2	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-25	9.1	19.99		-25	9.1	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24	7.1	18.96		-24	7.1	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-22.8	8.2	19.42		-22.8	8.2	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-22	8.9	20.64		-22	8.9	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.2	10	19.44		-24.2	10	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-22.2	10.5	14.40		-22.2	10.5	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-24.3	7.5	18.21		-24.3	7.5	Whittemore et al. 2023: SM 2
Ayawiri	Titicaca	4000	LIP	Archaeological	Chenopodium quinoa	Seed	C3 plant	-23.2	7.7	16.16		-23.2	7.7	Whittemore et al. 2023: SM 2
Ilave Basin	Titicaca	3900		Modern	Solanum tuberosum	Skin + Starch	C3 plant	-28.8	-1.14	29.9	1.5	-30.3	0.36	Flores-Blanco, Luis

Ilave Basin	Titicaca	3900	Modern	Solanum tuberosum	Skin + Starch	C3 plant	-28.7	-1.41	86.8	1.5	-30.2	0.09	Flores-Blanco, Luis
Ilave Basin	Titicaca	3900	Modern	Solanum tuberosum	Skin + Starch	C3 plant	-27.2	-0.65	104.9	1.5	-28.7	0.85	Flores-Blanco, Luis
Ilave Basin	Titicaca	3900	Modern	Solanum tuberosum	Skin + Starch	C3 plant	-26.7	5.07	174.0	1.5	-28.2	6.57	Flores-Blanco, Luis

Appendix 8. Data on the size of the settlements in the Titicaca Basin.

ID	Valley	Peri-ods	Area (m2)
1	Ilave	1	300
2	Ilave	1	774
3	Ilave	1	328
4	Ilave	1	510
5	Ramis	1	376
6	Ilave	2	2400
7	Ilave	2	450
8	Ilave	2	1120
9	Ilave	2	30
10	Ilave	2	3080
11	Ilave	2	1773
12	Ilave	2	2275
13	Ilave	2	3432
14	Ilave	2	551
15	Ilave	2	4623
16	Ilave	2	1395
17	Ilave	2	6640
18	Ilave	2	8250
19	Ilave	2	3575
20	Ilave	2	4324
21	Ilave	2	2832
22	Ilave	2	1054
23	Ilave	2	550
24	Ilave	2	2632
25	Ilave	2	3990
26	Ilave	2	100
27	Ramis	2	765
28	Ramis	2	665
29	Ramis	3	1765
30	Ramis	3	449
31	Ramis	3	158
32	Ramis	3	182
33	Ramis	3	3001
34	Ramis	3	66
35	Ilave	3	336
36	Ilave	3	5175
37	Ilave	3	1488
38	Ilave	3	4788
39	Ilave	3	695
40	Ilave	3	2860

Period 1 = Early Archaic
Period 2 = Middle Archaic
Period 3 = Late Archaic
Period 4 = Terminal Archaic
Period 5 = Formative
Period 6 = Tiwanaku

41	Ilave	3	1189
42	Ilave	3	1118
43	Ilave	3	1505
44	Ilave	3	4680
45	Ilave	3	2100
46	Ilave	3	1500
47	Ilave	3	864
48	Ilave	3	7200
49	Ilave	3	1156
50	Ilave	3	2760
51	Ilave	3	6391
52	Ilave	3	690
53	Ilave	3	630
54	Ilave	3	3417
55	Ilave	3	3100
56	Ilave	3	2436
57	Ilave	3	13689
58	Ilave	4	30153
59	Ilave	4	704
60	Ilave	4	5517
61	Ilave	4	13689
62	Ramis	4	2285
63	Ramis	4	1921
64	Ramis	4	3208
65	Ramis	4	11953
66	Ramis	4	1108
67	Ramis	4	3112
68	Ilave	5	510
69	Ilave	5	1173
70	Ilave	5	2000
71	Ilave	5	4400
72	Ilave	5	1750
73	Ilave	5	5517
74	Ilave	5	1200
75	Ilave	5	5451
76	Ilave	5	3465
77	Ilave	5	2880
78	Ilave	5	30153
79	Ilave	5	1968
80	Ilave	5	5024
81	Ilave	5	667
82	Ilave	5	810
83	Ilave	5	1120
84	Ilave	5	2860

85	Ilave	5	1118
86	Ilave	5	27120
87	Ilave	5	1773
88	Ilave	5	704
89	Ilave	5	2064
90	Ilave	5	3463
91	Ilave	5	7200
92	Ilave	5	8250
93	Ilave	5	1792
94	Ilave	5	3100
95	Ilave	5	3196
96	Ilave	5	15834
97	Ilave	5	8100
98	Ilave	5	1300
99	Ramis	5	10251
100	Ramis	5	129786
101	Ramis	5	40242
102	Ramis	5	6614
103	Ramis	5	369063
104	Ramis	5	10251
105	Ramis	5	116733
106	Ramis	5	88781
107	Ramis	5	2479
108	Ramis	5	21507
109	Ramis	5	40215
110	Ramis	5	832771
111	Ramis	5	40242
112	Ramis	5	3112
113	Ramis	5	1867
114	Ramis	5	567006
115	Ramis	5	61264
116	Ramis	5	116733
117	Ramis	5	269556
118	Ramis	5	5180
119	Ramis	5	4787
120	Ramis	5	5358
121	Ramis	5	55415
122	Ramis	5	4265
123	Ramis	5	1215
124	Ramis	5	1108

125	Ramis	5	4401
126	Ramis	5	25048
127	Ramis	5	1419
128	Ramis	5	23714
129	Ramis	5	673
130	Ramis	5	787
131	Ramis	5	11140
132	Ramis	5	1896
133	Ramis	5	26691
134	Ramis	5	171309
135	Ramis	5	13207
136	Ramis	5	3060
137	Ramis	5	710
138	Ramis	5	3578
139	Ramis	5	698496
140	Ramis	5	4747
141	Ramis	5	722
142	Ramis	5	3001
143	Ramis	5	4144
144	Ramis	5	3000
145	Ramis	5	2285
146	Ramis	5	4490
147	Ramis	5	1415
148	Ramis	5	43014
149	Ramis	5	568.6
150	Ramis	5	510
151	Ramis	6	35177
152	Ramis	6	9989
153	Ramis	6	269556
154	Ramis	6	4170
155	Ilave	6	5000
156	Ilave	6	5400
157	Ilave	6	1125
158	Ilave	6	1300
159	Ilave	6	4400
160	Ilave	6	3744
161	Ilave	6	768
162	Ilave	6	18850
163	Ilave	6	15834
164	Ilave	6	1617
165	Ilave	6	1120

Note: Ilave settlement area data were provided by Randall Haas.

Appendix 9. Raw material from the Titicaca Basin

Periods	Raw-Material	Value
Early Archaic	Fine-grained volcanic	6
Middle Archaic	Fine-grained volcanic	9
Late Archaic	Fine-grained volcanic	28
Terminal Archaic	Fine-grained volcanic	3
Formative	Fine-grained volcanic	7
Tiwanaku	Fine-grained volcanic	0
Early Archaic	Chert	9
Middle Archaic	Chert	11
Late Archaic	Chert	17
Terminal Archaic	Chert	13
Formative	Chert	4
Tiwanaku	Chert	1
Early Archaic	Obsidian	1
Middle Archaic	Obsidian	2
Late Archaic	Obsidian	11
Terminal Archaic	Obsidian	91
Formative	Obsidian	277
Tiwanaku	Obsidian	0
Early Archaic	Quartzite	3
Middle Archaic	Quartzite	4
Late Archaic	Quartzite	5
Terminal Archaic	Quartzite	7
Formative	Quartzite	9
Tiwanaku	Quartzite	0

NOTE: Additional information regarding the projectile points utilized in Chapter 5 is available in the Supplementary Data section of my paper.: Did archery technology precipitate complexity in the Titicaca Basin? A metric analysis of projectile points, 11–1 ka - ScienceDirect

Appendix 10. R Code

10.1. Chapter 4 Code

10.1.1. Figure 14

```
library(ggplot2)
library(dplyr)
library(cowplot)
# create a dataset
datos <-read.csv("C:/Users/LuisF/Documents/UCDavis/DISSERTATIION/Paper 3_Status
Isotopes Mounds_JAA/Rst/Female-Age.csv")
#Age
datos$Age<-factor(datos$Age,levels=c("children","youths","adults"))
tabla1 <- table (datos$Age)
tabla1 <- prop.table(tabla1)
#Sex
tabla2 <- table(datos$Sex, datos$Age)
tabla2 <- prop.table(tabla2)
barplot(tabla1, xaxt="n", yaxt="n", xlab = "", ylab = "", space=0, axes = F)
par(new=TRUE)
barplot(tabla2, space=0,
            xlab='Age', ylab='% individuals',
            col=c("coral", "darkcyan", "gray"),
            ylim = c(0, 1))
text(0.45, 0.22, "n = 3")
text(1.5, 0.085, "n = 1")
text(2.5, 0.2, "n = 5")
text(2.5, 0.55, "n = 6")
legend("topleft",title = "Sex",cex = 1,
      legend = c("M", "F", "NA"),
      fill=c("darkcyan", "coral", "gray"),
      border = "black")
```

10.1.2. Figure 15

We follow the model of Haas et al. 2020: Figure 5

10.1.3. Figure 16.

```
## data archaeological goods x age&sex x #just burials
goods4 <- read.csv("agesex3.txt", head=TRUE, sep=",")
goods4$burials <- factor(goods4$burials,levels=rev(goods4$burials))
goods4.m = melt(goods4)
#data.m <- ddply(data.m, .(variable), transform, rescale = rescale(value))
goods4.m[,"rescale"]<-rescale(goods4.m[,"value"],to=c(0,1))
fewer.labels <- c("Subadult \n (n=4) \n 2males+2Ind", "Adult Indet \n (n=6)","Adult Female \n
(n=1)", "Adult Male \n (n=3)")
d <- ggplot(goods4.m, aes(variable, burials)) +
```

```
  geom_tile(aes(fill = rescale), colour = "white") +
  scale_y_discrete(labels=fewer.labels) +
  scale_fill_gradient(low = "white", high = "darkred") +
  theme(axis.text=element_text(size=8))
d
```

10.1.4. Figure 17.

```
#data
goods <- read.csv('VsGoods.csv')
str(goods)
# Boxplot by group
png(filename = "plot2.png", width = 6, height = 5, units = "in", res = 400)
ggplot(data = goods, aes(x = site, y = number)) +
  theme(panel.background = element_blank())+
  stat_boxplot(geom = "errorbar", # Boxplot with error bars
               width = 0.2) +
  geom_boxplot(fill = "#4271AE", colour = "#1F3552", # Colors
               alpha = 0.9, outlier.colour = "red") +
  scale_y_continuous(name = "NGoods") +  # Continuous variable label
  scale_x_discrete(name = "Sites") +      # Group label
  ggtitle("") + # Plot title
  stat_compare_means(label.y = 15)+
  theme(axis.line = element_line(colour = "black", # Theme customization
                                 size = 0.25))
```

10.1.5. Figure 18.

```
library(SIBER)
# Data
datahumana <-read.csv("C:/Users/LuisF/Documents/UCDavis/DISSERTATIION/Paper 3_Status
Isotopes Mounds_JAA/Isotopes/Isotopes-Kaillachuro/Human_CN_Titicaca.csv")
dataTAEF <-read.csv("C:/Users/LuisF/Documents/UCDavis/DISSERTATIION/Paper 3_Status
Isotopes Mounds_JAA/Isotopes/Isotopes-Kaillachuro/Human_CN_TA-EF.csv")
data <- read.csv('C:/Users/LuisF/Documents/UCDavis/DISSERTATIION/Paper 3_Status
Isotopes Mounds_JAA/Paper/Tables/Table2isotopes.csv')
foodweb<- read.csv("C:/Users/LuisF/Documents/UCDavis/DISSERTATIION/Paper 3_Status
Isotopes Mounds_JAA/Isotopes/Isotopes-Kaillachuro/BaseLine_CN_Titicaca.csv")
# Late & Terminal Archaic
#extrac data of sites by mounds vs non-mounds
mound<-dataTAEF[1:11,16:17] #moun LA TA
non <- dataTAEF[12:20,16:17] #nonmound LA TA
# Early Formative
#extrac data of sites by mounds vs non-mounds
moundK <- dataTAEF[21:26,16:17] #mound EF KCO
moundC <- dataTAEF[27:34,16:17] #mound EF Chiripa
# Foodweb
camel <- foodweb[1:41,14:15] # extract data from camelids
```

```
mu <- colMeans(camel)
fish <- foodweb[42:53,14:15] # extract data from fish
muf <- colMeans(fish)
c4 <- foodweb[54:59,14:15] # extract data from C4 plants
muz <- colMeans(c4)
c3<- foodweb[60:145,14:15] # extract data from C3 plants
mup <- colMeans(c3)
#plot Archaic
png("C:/Users/LuisF/Documents/UCDavis/DISSERTATIION/Paper 3_Status Isotopes
Mounds_JAA/Paper/Figures/Fig.Isotopes.png",
   width=10, height=6, units="in", res=600)
par(mfrow = c(1,2))
plot(mound, pch = 17, col="blue",
    xlab = expression(paste(delta^{13}, "C(\u2030)")),
    ylab = "",
    ylim = c(-5, 15),
    xlim = c(-30, -8))
title(ylab = expression(paste(delta^{15}, "N(\u2030)")), line = 2)
points(non, pch = 3, col="black") #add points KCO corrected
addEllipse(mu, Sigma, p.interval = 0.95, col = "brown", lty = 3, lwd = 2)
addEllipse(muf, Sigmaf, p.interval = 0.95, col = "deepskyblue", lty = 3, lwd = 2)
addEllipse(muz, Sigmaz, p.interval = 0.95, col = "green", lty = 3, lwd = 2)
addEllipse (mup, Sigmap, p.interval = 0.95, col = "darkgreen", lty = 3, lwd = 2)
text(-27, 0.2, "C3 plant", col = "darkgreen", cex = 0.8)
text(-13.8, 14.2, "C4 plant",col = "green", cex = 0.8)
text(-11, 1, "lake fish",col = "deepskyblue", cex = 0.8)
text(-19, 2.7, "camelid",col = "brown", cex = 0.8)
legend("bottom", legend=c("TA mound site (KCO)", "TA non-mound sites"),
      cex = 0.8, text.font = 2, bty="n",text.width = 0.05,x.intersp = 0.5,
      pch = c(17,3) )
#plot2. Early Formative
plot(moundK, pch = 17, col="red",
    xlab = expression(paste(delta^{13}, "C(\u2030)")),
    ylab = "",
    ylim = c(-5, 15),
    xlim = c(-30, -8))
title(ylab = expression(paste(delta^{15}, "N(\u2030)")), line = 2)
points(moundC, pch = 17, col="black") #add points KCO corrected
addEllipse(mu, Sigma, p.interval = 0.95, col = "brown", lty = 3, lwd = 2)
addEllipse(muf, Sigmaf, p.interval = 0.95, col = "deepskyblue", lty = 3, lwd = 2)
addEllipse(muz, Sigmaz, p.interval = 0.95, col = "green", lty = 3, lwd = 2)
addEllipse(mup, Sigmap, p.interval = 0.95, col = "darkgreen", lty = 3, lwd = 2)
text(-27, 0.2, "C3 plant", col = "darkgreen", cex = 0.8)
text(-13.8, 14.2, "C4 plant",col = "green", cex = 0.8)
text(-11, 1, "lake fish",col = "deepskyblue", cex = 0.8)
text(-19, 2.7, "camelid",col = "brown", cex = 0.8)
```

```
legend("bottom", legend=c("EF mound site 1 (KCO)","EF mound site 2 (Chiripa)"),
      cex = 0.8, text.font = 2, bty="n",text.width = 0.05,x.intersp = 0.5,
      pch = c(17,17) )
dev.off()
```

10.2. Chapter 5 Code

10.2.1. Figure 21: Projectile point size over time in the Lake Titicaca Basin

```
## LOG=Y All periods###
png("/home/luis/Documents/UC DAVIS/DISSERTATION/Paper
1_BowArrow_QuatJ/Updated/Data/R-stat/LOG-TiticacaPoints",
   width=7,height=4,units="in",pointsize= 5, res=600)
par(mfrow = c(2,2))
par(mar=c(3,3,1,1))
#1. Width Titicaca (All Periods)
boxplot(Titicacadata$width~Titicacadata$Period,log="y",
las=1,xlab="Periods",ylab="",yaxt="none", xaxt="none",col=terrain.colors(5),notch=F)
axis(1,at=1:6,labels=F)
mtext(1,at=1:6,text=c("Early-Arch","Middle-Arch","Late-Arch", "Terminal-Arch",
"Formative","Tiwanaku"),line=1)
mtext(2,text="Width (mm)",line=2)
mtext(1,text="Periods",line=2)
axis(2)
mtext("Dart", side = 4, at = 22, col="brown", line = -1, cex = 0.8)
mtext("Arrow", side = 4, at = 14.5, col="blue", line = -1, cex = 0.8)
text(x = 6, y = 18.8, label = "Mean: 18.0 mm")
text(x=1:6,y=aggregate(Titicacadata$Width,by=list(Titicacadata$Period),FUN=median)[,2],label
s=aggregate(Titicacadata$Width,by=list(Titicacadata$Period),FUN=length)[,2] ,pos=3,col="blac
k")
abline(h=18.0, col="red", lty=2)
#2. Weight Projectil Points (All Periods)
boxplot(Titicacadata$weight ~ Titicacadata$Period,log="y",
las=1,xlab="Periods",ylab="",yaxt="none", xaxt="none",col=terrain.colors(5),notch=F)
axis(1,at=1:6,labels=F)
mtext(1,at=1:6,text=c("Early-Arch","Middle-Arch","Late-Arch", "Terminal-Arch",
"Formative","Tiwanaku"),line=1)
mtext(2,text="Weight (gr.)",line=2)
mtext(1,text="Periods",line=2)
axis(2)
mtext("Dart", side = 4, at = 5, col="brown", line = -1, cex = 0.8)
mtext("Arrow", side = 4, at = 1.5, col="blue", line = -1, cex = 0.8)
text(x = 6, y = 3.5, label = "Mean: 3.2 gr")
text(x=1:6,y=aggregate(Titicacadata$Weight ~
Titicacadata$Period,by=list(Titicacadata$Period),FUN=median)[,2],labels=aggregate(Titicacadat
a$Weight,by=list(Ramisdata$Period),FUN=length)[,2] ,pos=3,col="black")
```

```
abline(h=3.2, col="red", lty=2)
#3. Thickness Projectil Points (All Periods)
boxplot(Titicacadata$thickness ~ Titicacadata$Period, log="y",
las=1,xlab="Periods",ylab="",yaxt="none", xaxt="none",col=terrain.colors(5),notch=F)
axis(1,at=1:6,labels=F)
mtext(1,at=1:6,text=c("Early-Arch","Middle-Arch","Late-Arch", "Terminal-Arch",
"Formative","Tiwanaku"),line=1)
mtext(2,text="Thickness (mm)",line=2)
mtext(1,text="Periods",line=2)
axis(2)
text(x=1:6,y=aggregate(Titicacadata$Thickness,by=list(Titicacadata$Period),FUN=median)[,2],l
abels=aggregate(Titicacadata$Thickness,by=list(Titicacadata$Period),FUN=length)[,2] ,pos=3,c
ol="black")
mtext("Dart", side = 4, at = 6, col="brown", line = -1, cex = 0.8)
mtext("Arrow", side = 4, at = 3, col="blue", line = -1, cex = 0.8)
text(x = 6, y = 4.6, label = "Mean: 4.3 mm")
abline(h=4.3, col="red", lty=2)
# 4. Long
boxplot(Titicacadata$long ~
Titicacadata$Period,log="y",las=1,xlab="Periods",ylab="",yaxt="none",
xaxt="none",col=terrain.colors(5),notch=F)
axis(1,at=1:6,labels=F)
mtext(1,at=1:6,text=c("Early-Arch","Middle-Arch","LateA", "Terminal-Arch",
"Formative","Tiwanaku"),line=1)
mtext(2,text="Lenght (mm)",line=2)
mtext(1,text="Periods",line=2)
axis(2)
mtext("Dart", side = 4, at = 48, col="brown", line = -1, cex = 0.8)
mtext("Arrow", side = 4, at = 30, col="blue", line = -1, cex = 0.8)
text(x = 6, y = 40.5, label = "Mean: 38.7 mm")
text(x=1:6,y=aggregate(Titicacadata$Long,by=list(Titicacadata$Period),FUN=median)[,2],labels
=aggregate(Titicacadata$Long,by=list(Titicacadata$Period),FUN=length)[,2] ,pos=3,col="black"
)
abline(h=38.7, col="red", lty=2) # Mean arrow and dart
dev.off()
```

10.2.2. Figure 22. Site size over 10,000 years in the Titicaca Basin

```
# PLOT AREAS Final
png("/home/luis/Documents/UC DAVIS/DISSERTATION/Paper
1_BowArrow_QuatJ/Updated/Data/R-stat/TiticacaAreasF",
   width=2.5,height=4,units="in",pointsize= 5, res=600)
par(mfrow = c(3,1))
boxplot(tca$Area.1 ~ tca$Periods,las=1,main="Settlements Sizes per Time in the Titicaca
Basin",xaxt="none",
      xlab="Periods",ylab="",log="y",col=terrain.colors(6),notch=F)
```

```
mtext(1,cex=0.8,at=1:6,text=c("Early\n Archaic","Middle\n Archaic", "Late\n Archaic",
"Terminal\n Archaic", "Formative","Tiwanaku"),line=2)
mtext (side=2, "Log (Settlements Size (m^2))", cex=0.6, line=-1)
boxplot(tcr$Area~tcr$Periods,las=1,main="Settlements Sizes per Time in the Ramis
valley",xaxt="none",
      xlab="Periods",ylab="",log="y",col=terrain.colors(6),notch=F)
mtext(1,cex=0.8,at=1:6,text=c("Early\n Archaic","Middle\n Archaic", "Late\n Archaic",
"Terminal\n Archaic", "Formative","Tiwanaku"),line=2)
mtext (side=2, "Log (Settlements Size (m^2))", cex=0.6, line=-1)
boxplot(tci$Area~tci$Periods,las=1,main="Settlements Sizes per Time in the Ilave valley",
      xaxt="none",xlab="Periods",ylab="",log="y",col=terrain.colors(6),notch=F)
mtext(1,cex=0.8, at=1:6,text=c("Early\n Archaic","Middle\n Archaic", "Late\n Archaic",
"Terminal\n Archaic", "Formative","Tiwanaku"),line=2)
mtext (side=2, "Log (Settlements Size (m^2))", cex=0.6, line=-1)
dev.off()
```

10.2.3. Figure 23. Raw material use for projectile points over time in the Lake Titicaca Basin

```
# Barplot of Raw Material
# library
library(ggplot2)
#install.packages("ggarrange")
library(dplyr)
library(cowplot)
# create a dataset
df<- data.frame(read.csv("/home/luis/Documents/UC DAVIS/DISSERTATION/Paper
1_BowArrow_QuatJ/Updated/Data/RawMaterial-Simple.csv"))
dfilave<- data.frame(read.csv("/home/luis/Documents/UC DAVIS/DISSERTATION/Paper
1_BowArrow_QuatJ/Updated/Data/RawMaterial-Ilave.csv"))
dframis<- data.frame(read.csv("/home/luis/Documents/UC DAVIS/DISSERTATION/Paper
1_BowArrow_QuatJ/Updated/Data/RawMaterial-Ramis.csv"))
levels(df$Periods)
df$Periods = factor(df$Periods, levels = c("Early Archaic", "Middle Archaic", "Late Archaic",
"Terminal Archaic", "Formative", "Tiwanaku"))
levels(dfilave$Periods)
dfilave$Periods = factor(dfilave$Periods, levels = c("Early Archaic", "Middle Archaic", "Late
Archaic", "Terminal Archaic", "Formative", "Tiwanaku"))
levels(dframis$Periods)
dframis$Periods = factor(dframis$Periods, levels = c("Early Archaic", "Middle Archaic", "Late
Archaic", "Terminal Archaic", "Formative", "Tiwanaku"))
## Full plot Raw Material
p1<- ggplot(data=df, aes(x=Periods, y=Value, fill=Raw.Material)) +
  labs(title = "Titicaca Raw material per Period")+ylab("") +
  theme(plot.title = element_text(size = rel(1.5), colour = "black"))+
  geom_bar(stat="identity", position="fill") + scale_fill_manual(values = alpha(c("red", "azure4",
"black", "deeppink"), 1)) +
  theme(axis.title.x = element_text(face="bold", size=9))
```

```
ggsave(p1, filename = "TitiRaw.tiff", width = 20, height = 10, units = "cm", dpi = 300)
p2<- ggplot(data=dfilave, aes(x=Periods, y=Value, fill=Raw.Material)) +
  labs(title = "Ilave Raw material per Period")+ylab("") +
  theme(plot.title = element_text(size = rel(1.5), colour = "black"))+
    geom_bar(stat="identity", position="fill") + scale_fill_manual(values = alpha(c("red",
"azure4", "black", "deeppink"), 1)) +
  theme(axis.title.x = element_text(face="bold", size=9))
p3<- ggplot(data=dframis, aes(x=Periods, y=Value, fill=Raw.Material)) +
  labs(title = "Ramis Raw material per Period")+ylab("") +
  theme(plot.title = element_text(size = rel(1.5), colour = "black"))+
    geom_bar(stat="identity", position="fill") + scale_fill_manual(values = alpha(c("red",
"azure4", "black", "deeppink"), 1)) +
  theme(axis.title.x = element_text(face="bold", size=9))
library(gridExtra)
grid.arrange(p2, p3, ncol=1, nrow =2)
ggsave(p2, filename = "Ilave.tiff", width = 20, height = 10, units = "cm", dpi = 300)
ggsave(p3, filename = "Ramis.tiff", width = 20, height = 10, units = "cm", dpi = 300)
```

10.2.4. Figure 24. Cranial trauma rates over time in the South-Central highlands

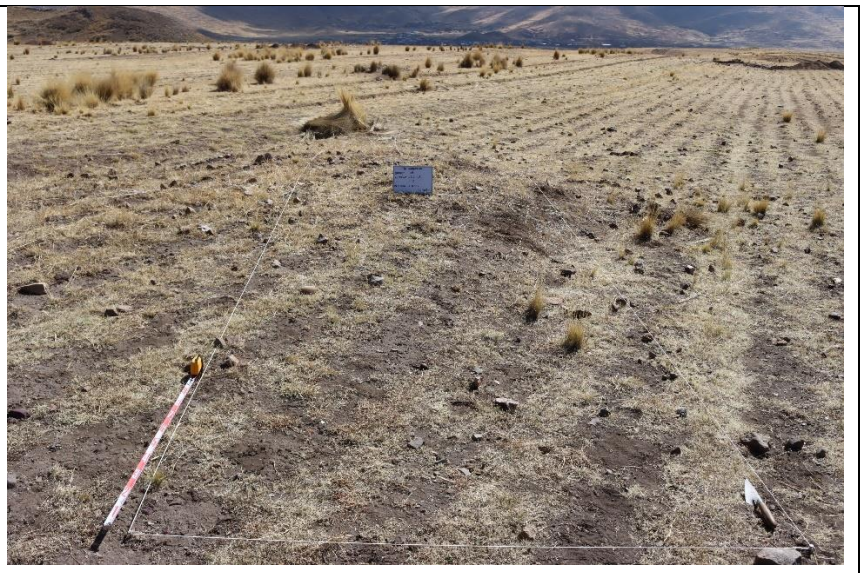
```
#comparison of *cranial* trauma rates in the LTB. Arkush and Tung only considered crania.
#Arkush and Tung (2013) LTB data
p<-c("Formative","Middle Horizon","Late Intermediate") #periods
n<-c(10,5+3,48+18) #individuals examined
t<-c(0,0+1,7+9) #individuals with trauma
r<-round(t/n*100,0) #proportion of individuals with trauma--trauma rate
data<-data.frame(period=p,count=n,trauma=t,rate=r)
data
sum(n)
#Add Haas and Viviano (2015) and Juengst et al (2016) data
p<-c("Late Archaic","Terminal Archaic",p)
n<-c(14,14,n) #Haas and Viviano note that only 14/16 individuals sufficiently intact to detect
trauma.
t<-c(1,1,t)
r<-round(t/n*100,0) #proportion of individuals with trauma--trauma rate
data<-data.frame(period=p,count=n,trauma=t,rate=r)
data[rev(rownames(data)),]
sum(n)
write.csv(data[rev(rownames(data)),],"/home/wrhaas/wsu/Advising/FloresLuis/trauma.csv")
png("/home/wrhaas/wsu/Advising/FloresLuis/trauma.png",width=5,height=2,units="in",res=300,
pointsize=8)
par(mar=c(4,4,1,2))
plot(r~c(1:length(p)),type="b",xaxt="n",xlab="Period",ylab="cranial trauma rate (%)")
axis(1,at=c(1:length(p)),labels=p)
abline(v=1.5,col="red",lty=2)
text(x=1.5, y=20,labels="archery",col="red",pos=4)
dev.off()
```

Appendix 11. Photos of the Kaillachuro site and archaeological contexts.

Description	Photo
11.1. The panoramic photo captures the view from the south to the north of the alluvial terrace, where the Kaillachuro site is located. The white truck indicates our excavation's location. The town of Totorani is in the background, next to the hill.	
11.2. Panoramic photo of the Jachacachi community from Kaillachuro.	

11.3. Panoramic image of our archaeological excavations during the 2021 field season. In the foreground, you can see the Mound 5 excavation, and in the background, you can see our excavations at Mound 1.	
11.4. Panoramic photo of our archaeological excavations during the 2022 field season. In the foreground, you can see Mound 6, and in the background, you can see our excavations at Mound 4.	

11.5. A view from the south-north of Mound 6 throughout the excavation season of 2021. We uncovered a stone platform built on ash strata.	
11.6. This is an aerial view of the stone platform located in Mound 6.	

11.7. S-N view of Mound 4, which has been largely affected by modern plowing.	
11.8. A detailed photo of the skull of Burial 1, which was found in layer 18 of Mound 4.	

11.9. Aerial perspective of Burial 2 prior to excavation.	
11.10. A panoramic photo of our completion of the Mound 4 archaeological excavation at the end of the 2021 season. We decided to excavate only Burial 2, leaving the other feature in the top corner for the next season in 2022. This feature would be part of something larger, which we later named Burial 3.	

11.11. Secondary Burial 4 found in SU-4 of Mound 4 during the 2022 Season.	
11.12. South-North view of the stone slabs found after removing the remains from multiple Burial #3. We found Burial 5 beneath the slabs.	

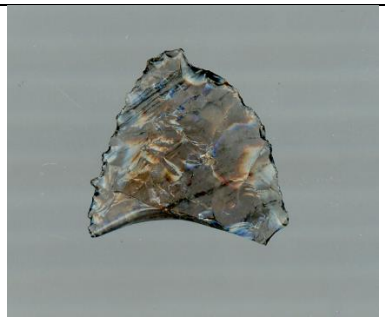
11.13. Beneath the stone slabs, there was a black layer of ash, fine gravel, and organic remains (SU-11).	
11.14. Panoramic photo of the stone cist containing Burial 5. A compact layer of red ochre deposit (SU-13) covers the burial.	

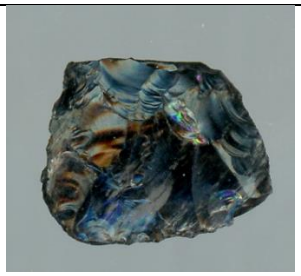
11.15. Top view of the fully excavated Burial 5.	
11.16. The stone cist after the human remains of Burial 5 have been completely excavated. This cist is located at the base of Mound 4.	

11.17. Photo of the end of the excavation of Mound 5. We found a series of pits at the base of the mound, the contents of which date to ~3630 cal BP, but there is no evidence of human burials.	
11.18. During our 2022 field season, we discovered three pits in excavation unit 3. We located this unit in a presumed open space, or plaza, at the site. We dated the contents of one of these pits to approximately 4590 cal BP.	

Appendix 12. Data and photographs of Kaillachuro artifacts found associated with burials.

Data	Artifacts photos
Burial 2	
12.1 Context: Burial 2 Project: Flores-Blanco, 2021 Type: 2A Length: 46 mm Width: 21.5 mm Thickness: 8 mm Weight: 7 g Base width: 2.9 mm Raw material: Silex Retouch: continuous, covering, and irregular bifacial.	
12.2 Context: Burial 2 Project: Flores-Blanco, 2021 Type: stone bead Length: 6.3 mm Width: 6.2 mm Weight: 0.1 g Hole: 2.9 mm Raw material: Stone with high silicate (Si), aluminium (Al), and chromium (Cr) content. It is not chrysocolla (according pXRF).	
Burial 3	
12.3 Context: Burial 3 Project: Flores-Blanco, 2022 Type: stone bead Length: 7.2 mm Width: 7.1 mm Weight: 0.1 g Hole: 2 mm Raw material: Unknow stone.	

Burial 5	
12.4 Context: Burial 5 Project: Flores-Blanco, 2022 Type: 5B Length: 19.5 mm Width: 15.3 mm Thickness: 3.7 mm Weight: 0.7 g Base width: 14.3 mm Raw material: silex Retouch: continuous, covering, and irregular bifacial.	
12.5 Context: Burial 5 Project: Flores-Blanco, 2022 Type: 5D Length: 16 mm Width: 9.9 mm Thickness: 3.05 mm Weight: 0.5 g Base width: 9.1 mm Width of concavity: 7 mm Depth of concavity: 1.1 mm Raw material: obsidian Retouch: continuous, covering, and irregular bifacial.	
Burial B4	
12.6 Context: B4 Project: Aldenderfer, 1997* Type: 3D/E Length: 27.65 mm (incomplete) Width: 20.3 mm Thickness: 6.6 mm Weight: 3.1 g Base width: 14.3 mm Raw material: silex? Retouch: continuous, deep, direct, and irregular with micro retouching.	

Burial B5	
12.7 Context: B5 Project: Aldenderfer, 1997* (2 projectile point fragments) Type: 5? Length: 14.9 / 18.7 mm (incomplete) Width: 11.2 / 12.85 mm (incomplete) Thickness: 3.2 / 2.6 mm Weight: 0.3 / 0.7 g Raw material: obsidian Retouch: continuous, covering, and irregular bifacial.	
12.8 Context: B5 Project: Aldenderfer, 1997* Type: 5B? Length: 25.6 mm (incomplete) Width: 22.3 mm Thickness: 6.5 mm Weight: 2.4 g Raw material: obsidian Retouch: continuous, marginal, and irregular.	
12.9 Context: B5 Project: Aldenderfer, 1997* Type: 5D Length: 15.5 mm (incomplete) Width: 16.6 mm Thickness: 4 mm Weight: 0.6 g Base width: 9 mm Width of concavity: 7.8 mm Depth of concavity: 1.4 mm Raw material: silex Retouch: continuous, covering, and irregular bifacial.	

Note: Those burials that have not been mentioned are because no artifacts considered prestigious were found or because they are general, such as deposits of ochre or obsidian flakes.
***** Mark Aldenderfer authorized the use of his field record to contextualize the findings.