MEALS IN MOTION: CERAMIC AND BOTANICAL INVESTIGATIONS OF FOODWAYS IN THE LATE FORMATIVE AND TIWANAKU IV/V, LAKE TITICACA BASIN, BOLIVIA

MEALS IN MOTION: CERAMIC AND BOTANICAL INVESTIGATIONS OF FOODWAYS IN THE LATE FORMATIVE AND TIWANAKU IV/V, LAKE TITICACA BASIN, BOLIVIA

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Abstract

In Andean South America, archaeological research demonstrates that rituals surrounding the consumption of food and drink have long played an important part in building relationships between individuals, families, and communities. This thesis focuses on foodways in the Late Formative (200BC-AD475) and Tiwanaku (475-1000AD) phases of the Lake Titicaca basin in highland Bolivia. I pair ceramic and botanical datasets from three assemblages: Late Formative contexts from Kala Uyuni (southern Titicaca Basin) and Challapata (eastern Titicaca Basin), and a Tiwanaku phase burial at Chiripa (southern Titicaca Basin). The goals of this thesis are to: identify microbotanical plant remains of foods associated with ceramic vessels, consider how these inform archaeological understandings of Titicaca Basin foodways, and evaluate whether studying plant residues from ceramic vessels is an effective method to study foodways.

Phytoliths and starch grains recovered from Challapata and Chiripa included remains of both local and non-local plants, while the Chiripa ceramic assemblage included non-local ceramic styles. These results offer new evidence for exchange between highland and lowland sites. Both local and non-local plant remains were recovered in public spaces where ceremonies may have taken place. While non-local goods may have been desirable and special because they were difficult to obtain, results of this thesis suggest that local plants may have been just as symbolically important. Overall, results indicate that pairing ceramic and botanical datasets can enable a richer understanding of foodways.

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Chapter 1
Introduction: Pairing Studies of Craft and Culinary Practices

This thesis is structured around a common idea: we are what we eat. Anthropologists and archaeologists recognize that foodways play an important role in the social lives of people, both present and past (Douglas 1984; Goody 1982; Hastorf 2016; Klarich, ed. 2010; Twiss, ed. 2007). In Andean South America, archaeological and ethnographic research demonstrates that rituals surrounding the consumption of food and drink played – and continue to play – an important part in building relationships between individuals, families, and communities (Bray 2003b; Hastorf 2003a, 2003b, 2012; Jennings and Bowser, eds. 2009; Nash 2010, 2012; Van Vleet 2008; Weismantel 1989). This thesis focuses on foodways in the Late Formative (200 BC-AD 475) and Tiwanaku (AD 475-1000) phases of the Lake Titicaca basin in highland Bolivia. I pair ceramic and botanical datasets from three assemblages: Kala Uyuni, a Formative Period site on the Taraco Peninsula in the southern Titicaca basin; Challapata, a Formative Period site in the eastern Titicaca basin; and a Tiwanaku phase burial at Chiripa, also located on the Taraco Peninsula. I study food and the vessels in which food was stored, prepared, and served to contribute to more well-rounded understandings of the practices surrounding the preparation and consumption of food and drink.

According to Christine Hastorf (2016:8), food is a social agent. It engages in political issues and can affect the ways in which people relate to one another. Food is both an essential part of people's everyday lives and a potent symbol that can communicate identities (Hastorf and Weismantel 2007). The kinds of foods that people either choose to eat or are required to eat communicate various levels of identity including ethnicity and social class (Hastorf 2016:11; Weismantel 1989:144-145). Food consumption, both at the household level, in the context of everyday or family meals, and at the community level, in the context of feasts, enables people to build and solidify relationships with one another (Hastorf 2016; Hastorf and Weismantel 2007). Public consumption events, such as feasts, can draw on collective memory to strengthen community cohesion (Roddick and Hastorf 2010). They are also venues in which people can publicly display their wealth and/or political power and solidify their social standing (Dietler and Hayden 2001).

Food is a valuable topic of archaeological study because it factors into many other dimensions of peoples' lives outside of simply diet. Studies of food can shed light on people's everyday practices, including those involved in food acquisition and agriculture, food preparation, and household level food consumption (Atalay and Hastorf 2006; Brumfiel 1991; Gokee and Logan 2014; Hastorf 2012; Lyons and D'Andrea 2003). Studies of food production and exchange can also enable better understandings of past subsistence and economies (Bruno 2008; Bruno and Whitehead 2003; Chevalier and Bosquet 2017; Korstanje 2017; Moore et al. 2010; Pearsall 2008). In addition, topics such as feasting practices and differential access to foods are valuable ways to learn about politics, ritual, and religion in the past (Bray 2003a, 2003b; Dietler and Hayden, eds. 2001; Goody 1982; Hastorf 2003a, 2003b; Hastorf and Johannessen 1993; Jennings and Bowser, eds. 2009; Klarich, ed. 2010; Mills 2007).

Hastorf (2016:7) challenges researchers to look beyond the material remains of food in the archaeological record and to consider the practices surrounding these materials. She describes the actions surrounding food preparation and consumption that are no longer visible to archaeologists: "the stirring of the pot, people's conversations, the sounds and smells of cooking, savoring the taste as the cook checks the sauce, the anxious hunger of the onlookers, the sated feeling after eating, or the sequence of courses consumed" (Hastorf 2016:7). It is these practices that make food such a rich topic of study. To gain a well-rounded understanding of food and food related practices in the past, archaeologists must not just study food itself, but "foodways," which includes the tools, practices, and beliefs surrounding the acquisition, preparation, consumption, and discard of food (Anderson 1971).

1.1 Intersections of Craft and Culinary Practices

The term foodways refers to the "whole interrelated system of food conceptualization, procurement, distribution, preservation, preparation, and consumption" (Anderson 1971:2 cited in Hastorf 2016:14). Studies of foodways go beyond food remains. Gokee and Logan (2014:88) advocate pairing studies of culinary practices with studies of craft production, defining these practices as "inseparable fields of social action." There are many ways in which culinary practices and craft production are linked, including the objects used to prepare and serve food; the sometimes shared techniques; their association with social identities; and their role in greater political economies

(Arthur 2014; Gokee and Logan 2014; Logan and Cruz 2014; Mills 1999; Sillar 1996; Stahl 2014).

Food is often prepared and served with vessels and tools that are the products of crafting. In fact, Gijanto and Walshaw (2014:272) consider these artifacts to be a fundamental part of meals. In many cases, the primary function of ceramics is to store, prepare, and serve foods (Mills 1999:100). This close connection is why scholars have frequently focused on ceramics to investigate foodways (Mills 1999, 2016). The symbolic meaning of food and ceramic vessels are often interconnected, with particular vessel types used to serve specific dishes (Brumfiel 1991:239), at least at particular times. Familiar vessels can also help to normalize unfamiliar foods. Lyons and D'Andrea (2003:517) argue that communities or individuals often reject potential new foods because they do not consider them to be edible or belonging to the category of "food." However, people are more likely to accept new foods if they are prepared and served in a similar way, using similar technologies, to familiar foods. In this sense, foods and crafts contribute to the construction of each other's identities, as foods can draw meaning from the tools used to prepare them and the vessels in which they are served, and particular tools can be reserved to the preparation and serving of specific dishes.

Culinary practices and craft production are both everyday practices that Logan and Cruz (2014:206) define as "key tasks that anchor the rhythms of everyday life." It is useful to think of the interrelated practices involved in food and craft production as part of the same taskscape (Logan and Cruz 2014). Ingold (1993:158) defines a taskscape as "mutual interlocking tasks" or "an array of related activities." Both craft production and culinary practices are embodied, learned activities (Gokee and Logan 2014:87; Roddick 2013) that are linked not only with everyday cycles in the context of meals, but also with longer term cycles such as agricultural seasons and annual rituals and ceremonies (Hastorf and Weismantel 2007).

Different crafting practices often share similar technologies and methods (Shimada and Wagner 2007). People sometimes use similar techniques to process clay and create pots as they do to prepare food. Sillar (1996:268-269) discusses the connections between clay preparation and *chuño* (freeze dried potato) production in the community of Pumpuri in Potosi, Bolivia. Both the language and practices involving collecting materials from the ground, grinding, trampling, and drying of potatoes and clay are similar. Sillar (1996:267) also notes that many Andean communities acknowledge a "crossover of technical know-how and terminology" between clay and food preparation. Often, people use the same tools in clay processing as they do in food production. For example, people use rocker mills to pound and grind clay, temper, cereal grains, and vegetables. Similarly, in some Amazon basin communities, people use shared techniques to fire clay vessels and cook foods (Siller 1996:262, 265). Craft and culinary practices are therefore frequently connected by the techniques and tools that people use to complete these tasks.

The preparation of food and production of crafts help construct people's identities, including gender (Brumfiel 1991; Logan and Cruz 2014). Brumfiel (1991) explains that cooking and weaving were two of the most important tasks associated with the female sphere in Aztec society. Studying these activities therefore became an important means for archaeologists to learn about women's lives in the past. In contemporary Andean communities, tasks related to ceramic production are distributed based on both gender and age (Sillar 1996:271). However, the gendered division of labour is flexible and can be enacted in various ways. Sillar (1996:266) explains that, in some communities, blind men carry out tasks that are typically associated with the female sphere, such as processing clay for potters. Arthur's (2014) ethnoarchaeological study of ceramic and ground stone production in southwestern Ethiopia demonstrates that craft production can also be connected to local caste systems and determines social organization. The production of craft and preparation of food are, in this sense, practices that enable people to perform gender or class identities. These practices can also constrain people's identities, marking them as belonging to particular groups or social strata.

People perform identities not only through the production of food and craft, but also through consumption (Dietler 1990). Cuisines help mark cultural membership (Hastorf 2016:223; Twiss 2007:3). For example, Goldstein et al. (2009) argue that *chicha* produced with pink peppercorn (*Schinus molle)* berries was particular to the Wari, and that drinking this variety of *chicha* therefore marked people as Wari themselves. Furthermore, following Gijanto and Walshaw (2014:272), I consider the tools used to serve and consume food to be part of meals. As such, these objects can also act as markers of identity within the context of meals or, more broadly, cuisines. Luxury foods, those foods that are "desirable or hard to obtain," or difficult to craft and prepare, are often used to mark social status (Van Der Veen 2003:405, 409; see also Hastorf 2003b; Hastorf and Weismantel 2007:322-323). Similarly, the possession and use of rare and desirable objects in the context of everyday meals and feasts can mark an individual's high status. In the Inca empire, for example, fine vessels functioned as "political tools" that displayed the wealth and status of people who consumed food and drink from them (Bray 2003b). Choices of food and culinary practices can also enable people or groups to reaffirm, subvert, or transform their identities (Hastorf and Weismantel 2007:319-323). In this sense, culinary practices and crafting both produce goods that people use to perform and solidify their identities.

The last area in which culinary practices and craft production intersect is political economy. As discussed above, both foods and craft goods can become important political tools that that enable the production or subversion of power through ownership and consumption of luxury goods. Food and craft goods also circulate within networks of exchange (Gokee and Logan 2014:97). These exchange networks can allow communities to build relationships with one another. Sillar (1997) describes the ways in which the exchange of pottery and other resources enables people to build fictive kin relationships in the Andes. Sillar (1997:16) also discusses the notion of "reputable pots," explaining that there are certain characteristics of ceramics that people in Andean communities believe make for good pots, and that particular ceramic producing communities have reputations for making good pots. This knowledge about what makes a good pot connects people, potters and pot buyers, who have never met. Similarly, Mills (2016) argues that the *meanings* of ceramic vessels travel with the objects. In this way, people who have never met hold shared ideas – to a certain degree – about what particular vessels mean or symbolize. The important place that culinary practices and craft production hold in political economies demonstrates that the everyday practices involving food and craft production are at the root of broader social processes. The objects and foods that circulate in networks of exchange and that lend their symbolic importance to established or aspiring political leaders gain their symbolic importance from how deeply rooted they are in everyday practices (Bourdieu 1984; Stahl 2002).

Archaeologists have employed a number of methods to investigate the intersections of craft and culinary practices. Ethnoarchaeological methods (Arthur 2014; Logan and Cruz 2014; Lyons and D'Andrea 2003; Sillar 1996, 1997) enable researchers to develop more robust datasets and nuanced interpretations (Stahl 2014:384). Other approaches rely exclusively on archaeological data. Mills (1999) draws solely on a ceramic dataset to study foodways, considering how ceramic attributes such as vessel size can inform us about changing culinary practices. In a more integrative approach, Gijanto and Walshaw (2014) study meals in Atlantic Trade contexts in Juffure, Ghana by combining ceramic, macrobotanical, and faunal datasets. Their study encompasses contexts from both everyday and episodic events to examine the ways in which Atlantic Trade affected life at Juffure. The approach that I take in this thesis is most similar to that of Gijanto and Walshaw (2014), as I am considering multiple lines of data (ceramics and botanicals) together.

1.2 Research Goals and Questions

Stahl (2014:384) notes that there are several factors that can affect the feasibility of investigating craft and culinary practice together, including available datasets. In certain cases, archaeologists must study materials or datasets that were acquired without these kinds of research questions in mind. Studying the intersections of craft and culinary practices poses methodological challenges that can limit results and interpretations. However, Stahl (2014:383-384) argues that, despite these limitations, studying the overlapping practices involved in crafting and food production is a valuable way to study the past "from the hearth up;" considering how daily practices can inform about broader social and political processes.

This thesis aims to contribute to the development of a more well-rounded understanding of foodways and the intersection of craft and culinary practices in the Andes. I study three contexts. First, I examine Late Formative domestic and potentially ritual contexts at Kala Uyuni, on the Taraco Peninsula. Excavations at Kala Uyuni have taken place over the last two decades as part of the Taraco Archaeological Project (TAP), directed by Dr. Christine Hastorf and Dr. Matthew Bandy from 2003 to 2009, and by Dr. Christine Hastorf, Dr. Maria Bruno, and Dr. Andrew Roddick since 2009. I also study Late Formative public contexts from Challapata, in the eastern Titicaca Basin. Challapata is the focus of the relatively new *Proyecto Arqueológico de Redes de Interacción Altiplano y Valles Interandinos* (PARIAVI) directed by Dr. John Janusek, Dr. Andrew Roddick, Carlos Lémuz, and Victor Plaza. One of the project's main goals is to investigate the circulation of goods between the Titicaca Basin and lowland valleys to the east. Finally, I study artifacts excavated from a Tiwanaku IV/V phase burial at Chiripa. Though Chiripa is also the subject of TAP research, this burial was excavated by members of the Chiripa community in 2015.

The Late Formative and Tiwanaku phases of the Lake Titicaca Basin are ideal contexts to study the relationship between ceramics and food because they are periods of political intensification and increasing interactions between regional polities. As will be seen in chapter 3, public consumption events, or feasts, played an important role in building community cohesion and asserting elites' wealth and power. During Tiwanaku phases, food and drink at these events were consumed from highly standardized decorated ceramic vessels. The results of my ceramic and paleoethnobotanical analysis enable me to investigate the place of foods and ceramic vessels in potentially public and ritual contexts in the Late Formative and Tiwanaku phases.

I address three major questions in this thesis:

1) In the Lake Titicaca Basin, which plant foods are associated with pots?
2) Based on ceramic and botanical data, how might the analysed artifacts have been used? What does this tell us about Titicaca Basin foodways?
3) What are the benefits and challenges of studying ceramic and plant data together?

I conducted paleoethnobotanical analysis to answer my first research question, specifically seeking out differences in plant assemblages between each individual vessel as well as between the three sites. My research is centered around foodways, and I therefore focus more heavily on plants that were likely consumed as food. However, I do list, and in some cases discuss, the non-food plants that I identified in these assemblages. To answer my second question, I consider both ceramic and paleoethnobotanical datasets. I connect these findings to previous research on Titicaca Basin foodways and discuss the ways in which my findings contribute to archaeological understandings of food. To answer my final research question, I consider the practical benefits and challenges of studying ceramics and botanicals together. I discuss how these two datasets enriched my understanding of foodways and contribute to the growing body of research about culinary practices and craft production. Finally, I discuss the challenges that I encountered in my project and propose solutions that could mitigate these challenges for future researchers.

1.3 Thesis Overview

In Chapter 2, I provide background on the Late Formative and Tiwanaku period Lake Titicaca Basin and on the three sites that I study in this thesis. In Chapter 3, I discuss Titicaca foodways, focusing on ingredients, food preparation practices, and the symbolic importance of food. Chapter 4 provides an overview of the methods I employed for both ceramic and paleoethnobotanical analysis. I also discuss paleoethnobotanical identification techniques, describing the diagnostic features of the phytoliths and starch grains of plants that I expected to recover in my analysis. In Chapter 5, I present ceramic results from each of the three sites. Ceramic analysis at Kala Uyuni encompasses a broad dataset of ceramics, which I use to contextualize and interpret the sherds from which I took paleoethnobotanical samples. My analysis of Chiripa and Challapata ceramics focuses specifically on the ceramics from which I completed paleoethnobotanical extractions. In Chapter 6, I address my first research question by presenting paleoethnobotanical results and discussing how these findings relate to previous paleoethnobotanical research in the Titicaca Basin. In Chapter 7, I answer my second research question by considering ceramic results and paleoethnobotanical results together and discussing the plant remains specifically in relation to the vessels from which they were extracted. Finally, in Chapter 8, I address my third question and outline the benefits and challenges of studying ceramic and botanical data together. I highlight the ways in which pairing these two datasets enabled me to develop more well-rounded interpretations of past foodways. I also discuss the methodological challenges that I encountered in this project and propose steps that archaeologists can take to facilitate this kind of research moving forward based on my experience.

My results contribute to ongoing debates in Titicaca Basin archaeology about circulation and exchange by offering new evidence for the presence of lowland crops at highland Titicaca Basin sites. I discuss luxury foods and their relation to highland identity, arguing that local foods may have been equally valued as exotic ones. Considering the ceramic contexts of probable food remains, I also speculate about the ways in which plants may have been prepared and served. Overall, pairing ceramic and botanical datasets proves to be an effective method that enabled me to develop richer understandings of Titicaca Basin foodways than I would have been able to achieve had I only studied one of these lines of evidence.

Chapter 2
The Titicaca Basin and Research Sites

In this chapter, I discuss previous archaeological research at the three sites that I study in this thesis: Kala Uyuni, Chiripa, and Challapata. I begin the chapter by presenting information about the Formative and Tiwanaku phases in the Lake Titicaca Basin, before turning to each site. I first discuss Kala Uyuni, focusing on Late Formative occupations and previous archaeological work about my sampled contexts. I then present information about previous excavations at Chiripa. While most research at Chiripa has focused on Formative period occupations, here I discuss Tiwanaku phase occupations because the Chiripa artifacts that I study in this project are from a Tiwanaku phase burial. Finally, I present results of recent excavations at Challapata, a Formative and Tiwanaku phase site in the eastern Titicaca Basin. Archaeological research at Challapata is in its infancy and I therefore complement this information with findings from the neighbouring site of Titimani.

2.1 Formative and Tiwanaku Phases in the Titicaca Basin

Archaeologists working in the Titicaca Basin divide the Formative period into three phases: the Early Formative (1500-800 BC), the Middle Formative (800-250 BC), and the Late Formative (200 BC-AD 475). During the Early Formative period, people settled more permanently in the southern Titicaca basin, building domestic structures and some ceremonial spaces (Hastorf 2008:548). In the subsequent Middle Formative period, communities grew in size and built more ceremonial architecture, including sunken courts and stepped platforms (Hastorf 2008:549). Exchange became more common during the Middle Formative, both between sites within the Titicaca Basin, and with sites in other regions (Bandy 2005; Hastorf 2008:550; Stanish 2003).

Figure 2.1 Map of South America, indicating the location of Lake Titicaca

During the Late Formative period (200 BC-AD475) larger political and ceremonial centers emerged throughout the Titicaca Basin. Pucara developed as the center of a northern Titicaca Basin polity that had trade connections with communities outside the basin (Hastorf 2008:554; Stanish 2003:142-144). Based on survey data, Bandy (2006:229-232) argues that a Late Formative multi-community polity with a three-tiered settlement hierarchy emerged on the Taraco Peninsula in the southern Basin with Kala Uyuni at its center. Bandy (2006) and Hastorf (2006; 2008) associate Late

Formative regional centers with an increase in public ritual, strengthened political ideologies, and large civic ceremonial architecture. The inhabitants of these regional centers likely had contact with one another through exchange, though the polities remained distinct from one another (Hastorf 2006). Long distance trade also further increased at this time (Bandy 2005; Hastorf 2006).

Figure 2.2 Map of Titicaca Basin (adapted from Roddick 2009:15) indicating sites discussed in this thesis

In Formative period contexts in the southern Titicaca Basin, the lines between domestic, public, and ritual practices are blurred. Excavations on the Taraco Peninsula have uncovered public, potentially ceremonial spaces and domestic middens, but no definitive domestic architecture (Roddick and Hastorf 2010:159). It can therefore be a challenge for archaeologists to speak to the differences and overlap between everyday and ritual practices at this time.

Tiwanaku was an important regional center in the Late Formative and rose as the center of an expansive state in the Tiwanaku IV/V periods (AD 475-1000) (Janusek 2004; Stanish 2003). Inhabitants of Tiwanaku built a ceremonial center, which includes the Akapana mound, the Kalasasaya (an elevated walled plaza), and a sunken court (Stanish 2003:172-174). The ceremonial core was surrounded by an "urban sprawl of adobe and stone structures" (Hastorf et al. 2006:430). Tiwanaku expanded throughout the Titicaca Basin and further afield, including the Cochabamba valley to the southeast and Moquegua to the west (Anderson 2009, 2013; Goldstein 1993a, 1993b; Hastorf et al. 2006). Tiwanaku archaeologists have argued that the goal of this expansion was to access desirable non-local goods, including food goods such as maize (Browman 1980, 1984; Dillehay and Nuñez 1988; Hastorf et al. 2006). According to Janusek (2004:162), Tiwanaku was a "nested hierarchy of semiautonomous sociopolitical groupings; more than a political centralization, the fundamental integrative mechanism was religious ideology." In this sense, Tiwanaku expansion was not based on political integration, but on the ritual and religious integration of other communities. Public feasts involving the consumption of *chicha* (maize beer) were an important part of Tiwanaku ritual practices, enabling elite to mark themselves as powerful through their access to and/or abundant possession of certain foods (Goldstein 2003; Janusek 2004:164). These events also indebted lower-class guests to their higher-class hosts, further cementeding the social standing of Tiwanaku elite (Janusek 2004:164).

I turn now to my discussion of the three sites that are the focus of this thesis: Kala Uyuni, Chiripa, and Challapata. Kala Uyuni and Chiripa are located on the Taraco Peninsula in the southern Titicaca Basin and have been the subject of extensive archaeological research as part of the Taraco Archaeological Project (TAP) (Bandy 2001, 2004, 2005, 2006; Bandy and Hastorf, eds. 2007; Bruno 2008; Hastorf 2003a; Hastorf, ed. 1999; Logan 2006; Logan et al. 2012; Moore et al. 2010; Roddick 2009, 2013; Roddick and Hastorf 2010; Roddick et al. 2014). However, the Chiripa samples discussed here date to the Tiwanaku IV/V phase, a period that was not the focus of TAP research. Challapata is located on the eastern shores of Lake Titicaca and excavations at this site, as part of the *Proyecto Arqueológico de Redes de Interacción Altiplano y Valles Interandinos* (PARIAVI), are still in their infancy (Janusek et al. 2014, 2016).

2.2 Kala Uyuni

Kala Uyuni is a Formative period site located near the southwestern tip of the Taraco Peninsula. TAP archaeologists have identified two Middle Formative occupation sectors at Kala Uyuni: Achachi Coa Collu (KUAC) and Ayrampu Qontu (KUAQ). Ayrampu Qontu was a domestic occupation sector and Achachi Coa Collu, to the northeast, was a ceremonial sector comprised of two trapezoidal sunken courts. These areas were closed at the end of the Middle Formative period as people shifted their occupation and activity spaces to the sector that TAP archaeologists call Kala Uyuni Kala Uyuni (KUKU), which was occupied from the Late Formative through Tiwanaku phases. All Kala Uyuni samples for this project are from the KUKU sector.

Based on his survey work on the Taraco Peninsula, Bandy (2004, 2005, 2006) argues that Kala Uyuni was a “stable village” during the Middle Formative period. The presence of sunken courts suggests that the occupants of Kala Uyuni engaged in public ceremonies. Middens associated with these courts included food remains and a ceramic assemblage of serving and storage vessels, which suggests that the ceremonies that took place in the courts involved food consumption (Roddick et al. 2014:147). According to Bandy (2005), these events promoted group cohesion and prevented the village from fissioning. Survey data suggests that the population at Kala Uyuni more than doubled from the Middle to Late Formative period (Bandy 2005). Bandy (2006:229-232) argues that Kala Uyuni was the capital of a Late Formative Taraco Peninsula-wide multi-community polity. He proposes that long-distance trade networks allowed Kala Uyuni elites to acquire exotic goods, thereby gaining social capital and solidifying the community’s place as the center of the Taraco Peninsula Polity.

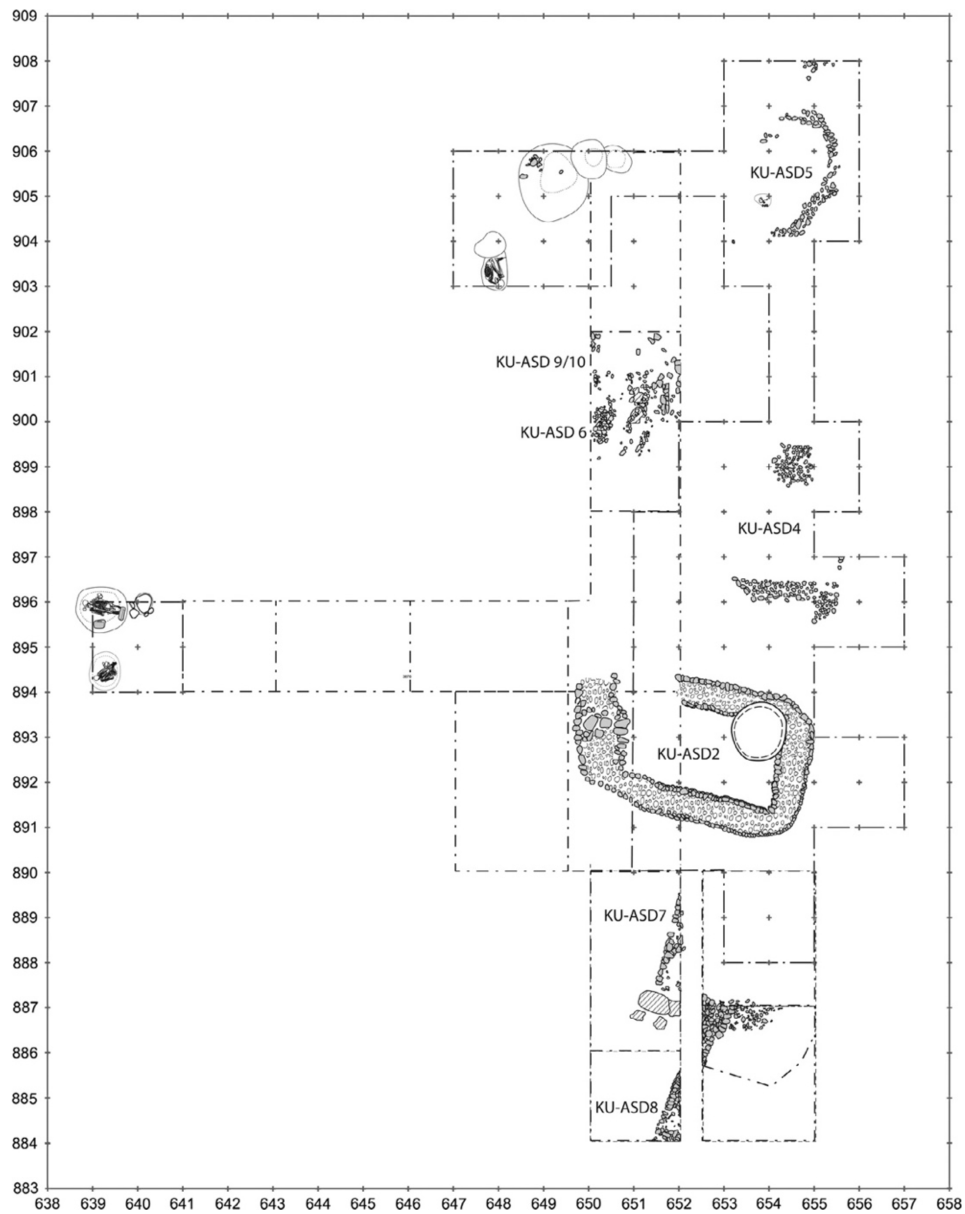

Figure 2.3 Plan map of KUKU sector, including ASDs (from Roddick et al. 2014:150)

Roddick et al. (2014) study Kala Uyuni from a more localized perspective. They take a "vertical approach," using stratigraphic information to focus on particular events at the site and examine how these local events may have catalyzed change at the regional level. The Late Formative occupation sectors at Kala Uyuni had complex stratigraphy, complicating interpretations but also revealing dynamic occupations (Roddick et al.

2014:153-154). There are four Kala Uyuni contexts, including from three architectural structures (ASDs), from which I have analyzed ceramic artifacts and microbotanical samples: ASD-2, ASD-5, ASD-9, and a high density midden to the West of ASDs 2, 4, and 5.

Roddick et al. (2014) distinguish three Late Formative construction and occupation phases at Kala Uyuni. The first of these phases dates to roughly 200 years after the closure of the Middle Formative structures and encompasses the construction and occupation of ASDs 9 and 10 (Roddick et al. 2014:149). ASD-10 was built immediately over sterile soil and is the earliest structure of its phase. ASD-9 was built atop ASD-10. ASDs 9 and 10 had similar circular semi-subterranean construction styles that borrowed from earlier Middle Formative architectural style (Roddick et al. 2014:149). Surfaces in and surrounding ASDs 9 and 10 contained fish and camelid bones, charred plants, and ceramic production tools. Plant remains from the interior occupation surface of ASD-9 included some potential food remains such as quinoa (*Chenopodium* sp.) and parenchyma (food storage tissue from grains or tubers), as well as several other plant remains including wood and grass (Poaceae family) that are not associated with food. Overall, plant remains in the structure are typical of Late Formative contexts and are not particularly indicative of food related activities (Maria Bruno, personal communication 2017). Late Formative ceramics, including diagnostic red-rimmed Kalasasaya bowls, were recovered from the clay floors in each of the structures (Roddick et al. 2014:149). Roddick and colleagues (2014:149) propose that unspecified household activities took place in both ASDs 9 and 10.

Figure 2.4 Excavation photo (by Andrew Roddick) of ASD-9 and ASD-10

The second building phase of Late Formative Kala Uyuni is marked by an intensification in the construction of public, possibly ceremonial, spaces (Roddick et al. 2014:149). Roddick and colleagues identified four structures belonging to this building phase: ASD-2, ASD-4, ASD-7, and ASD-8, all of which have similar cobble foundations. There is a high density of botanical remains in an open area between ASD-2 and ASD-4, which suggests that it was a cooking space (Bruno 2008:401-402, 416-417; Roddick et al. 2014:151). This cooking area is relatively small, indicating that large scale feasting may not have been common during this phase (Roddick et al. 2014:151). ASD-7 is represented only by a single wall and the authors speculate that the structure may once have been part of ASD-8. The form of ASD-7 and ASD-8 is unique at Kala Uyuni and is reminiscent of a patio enclosure (Roddick et al. 2014:150-151).

As ASD-2 was excavated over several field seasons, it is the most investigated of these four structures. It is a Late Formative I (200 BC-AD 250) U-shaped structure with an east-west alignment and a western entrance. The interior floor of ASD-2 was composed of yellow clay, about 3 cm thick (Paz and Fernandez 2007). Though the floor of the structure was relatively clean, it did yield a small number of ceramics, a high percentage of which were red-rimmed and incised polychrome vessels (Steadman 2007:75-77). Based on its ceramic assemblage and architectural style, the structure likely served ritual or ceremonial purposes (Bandy 2007; Bruno 2008; Roddick 2009; Roddick et al. 2014; Steadman 2007).

Figure 2.5 Kala Uyni excavation photos (by Andrew Roddick). Left: ASD-2; Right: ASD-5

Bruno (2008) carried out macrobotanical analysis of samples from the interior and exterior of ASD-2. The interior of the structure had a very low density of plant remains (Bruno 2008:399), while the exterior had higher densities and greater richness of taxa. The northern exterior of ASD-2 had the highest density of botanicals out of all contexts associated with the structure (Bruno 2008:401-405). Bruno identified Poacaea, quinoa (*Chenopodium quinoa)*, bean family species (Fabaceae), and mallow family species (Malvaceae) in the area to the north of ASD-2. She also found high densities of parenchyma in this area. It is likely that ASD-2 served a special, possible ritual purpose at

Kala Uyuni in the Late Formative period. Based on the low densities of ceramic and botanical remains inside this structure, it is possible that people did not prepare or consume food in this space. Another possibility is that inhabitants did consume food but that they cleaned the floor afterwards.

During the final construction phase of Late Formative Kala Uyuni, a new construction style emerged and public spaces became less clearly defined (Roddick et al. 2014:152). The defining feature of this phase is ASD-5, a domestic, circular structure with relatively thin walls and a cobble foundation that is north of ASD-2 and ASD-4 (Roddick 2009:118). Dating ASD-5 is complicated because ceramics from the structure are phased to Late Formative I, while radio-carbon dates indicate it was a Late Formative II (AD 300-500) structure (Roddick 2009:121). Roddick et al. (2014) nonetheless argue that its use dates to the terminal Late Formative, after ASD-2 was abandoned. The structure's interior surface is made of compact, uneven clay and has high densities of fish bones and carbonized plant remains. ASD-5 has the highest density of sooted and carbonized ceramic sherds of all Kala Uyuni contexts. Bruno (2008:421) found higher densities of plant remains on interior surfaces of ASD-5 than the interior surfaces of ASD-2. The northern area of ASD-5 had the highest densities within the structure. *Chenopodium quinoa* is the densest taxon in the structure, while bean family (Fabaceae), grass family (Poaceae), amaranth family (Amaranthaceae), and other species were also present (Bruno 2008:425). Parenchyma is present in low densities. *Chenopodium quinoa*, Fabaceae, Amaranthaceae, and parenchyma are all probable food remains. Ceramic and botanical remains from ASD-5 indicate that people may have prepared and served food in

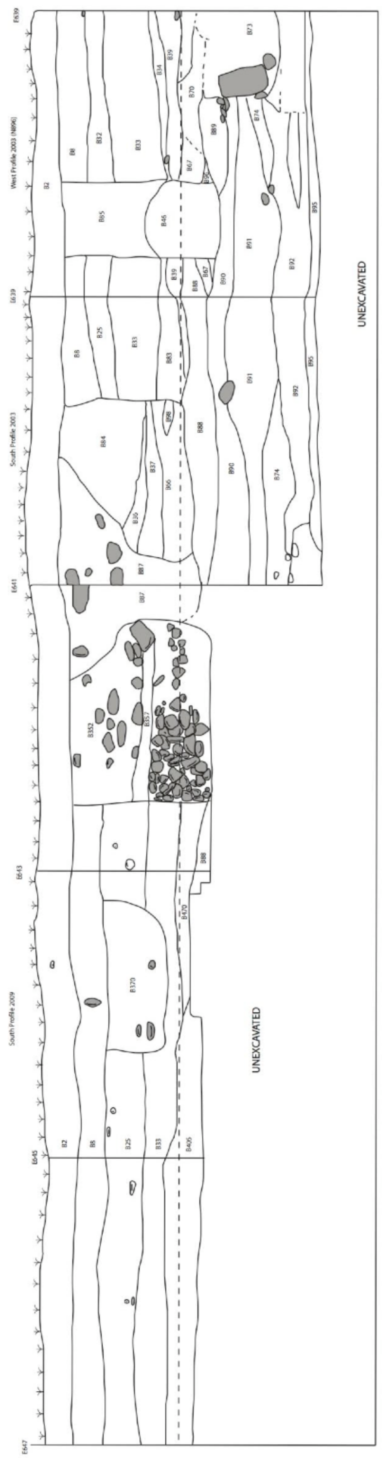

Figure 2.6 TAP profile drawing of Late Formative area west of ASDs 2, 4, and 5

this structure. There is no clear surface at the exterior of ASD-5, though there are midden-like deposits and two burials near the structure (Bruno 2008:426).

The differences in ceramic and botanical distribution between ASD-2 and ASD-5 suggest that cooking practices differed between the two structures. During the earlier phase, people seem to have prepared food outside. Food consumption does not seem to have taken place in ASD-2, though people may have consumed food inside other structures, such as ASD-4, which had a higher density of plant remains than ASD-2 (Bruno 2009:413). In the later phase, people seem to have cooked and likely consumed food inside of ASD-5. These differences could be attributed to a shift in practice between two phases or to the different functions of the two structures.

2.3 Tiwanaku at Chiripa

Occupation at Chiripa began in the Early Formative (1500-800 BC) period and continued through Tiwanaku phases (AD 475-1000). During the Early and Middle Formative Periods (800-250 BC), Chiripa was an important ritual center, where ceremonies involving public feasts and commemoration of the dead took place (Hastorf 2003a). The central defining feature of Chiripa is the ceremonial mound, the Monticulo. The Monticulo was a natural mound that became an important ritual space in the Early Formative as the inhabitants of Chiripa accentuated the feature (Hastorf 2012:223). In the Middle Formative, small house-like structures were built on the outer edges of Monticulo, enclosing the court at the center and creating smaller enclosed spaces for more specialized and exclusive gatherings (Hastorf 2012:224). During these periods, the mound appears to have been used as a gathering place for important ceremonies and feasts (Hastorf 2012). Based on the high number of graves on the mound, Hastorf (2003b) argues that the ceremonies that took place there played an important role in maintaining ties with community ancestors and strengthening social memory. Other areas of Chiripa include Llusco, to the south of Monticulo; Santiago, to the northwest of Monticulo; and Quispe and Alejoe, to the southeast of Monticulo.

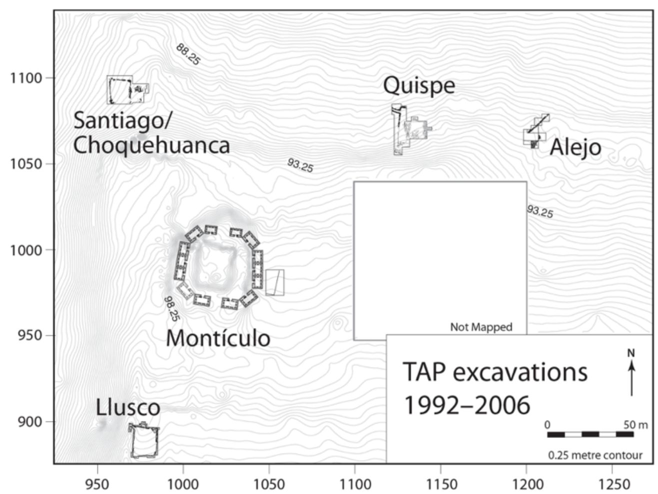

Figure 2.7 Plan of Chiripa (from Roddick and Hastorf 2010:170, drawn by William Whitehead)

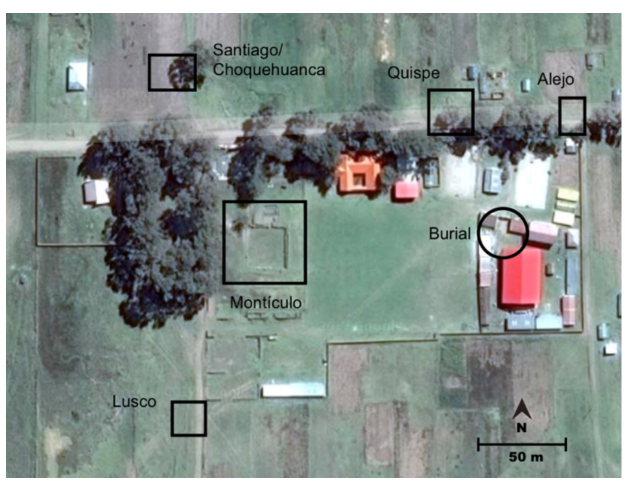

Figure 2.8 Map of Chiripa showing general location of burial in relation to Middle Formative architectural features

In this thesis, I discuss results from five ceramic vessels excavated from a Tiwanaku IV/V period burial at Chiripa. Members of the modern Chiripa community excavated the grave in 2015 as part of a construction project taking place east of the Monticulo mound (Christine Hastorf, personal communication 2017). Because this burial was not uncovered as part of systematic excavations, contextual information is limited. Archaeological research at Chiripa has tended to focus on Formative period occupations, so information about Tiwanaku phase occupations is also rather scant.

Nevertheless, several Tiwanaku structures and graves have been excavated. For instance, TAP excavations in 1992 and 1996 uncovered a Tiwanaku IV/V structure with plaster floors in the southern area of Chiripa's Santiago sector (Hastorf 1999:4). The structure was associated with several tombs and may have served ritual functions (Hastorf 1999:4). Blom and Bandy (1999) report on thirteen Tiwanaku period burials at Chiripa, noting continuity in grave construction style from the Formative period, which suggests a continuation of local traditions (Blom and Bandy 1999:119). Yet the number of multiple interments decreases and specific grave goods change. During the Formative period, sodalite and turquoise beads were common offerings in graves, whereas Tiwanaku phase graves tended to include ceramic vessels (Blom and Bandy 1999:118). Six of the Tiwanaku phase graves that Blom and Bandy (1999:119) discuss included ceramics as their principle offering, whereas only one of them had beads.

Most of the ceramics recovered from these burials were plainware *ollas*, *keros*, and *tazones*. One burial included a broken annular based incense burner, or *incensario* (Blom and Bandy 1999:119). The artifacts from the burial that I study in this thesis were mostly decorated (discussed in Chapter 5). Furthermore, the high number of Tiwanaku IV/V burials recovered in the Santiago sector has led Blom and Bandy (1999:118) to suggest that the area was likely used as a cemetery during Tiwanaku periods. However, the grave analysed in this thesis was located east of the Monticulo mound, whereas Santiago is northwest of the mound. While it is possible that there were other burials in this eastern area that have not been excavated, this burial is nonetheless separate from several Tiwanaku IV/V burials at Chiripa. Bermann (1994:204) reports status-based spatial segregation of burials at Lukurmata during Tiwanaku phases. This suggests that it is possible that the person interred in the burial studied in this thesis may have been of higher status or special in some other way.

2.4 Challapata

Challapata is a Late Formative site located on the northeastern shores of Lake Titicaca. Challapata, and its neighbouring site of Titimani, served as ritual and political centers and nodes in long distance trade networks between the Bolivian highlands and the Eastern valleys (Portugal Ortiz et al. 1993; Stanish 2003:154). In 2013, Dr. John Janusek, Dr. Andrew Roddick, Carlos Lémuz, and Victor Plaza established the *Proyecto Arqueológico de Redes de Interacción Altiplano y Valles Interandinos* (PARIAVI) and started archaeological investigations at Challapata. The project's main goal is to investigate networks of movement and exchange in the Formative period Titicaca Basin and to address the ways in which these networks affected social and political practices (Janusek et al. 2014:3).

Figure 2.9 Photo (by Andrew Roddick) of Challapata, including Oqo Qoya Pata Mound

Figure 2.10 Map (from Janusek et al. 2014:6) showing area of Challapata occupation and location of Oqo Qoya Pata mound

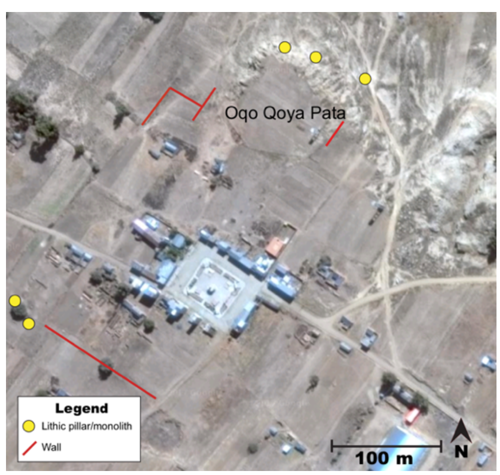

Figure 2.11 Map of Challapata (adapted from Janusek et al. 2014) showing locations of architectural features identified during survey

Excavations at Challapata in 2013 revealed that the site was likely first occupied in the Middle Formative and that a monumental platform mound, Oqo Qoya Pata, was an important center of activity at this time and in subsequent periods (Janusek et al. 2014). Ceramics recovered during the 2013 survey of the site indicate that Challapata was occupied from the Middle Formative period through to Inca times (Janusek et al. 2014:6). Challapata's location on the frontier between the Lake Titicaca Basin and the lowland Amazonian valleys to the East make the site a compelling locale at which to study ancient trade routes between these two regions. Titimani is a Formative period regional center west of Challapata that was four square hectares and included both ceremonial and domestic areas (Stanish 2003:154). The ceremonial sector included a raised platform with a sunken court that is similar in architectural style to the Monticulo mound at Chiripa (Janusek 2004:134). Excavations in the platform revealed human burials, storage enclosures, and caches of offerings (Janusek 2004:134; Portugal Ortiz et al. 1993).

I analyzed seven artifacts from Challapata. These were excavated during the 2016 field season from the Oqo Qoya Pata sector of the site. This sector is located in the northwestern area of the Challapata peninsula. Oqo Qoya Pata is a mound with monumental architecture in the form of stone walls and carved stones (Janusek et al. 2014:7). Ceramics recovered from surveys of the area in 2013 indicate that the mound was occupied during the Middle Formative, the Late Formative, and Tiwanaku phases. Sherds recovered from 2013 excavations on the mound, however, date only to the Middle and Late Formative periods (Janusek et al. 2014:8).

2.5 Summary

Kala Uyuni and Chiripa are Formative period sites on the Taraco Peninsula, with occupations spanning from the Middle Formative period through Tiwanaku phases. My overview of Kala Uyuni in this chapter focused on the Late Formative contexts from which I analysed samples. At Chiripa, I analysed contexts from a Tiwanaku IV/V phase burial, so I focused my discussion on previous research of Tiwanaku phase contexts and burial contexts at the site. Finally, I presented background information about Challapata, located in the eastern Titicaca Basin. Excavations at Challapata are more recent and less extensive that those on the Taraco Peninsula sites, but we nonetheless know that the context from which I analysed sherds – the Oqo Ooya Pata mound – was likely a space where ceremonial or ritual activities took place. Studying ceramics and plants at from two time periods at these three sites enabled me to discuss the circulation of goods in the Titicaca Basin, as well as the place of both local and exotic plants in highland foodways.

Chapter 3
Foodways in the Lake Titicaca Basin

I turn now to an overview of Formative and Tiwanaku phase foodways in the Lake Titicaca Basin. I first list and discuss the ingredients that likely comprised meals in the Titicaca Basin during those periods. This list is based on previous studies in paleoethnobotany, zooarchaeology, stable isotope analysis, and ethnoarchaeology. I then describe the probable food processing and cooking methods of the Formative and Tiwanaku phases, as well as the methods that archaeologists have employed to identify these cooking methods in the past. Finally, I explore the role of luxury foods and feasting events in Titicaca Basin foodways.

3.1 Ingredients

Hastorf (2012:219) lists several foods, almost all of which are local, that are common fare in the Titicaca Basin today. Based on paleoethnobotanical, zooarchaeological, and stable isotope data, archaeologists have determined that people likely consumed these foods in the past as well (Bruno et al. 2016; Hastorf 2012). Tubers – including potato (*Solanum tuberosum*), oca (*Oxalis tuberosa*), ulluco (*Ullucus tuberosus*), and *isañu mashua* (*Tropaoleum tuberosum*) – are among the most common plant foods. Potatoes are the most common among the tubers, while the other species are treated more as vegetables and are often served alongside potatoes rather than in their stead. Oca and ulluco are respectively the second and third most common tubers in highland communities today and can be prepared in similar ways as potatoes (Logan

2006:49-50). *Isañu mashua*, on the other hand, is not as popular as the other varieties of tubers, but is desirable because large quantities of the crop can grow in poor conditions (Logan 2006:50).

Quinoa (*Chenopodium* spp.) is a staple in the region today (Hastorf 2012:219), and Bruno's (2008) macrobotanical investigations in the southern Titicaca Basin demonstrate that it was an important food in the past as well. Plant foods that are present but less common include amaranth (*Amaranthus* sp.) and several varieties of beans including the common bean (*Phaseolus vulgaris*), the lima bean (*Phaseolus lunatus*), and the lupine bean (*Lupinus mutabilis*) (Hastorf 2012:219). Macrobotanical evidence suggests that, in addition to these domesticates, people in the Titicaca Basin also consumed some wild herbaceous plants and some from the cactus family (Cactaceae) (Hastorf 2012:219). Hastorf (2012:219) suggests that people used these wild species as garnishes to add flavour to soups and sauces. The main non-local plant that people in the region consumed during Middle Formative through Tiwanaku phases was maize (*Zea mays*). The principle sources of meat in the region were camelids, fish from Lake Titicaca, and birds (Hastorf 2012:219; Moore et al. 2010:187).

While a great deal of research in the Titicaca Basin has focused on foodways, few microbotanical study have been completed in the region (Chávez and Thompson 2006; Logan 2006; Logan et al. 2012; Rumold and Aldenderfer 2016). Microbotanical analysis can enable the identification of certain plant species that are not otherwise visible in the archaeological record. For instance, poor preservation of soft tissue has constrained the recoverability of macrobotanical remains of tubers, making microbotanical analysis an invaluable means of studying the place of these plants in past foodways (Logan 2006:47-48). One of the goals of this thesis is therefore to contribute to this list of Titicaca Basin ingredients used in the past.

Stable isotope analysis of residues from ceramics indicates that the ingredients that people had access to and foods that they consumed remained relatively stable on the Taraco Peninsula from the Middle Formative through the Late Formative and Tiwanaku phases (Miller 2005; Roddick and Hastorf 2010:168). However, the importance of some foods shifted through time. Stable isotope analysis of residues from ceramic vessels indicates that people consumed fish mostly in ceremonial contexts during the Middle Formative period (Miller 2005:52). In the Late Formative, however, fish were more common in domestic contexts and decreased in ceremonial contexts, whereas camelids became more common in ceremonial contexts (Miller 2005:53-54; Roddick and Hastorf 2010:168). Zooarchaeological analysis indicates that, at Kala Uyuni, people consumed fish at all phases of the Formative and Tiwanaku periods, but that fish decreased in importance from the Middle Formative through Tiwanaku periods (Moore et al. 2010:187). At Late Formative Kala Uyuni, Bruno (2008:479) recorded an increase in density and ubiquity tubers (*Solanum* spp. and *Oxalis* spp. seeds). Overall, the Late Formative period on the Taraco Peninsula saw an increased reliance on domesticated food sources (tubers, camelids), and a decrease in reliance on wild food sources (fish, birds) (Bruno et al. 2016). This could indicate that agriculture and pastoralism intensified on the Taraco peninsula during the Late Formative (Bruno et al. 2016). Ingredients remained relatively stable through Tiwanaku IV/V phases, when people consumed tubers, quinoa, maize, beans, camelids, and fish (Berryman 2010; Bruno et al. 2016; Vallières 2012; Wright et al. 2003).

While there was continuity in recovered ingredients from Formative to Tiwanaku phases, the onset of the Tiwanaku period saw a shift in ceramic style in the Southern Titicaca Basin (Goldstein 2003; Janusek 2003; Roddick 2009; Stanish 2003). The Tiwanaku ceramic assemblage was highly standardized in terms of both form and decoration style (Janusek 2003:57). Serving forms changed at this time, shifting away from the bowls that were more common during the Late Formative to *keros* and *tazones*. While cooking and storage vessel forms remained relatively consistent from Formative to Tiwanaku phases (Janusek 2003:57), these vessels did increase in quality in Tiwanaku IV/V (Goldstein 2003:150). This shift was accompanied by increased specialization in ceramic production at Tiwanaku (Janusek 1999; 2003). In his study of the Tiwanaku ceramic assemblage and the ways in which its dispersal throughout the Andes reflects Tiwanaku expansion, Goldstein (2003:148) argues that the emergence of the Tiwanaku ceramic assemblage marked "rapid and dramatic shift in culinary practices" between 350 and 600 AD.

This demonstrates that culinary practices are multi-faceted and do not just involve the kinds of foods that people consume, but also the culinary equipment involved in preparation and serving. While there appears to be continuity in at least some of the foods that people consumed from Formative to Tiwanaku phases, culinary practices nonetheless appear to have changed between the two periods. As Gijanto and Walshaw (2014:272) argue, meals are comprised not only of food, but also of the tools that people use to make and serve them. Ceramic were vessels, in this way, part of Tiwanaku meals. Change in ceramic assemblages is therefore indication of a change in certain aspects of culinary practices between the Formative and Tiwanaku phases.

As discussed above, tubers were likely among the most important local foods that Titicaca Basin communities consumed in the Formative and Tiwanaku phases. Potatoes (*Solanum tuberosum*) were likely domesticated in the highlands of Bolivia and Peru (Towle 1961:84). Overall, poor preservation of macrobotanical remains means potatoes and other tubers are underrepresented in the archaeological record. Nevertheless, some well preserved macrobotanical remains do shed light on tuber consumption in the Titicaca Basin. Rumold and Aldenderfer (2016) recorded 50 *Solanum* spp. starch grains on 14 grinding stones from Jiskairumoko in the western Titicaca Basin. These samples range in date from 2000 to 1000 BC. The authors report that 88% of these starch grains had damage consistent with freeze drying or grinding and propose that the presence of the starch grains on grinding stones could indicate that people at Jiskairumoko made flour from freeze dried potatoes (*chuño*) (Rumold and Aldenderfer 2016:13674).

In the southern Titicaca Basin, potato macroremains have been identified in a Middle Formative house at Chiripa (Towle 1961:86). Logan (2006:57) identified a single probable tuber starch grain on a llama mandible scraper from a Late Formative context at Sonaji. However, damage prevented Logan from securely identifying the species of this starch grain. As discussed above, Bruno (2008:479) also reports an increase in density and ubiquity of tuber macroremains (*Solanum* spp. and *Oxalis* spp. seeds) in Late Formative contexts at Kala Uyuni. Macrobotanical studies at Tiwanaku found remains of unspecified tubers in ritual contexts (Wright et al. 2003:392). I will discuss these findings further below in the context of luxury foods.

There are also several species of tubers, including manioc *(Manihot esculenta*), sweet potato (*Ipomoea batatas*), and arrowroot (*Maranta arundinacea*), that grow at lower elevations in areas surrounding the Titicaca Basin. While none of these have yet been recorded in the Titicaca Basin, it is possible that such lowland crops could have entered the region through trade. Given the importance of highland tubers in Titicaca Basin foodways, lowland tubers may have been familiar to highland communities and therefore desirable to acquire through exchange.

Colonial accounts indicate that manioc was consumed as an ingredient in soups as well as in the form of a fermented beverage in the Bolivian lowlands prior to European colonisation (Castillo 1670 in Dickau et al. 2012; Piperno 2006b:49). Microbotanical remains of manioc have been recorded in at Salvatierra (AD 1200-1500), Mendoza (AD 500-1400), and Bella Vista (AD 1400-1500) in the department of Beni, Bolivia (Dickau et al. 2012), at Real Alto (~ 2000 BC) in highland Ecuador (Chandler-Ezell et al. 2006), and in feasting contexts at Buena Vista (~ 2200 BC) in coastal Peru (Duncan et al. 2009). Macrobotanical remains of manioc have been recovered at Initial Period sites (1800 – 900 BC) in the Casma Valley, Peru (Ugent et al. 1986).

Sweet potato was a staple crop in the Casma Valley and in lowland valleys in Bolivia in the Spanish Colonial Period (Castillo in Dickau et al. 2012:358; Palomino in Ugent et al. 1986:82). Sweet potato starch grains have been recovered at Buena Vista, Peru (~ 2200 BC) (Duncan et al. 2009), while macrobotanical remains have been identified on the Peruvian coast (Ugent et al. 1986) and at Salvatierra (AD 1200-1500) in the Bolivian lowlands (Bruno 2010).

Arrowroot has been recorded in highland contexts at Wayuna, Peru (2000-1600 BC), north of the Titicaca Basin (Perry et al. 2006). Arrowroot starch grains identified at Wayuna were recovered in samples associated with a groundstone, which suggests that people at the site milled arrowroot to prepare it (Perry et al. 2006). Perry and colleagues (2006) suggest that the arrowroot at this site was traded into the highlands from eastern Amazonian valleys and note that this is the earliest evidence for exchange between the two regions. Arrowroot starch grains have also been recovered in feasting contexts at Buena Vista, Peru (Duncan et al. 2009).

Maize (*Zea mays*) is the main and most studied non-local plant in the Titicaca Basin. The earliest recorded maize on the Taraco Peninsula is from Middle Formative ceremonial contexts at Chiripa and Kala Uyuni (Logan et al. 2012:247). Maize has also been recorded in Late Formative ceremonial contexts at Kala Uyuni and Kumi Kipa (Bruno 2008:456; Logan et al. 2012:247-248). Chávez and Thompson (2006) found phytolith evidence of maize on the Copacabana peninsula as early as 800 BC. However, Logan (2006:80) challenges these findings because Chávez and Thompson did not study phytoliths produced in other species of Poaceae grasses that produce similar morphotypes (discussed in Chapter 4) and they interpret the remains as food because they were recovered from cooking pots. Logan's (2006) study demonstrates that comparative study of local wild grasses is necessary for the secure identification of maize in the Altiplano. Findings from this thesis (discussed in Chapter 6) demonstrate that grass phytoliths do appear in samples associated with ceramic vessels. As such, comparative studies of Poaceae phytoliths are necessary to securely identify maize, even when studying microbotanical remains associated with ceramic vessels.

Logan and colleagues (2012) argue that maize was likely consumed as *chicha* in public events, or feasts, during the Middle at Late Formative periods. The presence of maize microremains in grave contexts suggests that people may have offered *chicha* to the dead and/or served it to individuals soon to be sacrificed (Logan et al. 2012:252). The low densities of maize indicate that *chicha* was likely produced at the household level, not on large scales, and that maize was likely imported rather than grown locally (Logan et al. 2012:251). Berryman's (2010:260-267) stable isotope analysis at sites in the southern Titicaca Basin (that did not include Taraco Peninsula sites) found that, during the Late Formative, maize consumption was higher at sites that had public ceremonial architecture (such as Tiwanaku, Lukurmata, and Khonkho Wankane). However, there was no apparent differential access to maize among the inhabitants of these sites. During Tiwanaku phases, however, there is evidence for differential access to maize as people buried in ceremonial sectors of Tiwanaku consumed more maize than those buried in residential sectors.

During Tiwanaku IV/V phases at the site of Tiwanaku, Hastorf and colleagues (2006:443) identified maize in ceremonial spaces, indicating that it had both political and religious significance. Certain people of higher status likely consumed maize on a more regular basis (Berryman 2010; Hastorf et al. 2006:443). Based on a study of maize kernel and cob morphology, Hastorf and colleagues (2006) list three possible sources for the maize present at Tiwanaku: western valleys in Peru and Chile, specifically the Moquegua valley; southeastern valleys, specifically the Cochabamba valley; and in areas along the coast of Lake Titicaca, possibly on the Copacabana peninsula, the Taraco Peninsula, or near Lukurmata. They studied the morphology of maize kernels and cupules to evaluate the possibility that maize at Tiwanaku came from Moquegua and Cochabamba. Their findings indicate that Tiwanaku acquired maize from both the Moquegua and Cochabamba valleys as well as from other, as of yet unidentified, sources (Hastorf et al. 2006:442-443). In Chapter 7, I will consider whether Amazonian valleys to the east of the Lake Titicaca Basin may have been among these unknown sources.

3.2 Food Preparation

In contemporary Altiplano communities, many meals are comprised of boiled starch-based soups or stews to which people sometimes add meat or fish (Hastorf 2012:26). The stews that people make in the Titicaca Basin today are made from the same plant and animal foods that archaeologists recover in Formative and Tiwanaku contexts (Bruno et al. 2016). Ceramic data suggests that boiling was a common form of cooking on the Taraco Peninsula in the Late Formative (Bruno et al. 2016; Hastorf 2012:220). Though cooking practices change over time and European colonialism introduced new ingredients to the Titicaca Basin diet, it is nonetheless likely that boiled soups and stews were staple meals during the Formative period as they are today (Bruno et al. 2016; Hastorf 2012:220). Stews and soups are dishes that combine multiple ingredients and it is therefore probable that people would have cooked and consumed multiple kinds of plants and animals in single ceramic vessels. Paleoethnobotanical analysis of pot residues could shed light on the kinds of plants that people included in stews and what ingredients people may have combined, though the deposits of residues over time would likely be an index of multiple meals, not a single dish prepared over and over again. People also likely steamed or boiled potatoes and other tubers and roots and served them alongside soups and stews (Bruno et al. 2016). Roasting food in earth ovens is an important cooking method today, though it is reserved for special occasions and only occurs a few times a year (Bruno et al. 2016). It is difficult to identify roasting in the archaeological record, in part because roasted foods do not need to be cooked in ceramic vessels (Bruno et al. 2016). As will be seen in Chapter 6, however, there are some forms of damage to starch grains that indicates roasting. Microbotanical analysis can therefore contribute useful data to studies of roasting in the past.

Ceramic data offers evidence that people cooked food as stews in the Formative period. Fire-blackened and sooted bases are common in the Early Formative assemblage, which suggests that people placed pots directly in fires to cook food (Bruno et al. 2016). In later phases, unsooted oxidized bases and charred food remains inside vessels are more common occurrences, suggesting that vessels were placed over fires to cook (Skibo 2013:92; see discussion of carbonization patterns in Chapter 4). Steadman's (1995:145-153) study of cooking vessels at Camata, a Formative period site in the western Titicaca Basin, suggests that people likely employed slow cooking methods at the site. Steadman uses vessel form and charring patterns to identify cooking vessels. Vessels that were used for cooking will generally have charred food remains encrusted in the vessel or penetrating interior vessel walls, powdery soot on the exterior, glossy black discoloration, or grey/white scorch marks (Steadman 1995:146). *Ollas* – a form of necked vessel - are associated with cooking. Based on these attributes for identifying cooking vessels, Steadman found that most cooking vessels at Camata during the local Late Qaluyu (900-400 BC) and Initial Pucara (400- 300 BC) phases were produced from fiber tempered pastes. The walls of fiber tempered vessels retain heat more than those of mineral tempered vessels (Steadman 1995:150). Fiber temper vessels are more desirable for simmering foods by heating them more slowly and maintaining stable temperatures (Steadman 1995:150). Charring patterns on fiber tempered vessels suggest that they may have been favoured for cooking liquid foods, such as soups and stews (Steadman 1995:152). Stable isotope analysis of charred food remains from two fiber-tempered *ollas* at Camata indicates that C3 plants – quinoa, beans, and unspecified tubers – were cooked in these vessels (Steadman 1995:152). Steadman's analysis of Camata ceramics is further evidence for the importance of soups and stews in the Titicaca basin. The high density of ceramic vessels that were used to produce these kinds of meals suggests that they were common.

Another important method of preparing food in the Altiplano is freeze drying. Freeze dried tubers are known as *chuño* and *tunta* (or *moray*). Sammells (2011:103-105) describes how people make *chuño* in Altiplano communities today. Potatoes selected to make *chuño* are left outside during the winter, where they freeze and night and thaw during the day. After three days, people squeeze water from the potatoes and remove their skins by trampling on them. To produce *tunta*, people place the dried tubers in water for a month before storing them as they do with *chuño* (Sammells 2010:105). Once it is dried, *chuño* is light, easy to transport, can keep for years. *Chuño* needs to be soaked before it is cooked. It is usually boiled and served in a soup or as a side dish. While Sammells (2010) specifically references potatoes in the production of *chuño*, other tubers such as oca and ulluco can be freeze dried in the same way (Logan 2006:49-50). Logan (2006:57) found potential evidence of *chuño* at Sonaji in the form of a damaged tuber starch grain. Damage on the starch grain was consistent with processing involved in the production of *chuño* (starch grain damage and taphonomy is discussed further in chapters 3 and 5).

As discussed in the ingredients section above, there is also evidence for the grinding of potatoes and other tubers both in the Titicaca Basin and in other regions of the Andes. In some cases, tuber starch grains have been identified in samples extracted from tools associated with grinding: Rumold and Aldenderfer (2016) identified potato starch grains on grinding stones at Jiskairumoko in the Titicaca Basin, and arrowroot starch grains were identified on a groundstone at Wayuna in the Peruvian highlands. The tuber starch grain that Logan (2006:57) identified also had damage consistent with grinding, while over half of the potato starch grains that Rumold and Aldenderfer (2016) reported had damage consistent with milling or freeze drying. It is possible that people ground tubers for flour; Cobo's accounts (1882 in Rumold and Aldenderfer 2016:4) indicate that *chuño* could be used to make fine flour. Hastorf (2012:217) reports that people in the Titicaca Basin today make gruel, while Steadman (1995:152) states that cooking porridges would have left similar traces on ceramic vessels as the soups and stews discussed above. It is therefore also possible that potatoes and other tubers were ground and consumed as porridges in the Titicaca Basin.

3.3 Feasts and Luxury Foods

Feasts are communal consumption events that are different from everyday meals (Dietler 2001:67; Dietler and Hayden 2001:3; Hastorf and Weismantel 2007:311-312). Hastorf and Weismantel (2007:311-312) list characteristics that can mark meals as feasts: a greater abundance of food and drink; use of non-everyday, rare, or special ingredients; differential access to dishes or ingredients among guests; use of special preparation styles; and non-everyday presentation style including the use of special serving vessels. Feasts can be a means of labour mobilization, allowing hosts to bring people together to accomplish large tasks (Dietler 2001; Dietler and Herbich 2001). They can also solidify political power by demonstrating elites' wealth, including access to special foods or high quantities of foods, or by indebting guests to hosts. Finally, feasts can strengthen social cohesion by bringing members of a community together. In the Andes, feasts can be ceremonial events that enable people to commune with deities and/or ancestors (Hastorf 2003a, 2003b).

Bandy (2005:100) argues that competitive feasts involving exotic goods acquired through trade may have been an important method for Late Formative elites on the Taraco Peninsula to accrue social capital and strengthen political power. Hastorf (2003a, 2003b, 2012) and Roddick and Hastorf (2010), on the other hand, argue that feasts in the Middle and Late Formative periods strengthened community cohesion. Participants drew on collective social memory to build relationships between the living and local ancestors. Based on this model, Formative feasts would have been community-wide events, though certain spaces or practices might have been restricted to elites (Hastorf 2003b:322).

In Tiwanaku IV/V phases, feasting was likely competitive and used as a political tool to strengthen elite power and expand the polity's region of influence (Goldstein 2003). One of the main lines of evidence for the importance of Tiwanaku feasting is the emergence of a specialized ceramic assemblage with an emphasis on decorated serving vessels (Janusek 2003). The ceramic style appears not only at Tiwanaku, but also throughout the southern and northern Titicaca basin (Bermann 1994; Roddick 2009; Stanish 2003:199-200). Evidence for differential access to luxury foods, such as maize, supports the argument for competitive feasting at Tiwanaku (Berryman 2010; Hastorf et al. 2006; Wright et al. 2003).

Though feasting was already an important practice in the Middle Formative period, ceramic evidence indicates that serving and consumption practices changed at these events in the Late Formative (Bruno et al. 2016; Roddick 2009; Roddick and Hastorf 2010). The main change in the ceramic assemblage is the increase in ubiquity and density of bowl fragments (Roddick and Hastorf 2010:167). This suggests a possible emphasis on drinks and on liquid-based foods, such as soups or stews. Bowls also decreased in size during the Late Formative; average bowl diameter in Middle Formative contexts is 40 cm, whereas the largest Late Formative bowl recovered in TAP excavations has a diameter of 25 cm (Roddick and Hastorf 2010:167). This suggests a possible new emphasis on individual servings (Roddick and Hastorf 2010:167).

In Tiwanaku IV/V phases, a new Tiwanaku style serving assemblage appeared (Janusek 2003). This included specialized drinking vessels, *keros*, decorated, relatively standardized drinking goblets with flared rims (Janusek 2003:60). Janusek (2003:60) characterizes this form as "the paradigmatic Tiwanaku drinking goblet that was used to serve and consume fermented drinks such as *chicha* and *ch'ua*" (made from quinoa). The connection between *chicha* and *keros* is so strong that archaeologists often use the presence of *keros* at sites outside of the Tiwanaku heartland as evidence that those sites adopted Tiwanaku drinking practices (Anderson 2009; Goldstein 2003). The *kero* is emblematic of Tiwanaku drinking practices and a means through which archaeologists can study Tiwanaku beverages in culinary practices.

Figure 3.1 *Kero* from TAP excavations at Kala Uyuni (photo by Andrew Roddick)

As discussed above, maize, likely served as *chicha*, was an important part of feasts in both Formative and Tiwanaku phases. Though maize can be cultivated in small quantities on the shores of Lake Titicaca, it is more likely that it was imported to the

Titicaca Basin from other areas during the Formative period (Hastorf et al. 2006:430; Logan et a. 2012:248-249; Wright et al. 2003:393). Meals are multisensory experiences that can invoke memories and the addition of a new exotic food would therefore likely change the experience of a feast and the exotic food itself would have a great deal of symbolic power (Roddick and Hastorf 2010:168-169). Maize is, in this sense, a luxury food. It was a desirable inclusion in feasts, probably because of its use as *chicha*, and was difficult to obtain because it was non-local. If, as Hastorf (2003a) suggests, feasts in the Formative period were events during which to build community cohesion and relationships with ancestors, maize's main symbolic importance during this period would have been related to its place in rituals. During Tiwanaku phases, however, people seem to attribute another layer of meaning to maize as access to the plant became restricted to more elite individuals. During this time, maize remained ritually important and difficult to obtain, and it became a marker of high status. While maize is the most well-recorded non-local crop to have been consumed in the Lake Titicaca Basin, results from this thesis indicate that other non-local plants were present in the eastern and southern Titicaca Basin during Late Formative and Tiwanaku periods. In Chapter 7, I will discuss whether these other exotic foods may, like maize, may have been luxury foods that were important in feasts and rituals.

People also consumed local foods at feasts and included them as offerings in rituals (Hastorf 2012; Miller 2005; Wright et al. 2003). Middle Formative storage vessels associated with feasts at Chiripa contained remains of potatoes and chenopodium (Hastorf 2012:230). Similarly, stable isotope analysis of Late Formative ceremonial vessels indicates that they contained mostly C3 plants, such as potatoes and quinoa. Wright and colleagues' (2003:392) paleoethnobotanical analysis of Tiwanaku IV/V phase contexts at Tiwanaku found "regular distributions" of unspecified tubers in ritual contexts at the site, with the largest concentration of tuber remains in a Tiwanaku V offering on the summit of the Akapana mound. The authors argue that this demonstrates the importance of tubers at Tiwanaku and the potential incorporation of Altiplano rituals involving potatoes into Tiwanaku statecraft (Wright et al. 2003:392). While maize and *chicha* are often highlighted as important parts of rituals and feasts in the Titicaca Basin, the presence of potatoes in offerings suggests that it is important to consider the potential ritual significance of other plants. Camelids were also a common meat source at feasts in Late Formative and Tiwanaku phases (Miller 2005).

In her zooarchaeological study of everyday cuisine at Mollo Kontu, a residential sector at Tiwanaku, Vallières (2012) argues that camelids were emblems of local Altiplano identity. She suggests that camelids "were socially valued animals whose consumption reinforced a sense of tradition and a glorification of the local" (Vallières 2012:336). In a similar vein, Roddick and Hastorf (2010) argue that the continuity in feasting practices based in local traditions throughout the Formative period enabled the strengthening of collective memories. They contend that "continuity is an active process" (Roddick and Hastorf 2010:172-173), and that people in the Late Formative would have deliberately drawn on old traditions in feasting practices in order to promote communal memories. The use of local foods in Formative and Tiwanaku feasts is part of this process. These foods may have acted as emblems of local traditions and local landscape, contributing to a sense of shared-community and connecting people to their ancestors.

3.4 Summary

The goal of this chapter was to provide an overview of Titicaca Basin foodways in the Late Formative and Tiwanaku phases. I began by listing the ingredients that previous archaeological and ethnographic research has demonstrated were likely used in meals during these periods. As discussed in Chapter 1, studies of foodways should encompass not only investigations of food remains, but also of the practices surrounding foods. I therefore also discussed the ways in which these ingredients were likely prepared and turned into meals in the past. I also addressed culinary equipment such as ceramic vessels, as an index of past practices. Finally, I discussed food consumption, specifically focusing on feasting practices and on luxury foods. While maize was an important part of feasts in from the Formative period through Tiwanaku phases and was likely also a luxury food, previous archaeological research demonstrates that local foods were also consumed in ritual contexts.

Chapter 4
Methods and Botanical Expectations

In this chapter, I present the methods that I used to sample and analyze both ceramic sherds and paleoethnobotanical residues. The goals of this chapter are to 1) describe the methods of ceramic attribute analysis and paleoethnobotanical analysis that I employed, 2) explain sampling protocols, and 3) develop a list of expected botanical findings based on known modern ecologies and previous archaeological work. I first discuss the methods of ceramic attribute analysis that I used and explain why they are well-suited to this project. I then present the methods that I used to extract microbotanical residues from ceramic sherds as well those used to identify the phytoliths and starch grains in these residues. Then, I discuss the sampling protocols that I used to select artifacts for both ceramic and paleoethnobotanical analysis. Finally, I provide a list of plants that I expected to identify during my paleoethnobotanical analysis and describe the diagnostic features of their phytoliths and/or starch grains.

4.1 Ceramic Analysis

Ceramic analysis for Kala Uyuni and Chiripa artifacts was carried out by myself, Dr. Andrew Roddick (McMaster University), Kathleen Huggins (a graduate student at the University of California, Berkeley), and Ruth Fontela (an archaeology student at the Universidad Mayor de San Andrés). My analysis of the Kala Uyuni assemblage also relied on data from ceramic analysis that Dr. Lee Steadman and Roddick completed in previous field seasons. I completed ceramic analysis for the Challapata sherds in consultation with Dr. John Janusek (Vanderbilt University). Ceramic attribute analysis was completed in Bolivia in the summer of 2016.

We conducted ceramic attribute analysis for all assemblages in order to determine the kinds of choices that potters made while producing vessels. Potters make choices based on factors such as vessel use, available materials, and learned or habitual practices. Attribute analysis is a productive method because it enables the study of periods of transition as ceramics change, bringing to light the "steps" involved in these transitions as different features change over time (Shepard 1980:317). This method also allows the archaeologist to study both style and technology, and to explore the relationship between these two aspects of ceramics (Shepard 1980:317).

My methods were based on the TAP attribute analysis methods laid out by Roddick (2009:184-200, 202) and varied depending on whether the sherd was diagnostic or not. For non-diagnostic sherds (un-decorated body sherds), we recorded: paste, finish, exterior colour, interior colour, firing, maximum thickness, ware, weight, and count. Non-diagnostic sherds were not assigned a specimen number unless they were also sampled for paleoethnobotanical analysis. Diagnostic sherds (decorated, or having a feature used to identify form or particular part of the vessel) were all assigned a unique specimen number. We recorded all the same attributes as for the non-diagnostics as well as: form; decoration code; motif; exterior and interior luster, contour, direction of finish, carbonization, and size of mica inclusions. For base and rim sherds, we recorded the diameter, the diameter percentage, and the rim or base thickness. A selection of representative diagnostics was also illustrated. Following this data collection, my ceramic analysis focused specifically on attributes that can shed light on vessel use or intended vessel use, such as paste, form, surface finish, and carbonization patterns. Here, I provide a brief description of paste analysis and its utility, while I discuss these attributes and their connections with vessel use more in depth in Chapter 5.

We analyzed paste to highlight the choices that potters made with regards to the raw materials that they used to produce ceramics (Roddick 2009; Sillar and Tite 2000). A consideration of pastes can also shed light on the choices involved in culinary practices, as particular paste types can be better suited to cooking, storage, or even to serving particular foods (Roddick 2009; Steadman 1995). For example, Roddick (2009:187) notes that sand tempered pastes produce "more durable and efficient cooking pots" than fiber tempered pastes because they facilitate the transfer of heat from the outside to the inside of the vessel. Paste analysis is based on a consideration of temper materials, clay texture and compactness, colour, and luster (Roddick 2009:189). Unfortunately, due to unforeseen circumstances, paste groups had not been developed for the Challapata project by the time I completed my analysis and I did not have access to a large enough sample size to develop my own categories. I therefore described each sherd's paste, noting temper, inclusions, compactness, and similarities between the artifacts.

4.2 Paleoethnobotanical Analysis

4.2.1 Extractions

I completed paleoethnobotanical extractions in Bolivia, using the extraction methods of Logan (2006) and Pearsall (2015), and analyzed the residue samples at the McMaster

Paleoethnobotanical Research Facility (MPERF). I also received training in microtobanical extractions from Dr. Shanti Morell-Hart in the MPERF. I followed the following process in preparing my slides of residue for analysis:

1. Recording: Before beginning the extraction, I recorded each sherd's sample number and provenience. I also took photographs of each artifact.
2. Dry wash (DW): For all previously unwashed artifacts, I washed the sample dry, wearing sterile, powder-free gloves. I used my gloved fingers to gently scrub adhering sediments into a centrifuge tube, targeting the inside of the sherd and avoiding material clinging to the exterior. Once I had collected my sample, I dry brushed the rest of the sherd to remove extraneous sediment that might contaminate subsequent samples. Logan (2006) recommends using a toothbrush to scrub the artifact. However, I used my fingers to minimize the possibility of damaging the artifact, as well as to enable me to dispose of the contaminated gloves after each wash
3. Wet wash (WW): I transferred the artifact to a new, clean petri dish and changed gloves. Targeting the same area as I did for the DW, I pipetted distilled water onto the sherd and agitated the water using my gloved fingers and the tip of the pipette. I extracted the water using the pipette and transferred it to a new, labelled centrifuge tube. I repeated this process until I had an acceptable amount of sample water, roughly 5 ml to 50 ml. I then gently washed the rest of the artifact in the same manner to remove extraneous sediment that might contaminate the subsequent sample.

4. <u>Sonicated Wash (SW):</u> I again transferred the artifact to a new, clean petri dish and changed gloves. For this step, I used a different method than the one developed by Logan (2006) and Pearsall (2015) because I used a handheld sonicator rather than a sonicating bath. Targeting the same area as the other two washes, I pipetted distilled water onto the sherd. I then sonicated the sherd, immersing the sonicating spatula in the water and hovering it in solution just above the artifact's surface, adding more water as necessary. I extracted the water using the pipette and transferred it to a new, labelled centrifuge tube. I repeated this process until I had an acceptable amount of sample water, roughly 2 ml to 15 ml.

5. <u>Recording and clean-up:</u> I took photos of the artifact post-extractions and recorded anything noteworthy about the extraction process. I discarded the pipettes and gloves used for extractions, and cleaned all other materials with soap and water then rinsed them with distilled water to prevent cross-contamination between artifacts.

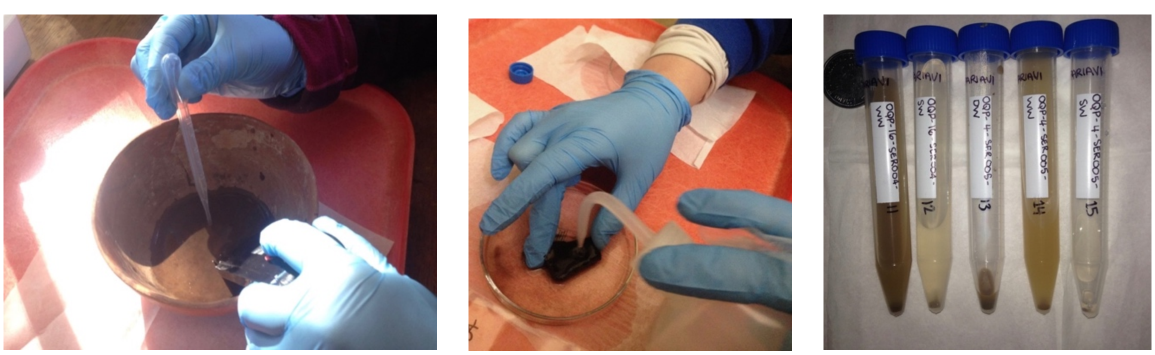

Figure 4.1 Completing paleoethnobotanical extractions. Left: Using handheld sonicator to sample from CH-SER006. Center: Taking WW samples from Kala Uyuni sherd. Right: Paleoethnobotanical samples in centrifuge tubes

Each of the sediment washes provides different information about the plant materials in and around the ceramic vessels. Microbotanical remains from the DW are not associated with vessel use; rather, they are from sediment surrounding the artifact and therefore provide information about the plants at the scale of the site. The SW provides information about plants that were associated vessel use, including plants that were stored, prepared, or served in these vessels. The handheld sonicator is useful for three main reasons: 1) it is portable and therefore easy to bring to the field, 2) it enables targeting specific areas of the sherd in a way that a sonicating bath does not, and 3) it avoids problems of contamination, sterilization, artifact damage, and expense presented by using sonicating toothbrushes. The WW compliments information from the first and third washes; remains from WW samples could represent the remains of plants related to vessel use or of plants that were present in the surrounding sediments. The WW also tracks potential movement of residues from the artifact to surrounding matrices and from surrounding matrices to the artifact's surface.

4.2.2 Identification

I processed and analysed residue samples to identify microbotanical remains at the McMaster Paleoethnobotany Research Facility (MPERF) in Hamilton, Ontario. I received training in microtobanical identification from Dr. Shanti Morell-Hart (McMaster University) at the MPERF as well as additional training in phytolith identification from Dr. Amanda Logan (Northwestern University). I also consulted with Dr. Neil Duncan (University of Central Floriday) for some identifications.

To identify phytoliths and starch grains, I pipetted drops of solution from the base of each sample's centrifuge tube onto a slide, which I then sealed. Most samples were mounted and scanned without being processed in any way. However, to concentrate phytoliths and starch grains from some Challapata samples, I completed heavy liquid flotation following the protocol laid out by Morell-Hart (2011:287). This process consists of adding aqueous samples to a solution of heavy liquid. This concentrates microbotanical remains while separating them from other residues. I scanned slides using a Zeiss high powered transmitted light microscope at 100x-400x, making occasional use of a polarizer to identify starch grains.

I used a diagnostic approach to identify phytoliths and starch grains. In this approach, paleoethnobotanists test possible diagnostic microfossils against the microfossils produced by other taxa. If there is no overlap in features, these phytoliths or starch grains are considered to be diagnostic (Logan 2006, Pearsall 2015, Perry 2004, Piperno 2006a). Here, it is crucial to rotate phytoliths and starch grains to see them three dimensionally (Logan 2006; Piperno 2006a). I relied on previous paleoethnobotanical research that describes the diagnostic features of Andean phytoliths and starch grains (discussed below) and complemented this information with a reference collection of Andean plants to compare phytoliths and starch grains from archaeological contexts to those from modern plants.

4.3 Sampling Protocols

I developed sampling protocols for ceramic and paleoethnobotanical analyses in tandem to obtain complementary datasets. Sampling for paleoethnobotanical analysis occurred in two stages: 1) extractions and 2) identification. I completed extractions of paleoethnobotanical materials from ceramic sherds in Bolivia in the summer of 2016. I then analyzed a subsample of these materials in the McMaster Paleoethnobotany Research Facility (MPERF). I completed ceramic analysis on all sherds from which I took paleoethnobotanical extractions and, when possible, also analysed all other sherds from the loci of residue-sampled sherds.

I had access to a limited number of unwashed artifacts from both the Challapata (n=7) and Chiripa assemblages (n=5). I therefore completed paleoethnobotanical extractions and ceramic attribute analysis from all available artifacts for these assemblages. The Kala Uyuni assemblage was much larger; TAP excavation teams have excavated thousands of sherds from the site. I therefore developed a sampling protocol based on archaeological context and sherd form, completing extractions on a total of 45 sherds. I targeted Late Formative domestic occupation areas, sampling from loci associated with architectural subdivisions (ASDs) and from middens. Within these contexts, I sampled sherds that were most likely to have paleoethnobotanical residues, including base sherds, large sherds, and sherds with interior carbonization (Pearsall 2015:263; Shanti Morell-Hart, personal communication 2016). Areas of vessels that have less contact with food, such as rims or exterior surfaces, are less likely to yield microbotanical remains of food (Shanti Morell-Hart, personal communication 2016).

Sampling protocol of paleoethnobotanical identification also varied between the assemblages. The TAP excavation team washed all Kala Uyuni sherds shortly after they were excavated, which decreased the likelihood that they would contain microremains (Bryant 2013). To increase my chances of recovering phytoliths and starch grains, I analyzed five samples with the highest concentration of residue visible to the naked eye, in other words, samples with the most sediment in the water. I analyzed the SW of these samples because these were most likely to contain microremains associated with artifact use and the least likely to contain contaminants. For the Chiripa assemblage, I analyzed the SW and DW from two vessels, as well as the sonicated wash of a third vessel. This enabled me to identify plant remains that were specifically associated with vessel use. I selected these samples based on vessel forms, targeting samples from different kinds of vessels. I was unable to analyze the dry wash of the third vessel due to time constraints. I analyzed all washes of all samples from the Challapata assemblage.

Sample	ASD	Context	Sherd type	Washed or Unwashed	Washes analysed	# of Slides
KU-9241-SER0015	9	Surface / Construction fill	Base sherd	Washed	SW	2
KU-5040/5-SER021	2	Clay lens	Complete bowl, sampled from base	Washed with some charred residue	SW	1
KU-5155-SER028	2	Fill below floor	Body sherd	Unscraped charred residue	SW	1
KU-5318-SER039	N/A	High density midden, West of ASDs 2, 4, 5	Base sherd	Washed	SW	1
KU-7590/5-SER045	5	Interior occupation surface	Base sherd	Washed	SW	2

Table 4.1 Kala Uyuni samples

Sample	Vessel	Sampled from	Washed or Unwashed	Washes analysed	# of Slides	Processing
CH-SER005	Wide mouth jar	Base	Unwashed	SW	2	
				DW	4	Hydrogen peroxyde in 2 slides to separate materials
CH-SER006	*Cuenco*	Base	Unwashed	SW	2	
				DW	1	
CH-SER008	Llama effigy *vasija*	Base	Unwashed	SW	2	

Table 4.2 Chiripa samples

Sample	Sherd type	Washed or Unwashed	Washes analysed	# of Slides	Heavy liquid flotation
OQP-16-SER001	Body sherd	Unwashed	SW	2	
			WW	2	
			DW	2	
OQP-15-SER002	Rim sherd	Unwashed	SW	2	
			WW	2	
			DW	2	
OQP-15-SER003	Body sherd	Unwashed	SW	2	
			WW	2	
			DW	1	X
OQP-16-SER004	Rim sherd	Unwashed	SW	1	X
			WW	1	X
			DW	1	X
OQP-4-SER005	Body sherd	Unwashed	SW	2	
			WW	2	
			DW	1	X
OQP-17-SER006	Body sherd	Unwashed	SW	2	
			WW	1	X
			SW	1	X
OQP-3-SER007	Handle	Unwashed	SW	1	X
			WW	2	
			DW	1	X

Table 4.3 Challapata samples

4.4 Botanical Expectations

Before starting my paleoethnobotanical analysis, I compiled a list of plants that I might encounter while carrying out my analysis. I based this on both archaeological and ethnohistoric research about plants in the Lake Titicaca basin and the Andes more broadly (Bruno 2008, 2010; Chandler-Ezell et al. 2006; Dickau et al. 2012; Duncan et al. 2009; Logan 2006; Logan et al. 2012; Perry et al. 2006; Towle 1961; Ugent et al. 1986). While I discussed the probable uses of several of these plants in Chapter 3, this database focuses on how to identify the plants in the archaeological record and includes descriptions of diagnostic features of their phytoliths and/or starch grains. There are plants, such as *Chenopodium quinoa* and *Chenopodium negra*, that are known to have been cultivated and consumed in the Lake Titicaca basin that I do not include here because they cannot be identified microbotanically. I also include plants that are not native to the highlands in this study because they may have entered the Titicaca Basin from lowland eastern valleys through exchange networks. As discussed in Chapter 2, Challapata is located on a potential trade route at the nexus between the Amazonian lowlands the Lake Titicaca basin. It is therefore important to consider non-local plants in a study of the site. I organized the database into two major sections: highland crops and lowland crops in order to clarify which plants can and which cannot grow in the highlands of the Lake Titicaca Basin. Within these two sections, plants are organized by family.

Family	Genus	Species	Common name	Grown in highlands?	Areas recovered	Contexts / Likely uses	Microremains
Basellaceae	Ullucus	U. tuberosus	Ullucu	Yes	Andean highlands; possible remains in Titicaca basin	Staple crop; prepared in soup, stews, and as *chuño*	Starch grains
Convolvulaceae	Ipomoea	I. batatas	Sweet potato	No	Coastal Peru; lowland Amazonian valleys	Staple crop; feasting contexts on Peruvian coast	Starch grains
Cucurbitaceae	Cucurbita		Squash	No	Coastal Peru; lowland Amazonian valleys	Feasting contexts in coastal Peru; domestic contexts in lowlands	Phytoliths; starch grains
Dioscoreaceae	Dioscorea		Yam	No	Lowland Amazonian valleys	Domestic contexts; possible processed (grinding)	Starch grains
Euphorbiaceae	Manihot	M. esculenta	Manio; yuca	No	Coastal Peru; lowland Amazonian valleys; southern Amazon	Staple crop; feasting contexts; fermented beverage	Phytoliths; starch grains
Fabaceae	Phaseolus		Bean	Yes	Andean highlands (Tiwanaku); coastal Peru; lowland Amazonian valleys	Staple crop	Phytoliths; starch grains
Marantaceae	Maranta	M. arundinacea	Arrowroot	No	Peruvian highlands, coastal Peru	Domestic contexts; feasting contexts	Starch grains
Oxalidaceae	Oxalis	O. tuberosa	Oca	Yes	Andean highlands; possible remains in Titicaca basin	Staple crop; prepared raw, boiled, roasted, or as *chuño*	Starch grains
Poaceae	Zea	Z. mays	Maize	Limited	Andean highlands (Titicaca Basin); lowland Amazonian valleys; Peruvian valleys	Staple crop; feasting contexts; fermented beverage (*chicha*)	Phytoliths; starch grains
Solanaceae	Capsicum		*Aji*	No	Peruvian highlands, coastal Peru; lowland Amazonian valleys	Domestic contexts; ritual contexts	Starch grains
Solanaceae	Solanum	S. tuberosum	Potato	Yes	Andean highlands (Chiripa, Tiwanaku)	Staple crop; ritual contexts; prepared boiled, baked, in stew, or as chuño or tunta	Starch grains

Table 4.4 Summary of botanical expectations

4.4.1 Highland Crops

Ulluco (Basellaceae *Ullucus tuberosus*)

As discussed in Chapter 3, ulluco is among the most common tubers consumed in the Titicaca Basin. Ulluco produces diagnostic starch grains that are ovate, with a smooth surface, double outer wall, open hilum and a fissure that is generally linear or Y-shaped

(Logan 2006:53-55). While there is some morphological overlap between ulluco, potato, and oca starch grains, ulluco starch grains are smaller than the other two species, ranging in size from 13x8μm to 45x23 μm. The extinction cross has a non-90° angle with narrow, bent arms.

Beans (Fabaceae *Phaseolus vulgaris*)

Common beans produce both diagnostic phytoliths and starch grains. *Phaseolus vulgaris* produces hooked hair phytoliths (Bozarth 1990). While other species in the *Phaseolus* genus also produce similar hook forms, *Phaseolus vulgaris* phytoliths are distinct in that they are longer (~20 μm in length) and wider (2-10 μm) than other hooked forms (Bozarth 1990:100-101).

Phaseolus vulgaris starch grains are ovular and range in size from 6-14 μm (Piperno and Holst 1998). Their most distinctive feature is a large, ragged fissure that runs their entire length (Piperno and Holst 1998). Lamellae are distinct and fine (Piperno and Holst 1998) and they have a centric hilum that is almost always obscured by the fissure (Reichart 1913:390). The extinction cross is centric or slightly eccentric, with broad arms (Reichart 1913:390). Phaseolus starch grains are susceptible to damage from cooking and processing (Babot 2003; Piperno and Dillehay 2008). When these starch grains are cooked, they expand to roughly three times their normal size, their lamellae and fissure fade, and their extinction cross either disappears or is damaged (Piperno and Dillehay 2008). Dehydration can cause the appearance of small, isolated fissures; flatten the starch grain; or damage the extinction cross (Babot 2003). However, the effects of dehydration seem to reverse when starch grains are rehydrated (Babot 2003). Milling can also damage starch grains, causing them to appear incomplete, fractured, or collapsed (Babot 2003).

Oca (Oxalidaceas *Oxalis tuberosa*)

Oca starch grains are similar to those produced by potatoes and ullucu (Logan 2006:53-55). However, they have a unique clam shell shape that helps to distinguish them from the other two tubers. Their size ranges from 15x13μm to 75x33μm. Oca starch grains have an open hilum and often a Y-shaped or linear fissure. Their surface is smooth with a double outer wall and fine lamellae. The extinction cross has narrow arms and a sharper angle than those of potatoes and ullucu.

Wild Grasses (Poaceae spp.)

Wild grasses are likely to have come into contact with artifacts during their use or discard and to make their way into the archaeological record. Grasses can even have been part of the ceramic artifacts themselves, as temper in pastes. A study of fiber tempers from vessels at Chiripa found that *Poaceae* grasses were used as temper, specifically those from the Pooideae (festucoid) and Panicoideae (panicoid) sub-families (Mohr 1966). The Andean highlands are dominated by festucoid grasses, though panicoid grasses are also present (Logan 2006).

Poaceae grasses produce phytoliths, some of which are diagnostic to the sub-family, genus, or species level. Piperno (2006a:33) notes that sub-families are adapted to environmental conditions, and that genus level identification is therefore not necessary for climate reconstruction. The morphology of phytolith bases are most useful in identifying subfamilies. For example, panicoid grasses produce bilobate and cross-based phytoliths, whereas festucoid grasses produce circular, ovular (rondel), and rectangular bases (Piperno 2006a:28). Some overlap can occur between sub-families. I used the Andean Grass Typology developed by Logan (2006:165-168) to identify grass phytoliths.

Potato (Solanaceae *Solanum tuberosum*)

Potato starch grains are similar to those produced in other Andean tubers, notably oca (*Oxalis tuberosa*) and ullucu (*Ullucus tuberosus*) (Logan 2006:53-55). Their shape is spherical to ovate and they range in size from 28x15μm to 70x50 μm. When rotated, they tend to be round, though sometimes have a flat bottom. Their surface is smooth, a double outer wall, and an open hilum. Fissures are rare, and radiate from the hilum when they do occur. Potatoe starch grains have coarse lamellae that are more pronounced than those of ulluco and oca starch grains. The extinction cross has narrow arms and meets at a non-90° angle.

As discussed in Chapter 3, potatoes and other tubers are freeze dried and consumed as *chuño* or *tunta* in contemporary highland communities and it is likely that people used this processing technique in the past as well. The processes involved in turning potatoes into *chuño* or *tunta* affect the morphology of the starch grains (Babot 2003:74-75; Torrence and Barton, eds. 2006:70 [photos only]). *Chuño* starch grains can have a flat relief, their extinction cross can be invisible or have broken arms, and some areas of the grain can be damaged. Larger potato starch grains tend to exhibit these effects more. *Tunta* starch grains do not exhibit these alterations as much, likely because they have been rehydrated. Potato starch grains are also highly susceptible to damage from milling

(Babot 2003:76-78). The starch grains of potatoes that have been milled tend to appear incomplete, fractured, dented, collapsed, or burst. They can have a hole or star at the hilum, a cavity at their center, or additional fissures. Because I will be using water to extract and mount my samples, it is possible that *chuño* starch grains will not retain all features related to dehydration. The features most likely to occur are: damage to the extinction cross and damage or flattening or certain areas of the starch grain.

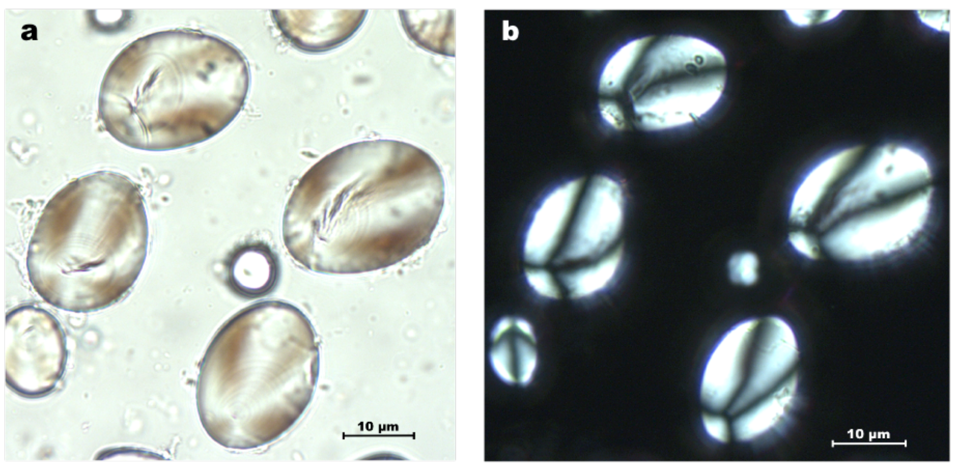

Figure 4.2 *Solanum tuberosum* starch grains from reference collection (photos by Sophie Reilly)
a) transmitted light, b) polarized light

4.4.2 Lowland Crops

Sweet Potato (Convolvulaceae *Ipomoea batatas*)

Sweet potato starch grains are generally compound, meaning they form connected to one another (Piperno and Holst 1998). They occur in a range of shapes, the most recognizable of which are: domed, quadrangular, spherical, or polygonal (Reichart 1913:884). Their most recognizable feature is their pressure facets, which have "distinct margins" that form ridges (Piperno and Holst 1998). They tend to have a small, transverse fissure (Piperno and Holst 1998). The extinction cross is eccentric with arms that generally become broader at the starch grain's edges (Reichart 1913:884). Sweet potato starch grains range in size from 4-34 μm (Piperno and Holst 1998). Milling and cooking sweet potato can cause its compounded starch grains to disjoin (Babot 2003:76-78).

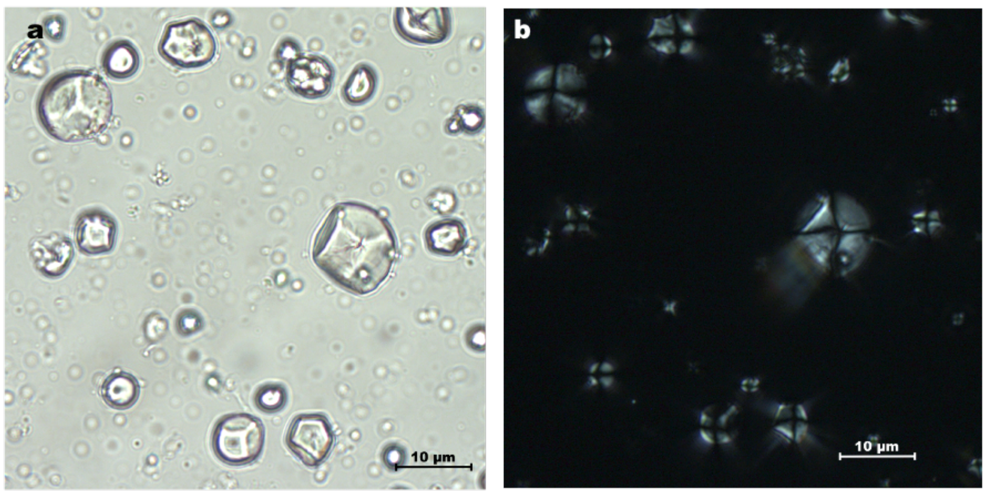

Figure 4.3 *Ipomoea batatas* starch grains from reference collection (photos by Sophie Reilly) a) transmitted light, b) polarized light

Squashes (Cucurbitaceae *Cucurbita* spp.)

Cucurbita produce phytoliths that allow for identification to the genus level and that sometimes allow for a distinction between wild and domestic species (Bozarth 1987; Piperno et al. 2000; Piperno et al. 2002; Piperno 2009). They produce scalloped phytoliths, named for their distinctive surfaces that have scallops and deep cavities. These phytoliths are spherical or semi-hemispherical. The hemispheres occur because the phytoliths are produced in the area between the squash's hypodermis and mesocarp (Piperno 2009:147-148). The hypodermal hemisphere has small, regular scalloped impressions, while the mesocarpal hemisphere has large, deep scalloped impressions. Phytolith size varies depending on whether they come from wild or domestic species: the length and width of wild *Cucurbita* phytoliths range from 43-72μm and 31-59 μm respectively, while phytoliths from domestic species are larger, up to 112 μm long (Piperno et al. 2000:196). Domesticated *Cucurbita* also produce fewer phytoliths than wild species and they are therefore underrepresented in the archaeological record (Piperno et al. 2000:195).

The flesh of *Cucurbita moschata* also produces diagnostic starch grains (Piperno and Dillehay 2008). They are round or bell-shaped with pressure facets (Piperno and Dillehay 2008:19264; Piperno and Holst 1988:775). These starch grains have a closed hilum and distinct lamellae. They range in size from 8-25 μm (Piperno and Holst 1988:775).

Yam (Dioscoreaceae *Dioscorea* spp.)

Starch grains from *Dioscorea* genus plants are ovoid to obovate in shape, have distinct lamellae, and their hilum is closed and eccentric (Cortelleti et al. 2015:52). The domesticate *Dioscorea trifida* can be distinguished from other *Dioscorea* genus plants based on a "distinct point" at its hilum, and a cuneiform depression from its hilum to its base (Piperno and Hoslt 1998). *Dioscorea trifida* starch grains range in size from 24-84 μm (Piperno and Holst 1998). Grinding damage can be visible on *Dioscorea* starch grains in the form of "enlarged hila, radial fissures, poor birefringence, and split, torn, or partial grains" (Dickau et al. 2012:363).

Manioc (Euphorbiaceae *Manihot esculenta*)

Manioc produces both diagnostic phytoliths and starch grains. Manioc phytoliths are produced in low abundance the plant's root rind, leaf, stem, and fruit. (Chandler-Ezell et al. 2006:107,109). They are heart-shaped and sometimes have a "thin, flat marginal flange" (Chandler-Ezell et al. 2006:109). Manioc phytoliths have a raised outer rim and indented interior and range in size from 5-12 μm. These phytoliths can be useful for identifying manioc that has been processed because the plant's starch grains are very susceptible to damage.

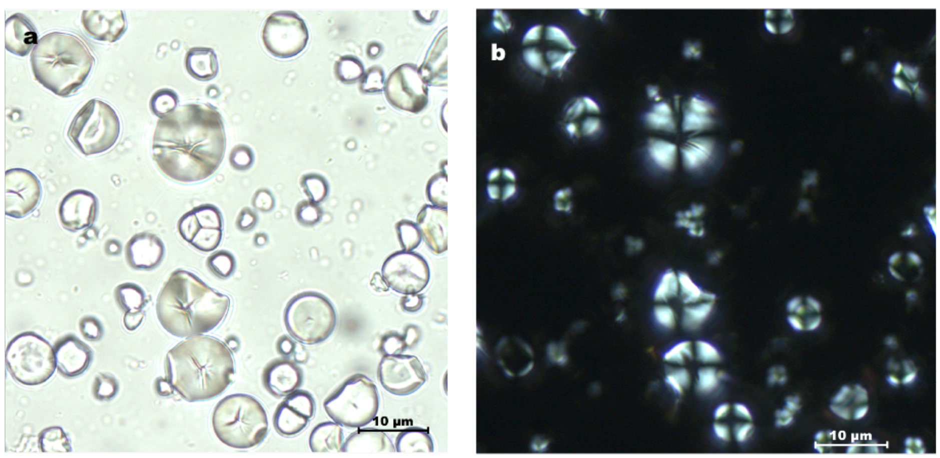

Figure 4.4 *Manihot esculenta* starch grains from reference collection (photos by Sophie Reilly)
a) transmitted light, b) polarized light

Piperno and Holst (1998:775) describe manioc starch grains having a distinctive bell shape; facetate base; smooth surface; and a deep, central, star-shaped fissure. Their length ranges from 5-20 μm. Perry (2002) argues that the starch grains that Piperno and Holst describe only occur in lowland manioc. Whereas lowland manioc starch grains have a star-shaped fissure, Perry (2002) observes that coastal Peruvian manioc has a linear fissure.

Chandler-Ezell et al. (2006) studied the effects of food processing on manioc starch grains and found that they are particularly susceptible to damage. Starch grains that had been pounded with a *mano* had enlarged circular or star-shaped fissures at the hilum, generally lost their extinction cross, and sometimes had split surfaces (Chandler-Ezell et al. 2006:109-110). Soaking manioc in water causes swelling, while heating causes swelling, gelatinization, and the loss of the extinction cross (Chandler-Ezell et al. 2006:110). It can sometimes be impossible to securely identify manioc starch grains due to damage (Chandler-Ezell et al. 2006:110, 113).

Arrowroot (Marantaceae *Maranta arundinacea*)

Arrowroot produces both phytoliths and starch grains. Arrowroot phytoliths are produced in the plant's rhizome and also occur in *Calathea* (Marantaceae family) (Chandler-Ezell et al. 2006). These phytoliths have a "cylindrical body that tapers gradually to a pointed tip" (Chandler-Ezell et al. 2006:107). When rotated, the base is circular. Surface decorations are nodular. The presence of these phytoliths at a site that also has arrowroot starch grains (and no evidence of *Calethea*) can complement the starch grain information about the plant's use.

Arrowroot starch grains are ovular in shape and have one or two dents (Piperno and Holst 1998). They have a distinct, round or lenticular, eccentric hilum (Reichart 1913:816). They also have a fissure that is Y-shaped in wider starch grains and linear in thinner ones (Reichart 1913:816). The lamellae are distinct, generally finer near the edges and thicker near the hilum (Reichart 1913:816). Arrowroot starch grains are relatively flat with one end narrower than the other, when viewed from the side (Reichart 1913:816). Their size varies significantly, from 10-50μm (Piperno and Holst 1998).

Maize (Poaceae *Zea mays*)

Maize has been the subject of a great deal of paleoethnobotanical research because it was cultivated in pre-Columbian times throughout most of the Americas. Paleoethnobotanists have focused heavily on establishing methods for its identification (Bozarth 1993; Logan 2006; Pearsall et al. 2003, 2004; Piperno 2003; Rovner 2004; Staller and Thompson 2002). These studies have resulted in the identification of several kinds of phytoliths and starch grains that are diagnostic to maize in the Altiplano. In areas where teosinte is not present, "only genus level identification is necessary" to securely identify maize (Pearsall et al. 2003:622). There is no teosinte in highland Bolivia. For the purposes of this project, it is therefore only necessary to identify maize based on genus level diagnostic features.

Different parts of the maize plant produce different diagnostic microfossils: the leaves produce cross-shaped phytoliths, the cupule produces rondel phytoliths, and the kernels produce starch grains (Bozarth 1993; Pearsall 2015:26). This enables a better understanding the ways in which people in the past processed and consumed maize. For example, maize leaf phytoliths are more likely to be recovered from processing contexts, whereas starch grains from the kernel are more likely to be recovered in consumption contexts (Logan et al. 2012).

Maize cupules produce rondel phytoliths. Pearsall et al. (2003:613) identify wavy top rondels as useful diagnostic indicators of maize. They describe the wavy top rondel as having a flat, circular or oval base, which is "longer than the body is tall." The top is a complete wave that is either the same size as or smaller than the base. The rondel's sides are slightly concave. Pearsall and colleagues (2003) state that maize is the only plant to produce wavy top rondels, and that they are therefore indications of the presence of maize in all areas. However, Logan (2006) found that wild grasses in highland Bolivia and Ecuador also produce wavy-top rondels. These phytoliths are therefore not diagnostic to maize in those areas and will not be used as maize indicators in this project.

Ruffle top rondels are similar to wavy top rondels and *can* be used as indicators of maize in the Andean highlands (though not in regions where both maize and teosinte grow). Ruffle top rondels have flat bases that are circular or oval in shape. Their bases must be longer than the phytolith’s height (Pearsall et al. 2003:613). The tops of these phytoliths are filmy and “ruffled or undulating,” with no sharp angles (Pearsall et al. 2003:613). Though these phytoliths are useful, maize plants do not produce them in great abundance. Maize runs the risk of being under-represented in the archaeological record if paleoethnobotanists rely exclusively on this type of phytolith to identify it.

Luckily, Logan (2006:99) identified another rondel phytolith that is diagnostic to maize in highland Bolivia: the narrow elongate rondel (NER). Logan describes the NER as an "elongate, thin rondel with concave sides that is heavily silicified, particularly the top and bottom faces" (Logan 2006:99). A similar rondel is the plateau top rondel that wild grasses also produce. However, there are two major differences that should be used to distinguish the two: 1) narrow elongate rondels have "heavily silicified, indented sides," while plateau top rondels have slanted sides, and 2) the bases of narrow elongate rondels are thin and elongate (ovals), while the bases of plateau top rondels are circular (Logan 2006:100). The differences between these two types of phytoliths are generally subtle, which makes it crucial to rotate them during identification. Narrow elongate rondels are very useful because they occur in higher abundance than ruffle top rondels. In her analysis of residue from artifacts, the only maize phytoliths that Logan (2006:102, 160) identified were narrow elongate rondels. In her analysis of soil samples, she identified a single ruffle top rondel, 14 narrow elongate rondels, and 28 cf. narrow elongate rondels.

Figure 4.5 *Zea mays* Narrow Elongate Rondel phytoliths from reference collection; photos taken at 400X (photo Sophie Reilly)

Maize plants also produce cross-body phytoliths in their leaves. Many other grasses produce cross-body phytoliths as well and it is therefore important to be familiar with the characteristics of maize phytoliths (Piperno 2006:52). Maize cross-body phytoliths are larger than those produced in other grasses: maize phytoliths generally have a width of 12.7-15 μm, whereas those produced in other grasses range from 10-12.5 μm (Piperno 2006:52, 54). Maize phytoliths are also distinguishable from other cross-body phytoliths because they have mirror-image proportions when rotated (Piperno 2009:149-150). Piperno (2006:56) notes that not all maize varieties produce cross-bodied phytoliths that are distinguishable from non-*Zea* grass phytoliths. Andean maize that occurs above 3,000 masl does not produce cross-shaped phytoliths (Logan et al. 2012:241).

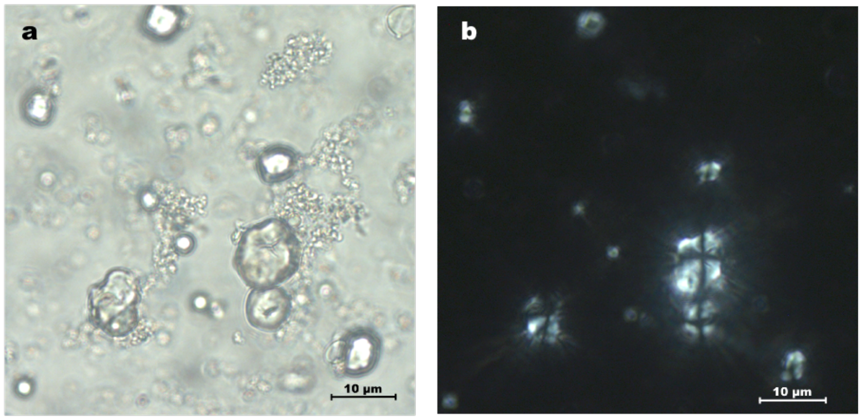

Figure 4.6 *Zea mays* starch grains from reference collection (photos by Sophie Reilly)
a) transmitted light, b) polarized light

Maize kernels produce diagnostic starch grains that are generally spherical or oval-spherical in shape (Pearsall et al. 2004b:430). Though they do not have distinctive lamellae, these starch grains do have a double border. Maize starch grains have a central open hilum (Pearsall et al. 2004b:430) and a crisp and narrow, right-angled extinction cross (Logan 2006:102). Their size ranges from 4-24 μm and is one of the important characteristics that distinguishes them from starch grains produced by other grasses, which tend to be smaller (Pearsall et al. 2004b:430-431). Different types of maize can be used for different purposes and these types are sometimes identifiable based on starch grains. Maize used for popping, for example, tends to produce starch grains that are blocky in shape, have distinct pressure facets, and Y or X shaped fissures. Flour maize starch grains, on the other hand, have smooth surfaces, and are more spherical in shape

(Pearsall et al. 2004b:430). Maize kernels also sometimes produce distinct vase-shaped starch grains (Pearsall et al. 2004b:430).

Processing can affect maize starch grains in several ways. When maize is dehydrated, starch grains tend to have small, isolated fissures and an opening at the hilum (Babot 2003:72). They can also appear flattened with a faint or invisible extinction cross (Babot 2003:72). If the starch grains are rehydrated, these characteristics are no longer visible. When roasted, maize starch grains have a pronounced, star-shaped projection over their hilum, which appears as a dark center under polarized light (Babot 2003:72-73). The starch grains of roasted maize also tend to gelatinize and clump together, to be flattened, and to have a deformed extinction cross (Babot 2003:72-73). Finally milling also affects maize starch grains, making them appear flattened, collapsed, or burst; denting their surfaces; causing a hole to appear at the hilum; and damaging the lamellae (Babot 2003:76-78).

Chile (Solanaceae *Capsicum spp.*)

There are three species of chiles (*Capsicum*) believed to have been domesticated in Andean South America: *C. baccum*, in lowland Bolivia; *C. chinense*, in the northern lowlands of the Amazon; and *C. pubescens*, in the mid-elevation southern Andes (Perry et al. 2007:968). Colonial accounts indicate that it was second only to maize in importance during the Inca period (Cobo 1890 in Chiou et al. 2014:192). The earliest evidence for *Capsicum* in the Andes dates to 4,000 BC from the Real Alto site in southwestern Ecuador (Perry et al. 2007). Chile starch grains have been identified in domestic food processing contexts at Waynuna, Peru in association with other food plants, including arrowroot, potato, and maize (Perry et al. 2007:987). There is both microbotanical and macrobotanical evidence for *Capsicum* at lowland sites in the department of Beni, Bolivia (Bruno 2010; Dickau et al. 2012).

Perry and colleagues (2007) identify and describe starch grains that are diagnostic of the *Capsicum* genus. These are lenticular, flattened starch grains with a shallow depression at their center. Perry et al. (2007:986) liken their shape to that of a red blood cell. Their length ranges from 13-45 μm, with the starch grains of domesticated species typically being larger than those of wild species. When viewed from the side, the starch grains have a "central linear figure" that can appear as a clean line or with sharp edges, and that can extend the entirety of the starch grain or only on part of it (Perry et al. 2007:986). There is micromorphological variation between the starch grains of the five species of chiles mentioned above (Perry et al. 2007). However, these are very minor variations (to the grains' central depression) that occur infrequently. It is therefore necessary to have a large archaeological assemblage to more securely identify *Capsicum* to the species level.

4.5 Summary

In this chapter, I discussed the methods that I used to sample and analyse artifacts. I first discussed the ceramic attribute analysis methods that I employed and explained why attribute analysis is well-suited to this project. In Chapter 5, I will complement this explanation of ceramic analysis methods with a discussion of ceramic attributes that are specifically related to use. Following my explanation of ceramic analysis methods, I presented the methods that I employed for paleoethnobotanical analysis, including extractions and identification. I then discussed the sampling protocols that I developed for this research. I employed the diagnostic method of microbotanical identification for this research, and closed the chapter by discussing plant taxa that I anticipate encountering in my analysis and describing the diagnostic features of their phytoliths and/or starch grains.

Chapter 5
Ceramic Findings

In this chapter, I present the findings of my ceramic analysis. First, I provide an overview of Late Formative Titicaca basin ceramics, focusing on attributes that are related to use. I then discuss ceramic findings at Kala Uyuni. Kala Uyuni ceramic analysis includes interpretations not only of the vessels from which I took paleoethnobotanical extractions, but also of other vessels from the same contexts. I use the broader dataset to contextualize the five Kala Uyuni vessels that also have botanical data associated with them. I then discuss ceramic findings at Challapata. Here I was limited by the lack of previous research on Challapata ceramics. The section therefore only includes a description with minimal interpretation of the seven Challapata sherds from which I completed paleoethnobotanical extractions. Finally, I discuss the five vessels that were included as offerings in the Tiwanaku IV/V phase burial at Chiripa. This final section uses previous work on Tiwanaku ceramics to contextualize the five vessels.

5.1 Titicaca Basin Ceramics

In this section, I discuss the four main attributes that I focused on in my ceramic analysis: paste, form, surface finish, and carbonization. Potters select paste, form, and surface finish of vessels during their production and these attributes can therefore shed light on the potential intended uses of vessels. Patterns of carbonization deposits, on the other hand, is directly associated with use.

5.1.1 Paste

Paste reflects technological choices and the kinds of materials that potters had access to (Arnold 1985; DeBoer 1984; Rivas-Tello 2016; Roddick 2009; Sillar 2000; Steadman 1995). It is a useful attribute to study potential intended use of vessels because certain pastes lend themselves better to certain functions. For example, compact pastes are more impermeable than porous pastes, making them favourable in the production of vessels that will be used to serve liquids (Roddick 2009:351). However, it is important to keep in mind that potters are likely to have used the same paste to produce multiple forms of vessels (Roddick 2009:188-189). Paste therefore cannot be used as a sole or definitive marker of intended use.

TAP ceramicists divide Late Formative pastes are divided into two broad groups: mineral tempered and fiber tempered (Roddick 2009:227). Mineral tempered pastes make more effective cooking vessels than fiber tempered pastes because they enable the production of thinner walled vessels, which are more efficient for heating and are less likely to crack due to thermal pressure (Rice 2015:226-232; Roddick 2009: 351; Skibo 2013:40; Steadman 1995:149). Mineral temper also increases thermal shock resistance, which makes pots more suited to direct heat cooking (Roddick 2009:351; Skibo 2013:40). Fiber tempered vessels do not conduct heat as effectively, sometimes making it impossible to bring the contents to a boil (Skibo et al. 1989:131). Fiber tempered vessels are, however, more suitable for cooking food at lower temperatures over longer periods of time (Steadman 1995:150). In Steadman's study of Camata (see Chapter 2), she found that the majority of cooking vessels were fiber tempered (1995:146-153). The paste of cooking vessels can therefore potentially inform archaeologists about cooking methods.

More compact mineral tempered pastes are also better suited to produce serving vessels. Compact pastes are more impermeable, making them more efficient for serving liquids than porous pastes (Roddick 2009:351). At Late Formative Taraco Peninsula sites, very compact "buff" pastes (TAP pastes 5 and 6) were generally used to produce serving bowls and were never used for cooking (Roddick 2009:351). Paste 5 and 6 bowls were often burnished, slipped, and/or decorated (Roddick 2009:351). Roddick (2009:352) suggests that Taraco Peninsula potters may have acquired these pastes through trade with other communities, which may have made them more desirable in the production of serving vessels.

Figure 5.1 TAP pastes (photos by Sophie Reilly). Left: Paste 1; Center: Paste 18; Right: Paste 5

Janusek (2003) discusses patterns of pastes in Tiwanaku phase vessels, describing pastes that are most common in particular forms. Cooking vessels (*ollas*) tend to have porous pastes tempered with medium white grains and occasionally mica (Janusek 2003:58). The colour of cooking vessel pastes ranges from greyish-brown to brownish-orange (Janusek 2003:58). Most forms of storage vessels were produced with pastes that were denser and more compact than those used to produce cooking vessels (Janusek

2003:60), However, storage vessels that Janusek (2003:59) associates with storing and pouring liquids have soft orange pastes. Pastes used in the production of serving vessels such as *keros* changed throughout Tiwanaku IV/V phases (Janusek 2003:63). Early Tiwanaku IV *keros* were produced from porous orange and brown pastes with fine white and occasionally mica temper. In late Tiwanaku IV and early Tiwanaku V periods, were produced from compact orange oxidized paste, or grey reduced paste (Janusek 2003:63).

5.1.2 Form

Form can be a useful indicator of intended use of a vessel (Rice 2015; Skibo 2013). In this section, I will discuss common Formative and Tiwanaku period forms that Titicaca Basin ceramicists (Janusek 2003; Marsh 2012; Roddick 2009; Smith 2009; Steadman 1995) associate with food: *ollas* (cooking vessels), jars (storage and transportation vessels), and bowls (serving vessels). As with pastes, forms should not be used as definitive indicators of vessel use because potters likely produced vessels of similar forms for a wide range of uses (Janusek 2003:41). Steadman (1995:50) notes that the ways that archaeologists think about and classify form may not be the same ways in which potters thought of forms as they produced vessels. Despite these limitations form can still be a useful indicator of general vessel use.

Ollas are large, globular cooking vessels most suitable for cooking soups and stews (Janusek 2003; Marsh 2012; Roddick 2009; Smith 2009:296). *Ollas* are often produced from porous pastes and have exterior carbonization patterns that indicate they were likely used for cooking (Janusek 2003:58; Roddick 2009:241). People in modern Aymara communities also still use *ollas* for cooking during special events (Janusek

2003:58). It can be difficult to distinguish them from other necked vessels, specifically storage jars, in the archaeological record (Roddick 2009:240; Smith 2009:260). *Ollas* are generally thin-walled vessels (Janusek 2003:57), likely because thinner walls are more efficient for cooking. Roddick (2009:241) found that micaceous pastes (TAP pastes 1 and 18) were favoured for *ollas* at Late Formative sites on the Taraco Peninsula. *Olla* style is fairly continuous from the Late Formative period to Tiwanaku phases (Janusek 2003:57). Smith (2009) proposes that people at Khonkho Wankane developed specialized cooking vessels in the Late Formative period before they developed specialized serving vessels such as *keros* and *tazones* in the Tiwanaku period. The consistency in *olla* form throughout the southern Titicaca basin from the Late Formative to Tiwanaku phases suggests that this is the case at other sites as well.

Jars are necked vessels used for the storage and transport of food goods including grains and liquids (Janusek 2003:58). Janusek (2003:58-60) argues that jars were used for storage based on contexts of recovery, paste (which is more compact than pastes used to produce *ollas*), vessel size. Their form is similar to that of *ollas*, though jars typically have thicker vessel walls (Janusek 2003:60; Marsh 2012:222). Smith (2009:276) and Marsh (2012:221-222) found that the interior of Khonho Wankane jars were often smoothed, burnished, or wiped. These finishes decrease permeability and would therefore be useful for liquid storage vessels (Smith 2009:276). Ethnoarchaeological work in contemporary Aymara communities indicates that jars were likely used not only for storage, but also to ferment beverages (Janusek 2003:59).

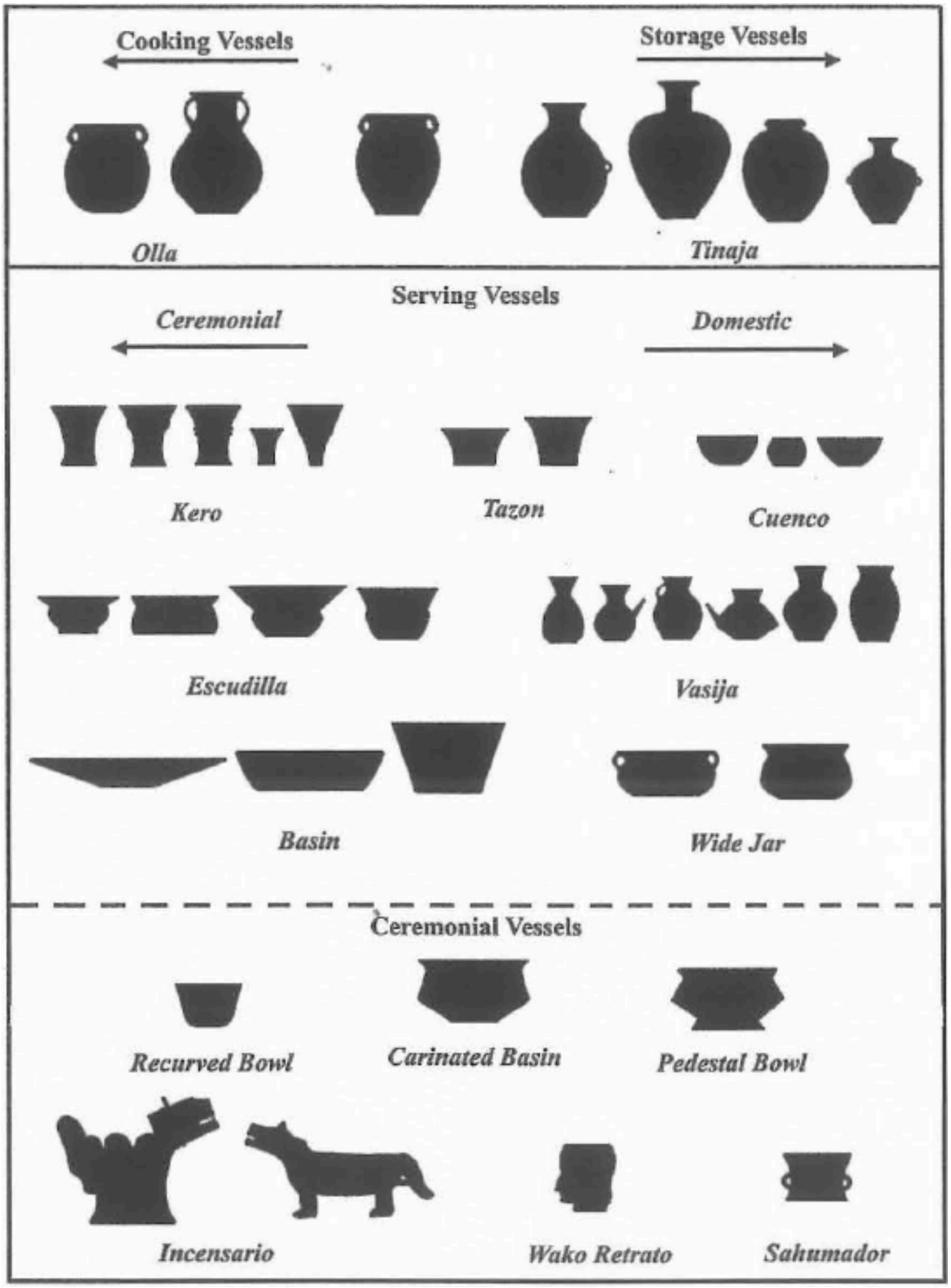

Figure 5.2 Principle forms of Tiwanaku vessels (from Janusek 2003:57)

In the Late Formative, bowls were the dominant serving vessels, used for both food and drink. Bowl form diversified and bowl ubiquity increased at Taraco Peninsula during the Late Formative (Roddick 2009:247). Bowls size also decreased at this time, suggesting a possible new focus on individual consumption (Roddick and Hastorf 2010:167). Marsh (2012:224) notes that bowls were likely useful serving vessels at feasts because they can be easily passed around from one person to another. Bowls were also potentially washed and re-used for different foods or drinks within the span of a single event (Marsh 2012:224). Roddick (2009:349) proposes that there were likely three distinct functions for bowls in the Late Formative: specialized serving, multipurpose, and incense burners. At Late Formative sites on the Taraco Peninsula, about 50% of bowls were made from micaceous pastes while the other 50% were made from finer buff pastes (Roddick 2009:348). This suggests that people may have owned both general everyday serving bowls (made from micaceous pastes) and more specialized serving bowls (made from finer pastes) (Roddick 2009:348). Interior carbonization on some bowls, especially annular based bowls, suggests they were used for burning activities (Roddick 2009:348). Serving vessel form changed at the onset of the Tiwanaku IV phase, when bowls became less common and *keros* and *tazones* became dominant serving vessels (Janusek 2003:63).

5.1.3 Surface Finish

Different surface finishes lend themselves better to certain functions. The TAP method of ceramic analysis has isolated six types of surface finish that potters used in the Formative Period on the Taraco Peninsula: smoothed, rubbed, wiped, incomplete burnished, burnished, and stucco. The stucco finish is a “slurry of clay” applied to the base of vessels (Roddick 2009:194). It is useful in the production of cooking vessels because it increases thermal shock resistance (Steadman 1995:148). While it is common on the Taraco Peninsula in the Middle Formative and in Camata cooking vessels, stucco is rare in Late Formative ceramics (Roddick 2009:333; Steadman 1995:148). In Tiwanaku phases, burnishing became a more common surface finish across all vessel forms (Janusek 2003:54). Burnishing, smoothing, and wiping decrease the permeability of vessels (Rice 2015:418; Smith 2009:276). Other methods that potters used to make vessels more impermeable include adding a coating, such as a glaze or slip (Rice 2015:418). Though there were no glazed vessels in the Late Formative and Tiwanaku period, several are slipped. Impermeability is useful in storage vessels (Rice 2015:411). Complete impermeability is not a favourable trait for the inner walls of cooking vessels, however, because it makes them more susceptible to thermal shock damage (Skibo 2013:48).

5.1.4 Carbonization

Carbonization is not the product of technological choices that potters made while producing vessels like the attributes discussed above; rather, it is a direct product of use. The location of exterior carbonization can indicate the way in which a pot was placed over a fire to cook food. Carbonization on exterior vessel walls, often called sooting, generally indicates that the pot was placed directly in the fire, whereas carbonization on the base indicates that it was suspended over the fire (Rice 2015:429). Base carbonization is also usually indicative of food having been cooked with water (boiling or simmering), whereas food that was cooking without water (roasting) will generally leave an oxidized base (Skibo 2013:92). Rings of encrustation on interior walls is also an indication of boiling or simmering. Dry cooking, on the other hand, results in carbonization throughout the vessel (Skibo 2013:97). Interior carbonization can also indicate that a vessel was used for burning incense, herbs, or fats (Roddick 2009:340). Bermann (1994:195) reports a plant tentatively identified as *tola* (*Lepidophyllum quadrangulare*) as a burned offering in a Tiwanaku IV/V phase ceramic vessel from Lukurmata. Bermann does not, however, specify what methods were used to identify the botanical remains in the vessel As discussed in Chapter 2, carbonization patterns were among the attributes that enabled Steadman (1995:145-153) to argue that people boiled food in fiber-tempered vessels at Camata. She identified a ring of encrusted food remains on the interior of a complete fiber-tempered *olla*, indicating that food in this vessel was likely boiled (Steadman 1995:152).

Roddick (2009) studied carbonization patterns of ceramics at Kala Uyuni, Kumi Kipa, and Sonaji. At these sites, vessels with both interior and exterior carbonization were mostly made from micaceous tempered pastes (Roddick 2009:340). Paste 9, which is mineral tempered, had the highest percentage of vessels with both interior and exterior carbonization. Vessels with interior carbonization were mostly made from non-fiber micaceous pastes (TAP pastes 1 and 2), followed by pastes with both mica and fiber tempers (TAP Pastes 17 and 18) (Roddick 2009:340). Finer pastes (5 and 6), however, never had carbonization. Janusek (2003:58) found that the majority of Tiwanaku IV/V phase *ollas* (70-90%) were encrusted with soot, though he does not specify where on the vessels these encrustations were located.

5.1.5 Summary

Paste, form, and surface finish are indicative of choices that potters made as they produced vessels and can therefore reflect intended use of those vessels. However, potters also likely used the same technologies and practices in the production of a variety of vessel types and ceramicists therefore should not treat these attributes as definitive markers of intended use. Carbonization patterns, on the other hand, are direct products of vessel use and can shed light on past cooking practices. In this chapter, I use these four attributes as the main lines of evidence with which to interpret the possible uses of ceramics.

5.2 Ceramics at Kala Uyuni

5.2.1 Broader Dataset

My ceramic analysis at Kala Uyuni was two-faceted. I completed paleoethnobotanical analysis of residues associated with five Kala Uyuni sherds. I employ ceramic attribute analysis to determine the potential uses of these sherds. However, before discussing these sherds specifically, I discuss a broader dataset of Kala Uyuni ceramics (Table 5.1). I use results from analysis of the broader dataset to contextualize and interpret the five sherds that have associated paleoethnobotanical data. Table 5.2 shows the weight and densities of ceramic sherds from each analysed context. Following Roddick (2009:108-109), I include this information so that I can compare densities of particular sherd attributes across the five contexts. My analysis of these datasets focuses on paste, form, carbonization patterns, and surface finish.

PEB Sampled Artifact	ASD	Event	Context	Loci with ceramic data
KU-9241-SER015	9	B409	Surface/Construction Fill Inside Structure	9229, 9241
KU-5040/5-SER021	2	B22	Clay Lens	5040, 5152, 5164
KU-5155-SER028	2	B12, B100	Floor, Fill Below Floor	5045, 5154, 5358
KU-5318-SER039	N/A	B91	High Density Midden	5317, 5318
KU-7590/5-SER045	5	B249	Interior Occupation Surface	7507, 7508, 7578, 7579, 7588, 7590, 7593

Table 5.1 Kala Uyuni broader ceramic dataset contexts. Note: No ceramics from Event B100 were analysed other than the PEB sampled artifact KU-5155-SER028. I therefore used ceramic data from the floor (B12) above the fill (B100).

Event	Loci Analysed	# (weight) sherds	Average sherd weight	Density (Sherd weight/Soil Volume excavated)
B409	9229, 9241	377 (2409)	6.4	6.9
B22	5040, 5152, 5164	309 (2222.6)	7.2	N/A
B12	5045, 5154, 5358	203 (1441)	7.1	1.8
B91	5317, 5318	763 (5884.6)	7.7	4
B249	7507, 7508, 7578, 7579, 7588, 7590, 7593	887 (8631.6)	9.7	14.2

Table 5.2 Kala Uyuni ceramic densities. Note: I could not calculate ceramic density of event B22 because excavators did not record the volume of soil excavated from locus 5164.

Paste 1 is the most common across the samples (39%), followed by paste 18 (26%) (Figure 5.2). Paste 1 is a subcompact mineral tempered paste with micaceaous and medium sized angular and subangular inclusions. Paste 18 has the same composition as paste 1, but with fiber temper as well as mineral temper. Pastes 2 and 17 are the next two most common pastes, at 9% and 8% respectively. Paste 2 is a subcompact mineral tempered paste with translucent rounded inclusions. Paste 17 is likely the fiber tempered version of paste 2 (Roddick 2009:222). Pastes 3 and 9, both mineral tempered pastes that are common in Late Formative II cooking vessels (Roddick 2009:224), occur in relatively low percentages (5% and 4% respectively). Buff pastes 5 and 6 are also present at 3% and 2% respectively.

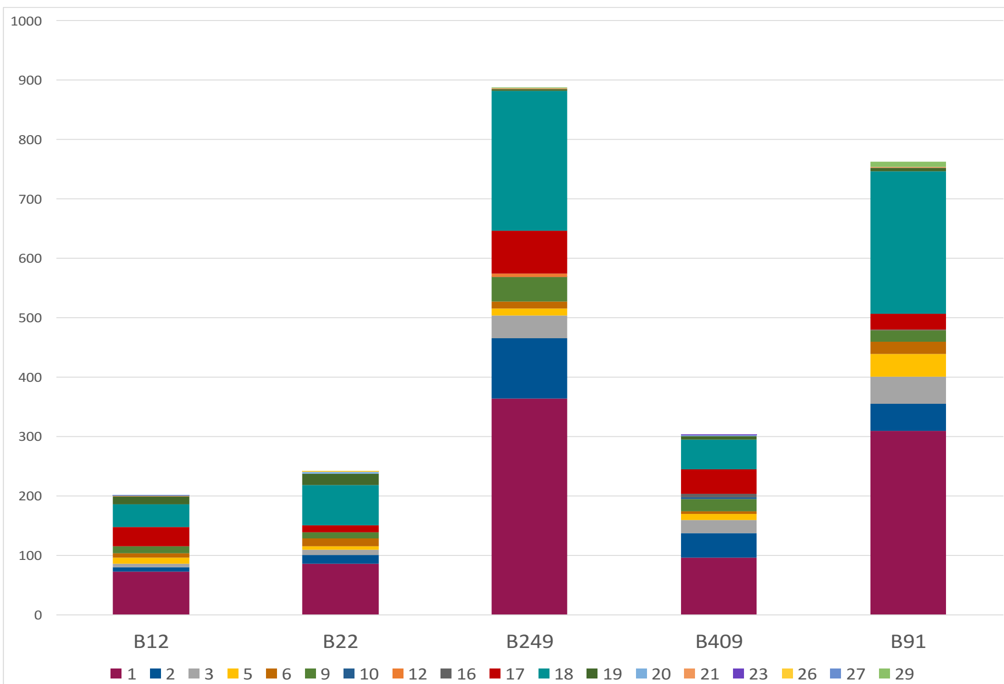

Figure 5.3 Count and percentage of pastes from all sherds in the analysed Kala Uyuni contexts

Overall carbonization within the assemblage was 0.9% exterior carbonization, and 1.8% interior carbonization. This is relatively similar to Roddick's (2009:341) findings of 0.56% exterior carbonization and 1.27% interior carbonization in sherds from Kala Uyuni, Kumi Kipa, and Sonaje. Pastes 9 and 19 had the highest percentages of interior carbonization, though neither had traces of exterior carbonization (Figure 5.3). Sherds from event B409, in ASD9, had the highest rates of carbonization in this assemblage. In fact, 77% of sherds with exterior carbonization and 50% of sherds with interior carbonization were from event B409. In this event, paste 1 (Ext. 9.3%; Int. 10.4%) and paste 3 (Ext. 8.7%; Int. 8.7%) had the highest percentage of carbonization, following paste 19 (Figures 5.5, 5.6). The ubiquity of paste 1, combined with the higher occurrence of carbonization on paste 1 sherds, suggests that this paste may have been favoured for utilitarian and cooking vessels.

Across all analysed events, there is a higher number of sherds with interior carbonization than of sherds with either exterior carbonization or carbonization on both surfaces (Figure 5.5). This suggests that pots may not have been placed directly in fires for cooking. Unfortunately, the dominance of body sherds makes it difficult to ascertain the location of carbonization on pots. That being said, of the 90 bases in this assemblage, one had exterior carbonization, eight had interior carbonization, and one had carbonization on both the interior and exterior. These bases may represent vessels that were used to boil or simmer food.

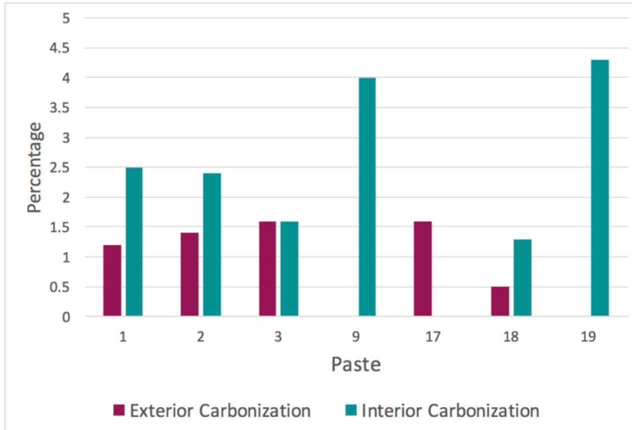

Figure 5.4 Percent of sherds with interior and exterior carbonization organized by paste

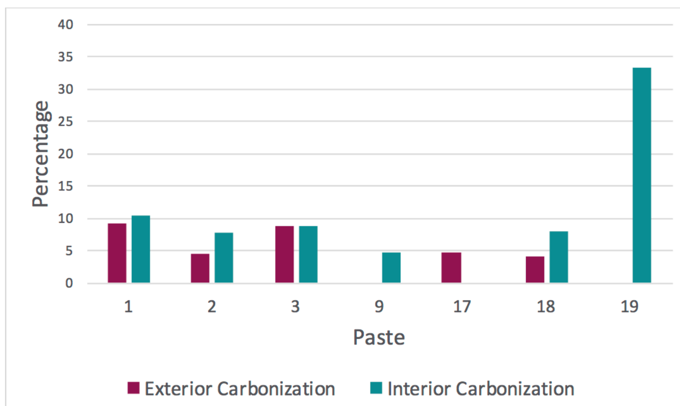

Figure 5.5 Number of sherds with interior or exterior carbonization from event B409

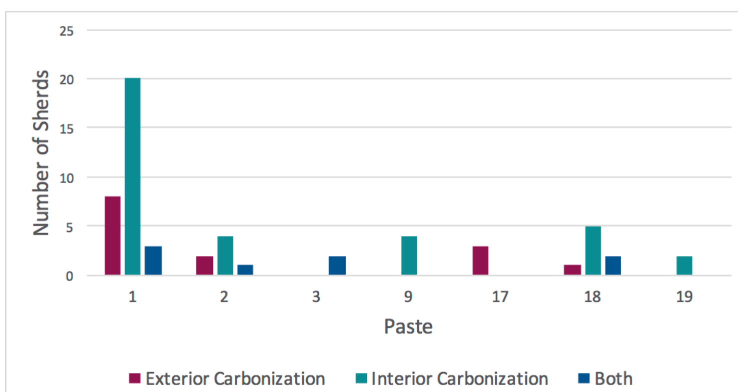

Figure 5.6 Number of sherds with exterior carbonization, interior carbonization, or carbonization on both surfaces, organized by paste

Roddick (2009:342) identifies event B249 as the event with the highest number of carbonized sherds of all Kala Uyuni contexts he analysed. This finding, combined with botanical data (Bruno 2008) and architectural data, has lead TAP archaeologists to interpret ASD-5 as a domestic occupation space where cooking activities took place (see Chapter 2). It is therefore significant that B409 in ASD-9 had a higher density of carbonized sherds than B249. Whereas B249 contained three sherds with exterior carbonization and nine sherds with interior carbonization, B409 contained 17 sherds with exterior and 22 sherds with interior carbonization. It is possible that ASD-9 was an area where burning activities, possibly including cooking, took place.

Diagnostic forms in this assemblage include: bases, bowls, decorated body sherds, figurines, handles, jars, necked vessels, *ollas*, polishing tools, and unknowns (Table 5.3). Paste 1 is the most common across all types. It occurs in slightly higher percentages in *ollas* (56%) and necked vessels (52%), which supports the idea that the paste may have been favoured for cooking. Paste 1 is least common in decorated body sherds (21%) indicating it was not favoured in the production of serving vessels. The "buff" pastes, 5 and 6, occur most frequently in bowls and decorated body sherds, demonstrating that the pastes were likely reserved for special use vessels. However, pastes 5 and 6 were also used to produce two *ollas* and one necked vessel, potentially indicating that the use of even specialized pastes was fluid and that potters would occasionally use them to produce utilitarian vessels.

	B12	B22	B249	B409	B91	Total
Base	4	10	16	10	50	**90**
Bowl	13	9	16	9	65	**112**
Decorated body	3	5	3		22	**33**
Figurine					2	**2**
Handle	2	2	4		5	**13**
Jar		1				**1**
Necked vessel	3	3	3	3	36	**48**
Olla	5	1	10		25	**41**
Polishing tool			1			**1**
Unknown	6	4	12	14	75	**111**

Table 5.3 Forms of diagnostic sherds, organized by event

Ollas occur most frequently in the high density midden, event B91 (n=25). This is not surprising given that B91 has the highest count of sherds overall. B249 has the second highest count of *ollas* (n=10). It is likely that some of these sherds represent smashed vessels from a single event that may be related to the closing of ASD-5 (Bruno 2008:425). However, given TAP archaeologists' interpretation of this structure as a domestic space where cooking took place (Bruno 2008; Roddick 2009; Roddick et al. 2014), it is likely that some of these vessels were used for cooking. There were no sherds identified as *ollas* B409, the event that contained the highest number of carbonized sherds. This could be a due to of the high fragmentation rates of Late Formative ceramics. It could also indicate that the charring in B409 sherds is from non-cooking related activities, such as incense burning. Future analysis of ASD-9 could shed light on the activities that took place in this structure and on the causes of sherd carbonization.

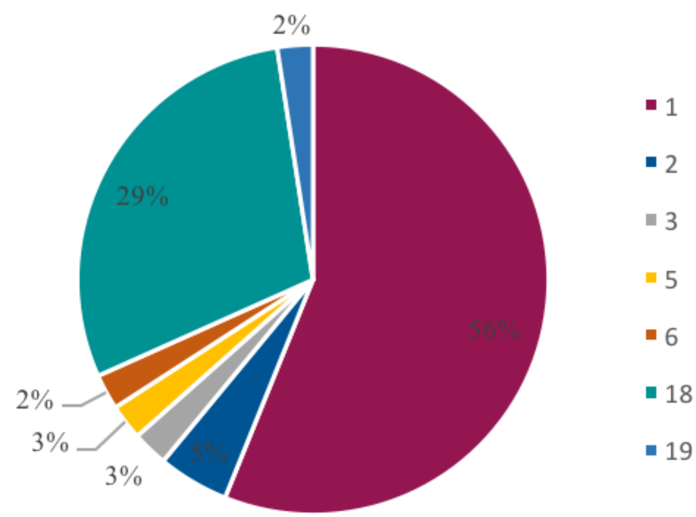

Figure 5.7 Paste distribution in *ollas* (n=41)

The two most common *olla* pastes are 1 (56%) and 18 (29%) (Figure 5.6), indicating that people at Kala Uyuni cooked with both mineral and fiber tempered vessels. One of the advantages of mineral tempered pastes in the production of cooking vessels is that it is easier to produce thinner walled vessels using mineral temper. Thin walls are beneficial for cooking vessels because they are more resistant to thermal shock (Roddick 2009:351). However, wall thickness of paste 1 and paste 18 *ollas* in this assemblage are relatively similar: minimum wall thickness is 5.5 mm in paste 1 and 5 mm in paste 18, while maximum thickness is 11.9 mm in paste 1 and 9 mm in paste 18. Both paste 1 and paste 18 *ollas* have an average wall thickness of 6.9 mm. This suggests that potters may not have selected mineral tempered pastes in order to produced thin-walled cooking vessels. It is nonetheless possible that potters selected pastes based on cooking practices and that the presence of fiber tempered cooking vessels indicates that people at Kala Uyuni used slow cooking methods. The low number of carbonized *olla* sherds in the assemblage (n=2) makes this theory difficult to test.

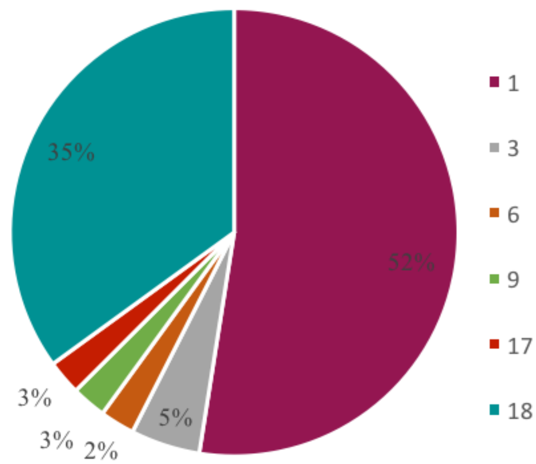

Figure 5.8 Paste distribution in necked vessels (n=40)

When TAP ceramicists are unable to identify a necked vessel as either an *olla* or a jar, they classify them as "necked vessels." As with the *ollas*, the high density midden had the highest count of necked vessels (n=28). All other events had three necked vessels each. Paste distribution among necked vessels (Figure 5.7) is similar to *ollas*, with paste 1 dominating (52%), followed by paste 18 (35%). These similarities between *ollas* and necked vessels could indicate that several of these vessels are, in fact, *ollas*. Alternatively, they could suggest that production techniques and spatial distribution of *ollas* and jars were very similar. Janusek (2003:57) suggests that *ollas* and jars may have been relatively interchangeable, with *ollas* being used for storage and transport later in their use-lives. Unfortunately, only one vessel in this assemblage was identified as a jar so it is not possible compare the *olla* and necked vessel data with data about jars.

Surface finish patterns are very similar in *ollas* and necked vessels. Surface finish 1 (exterior wiped/interior wiped) is the most common finish in both forms (32% *ollas*; 32% necked vessels) and finish 25 (exterior complete burnish/interior complete burnish) is a close second (27% *ollas*; 23% necked vessels). All interior surfaces had finishes that decrease permeability: wiped, smoothed, or burnished (Rice 2015:418; Smith 2009:276). Of these finishes, burnishing is the most effective to make vessels impermeable. Burnishing also makes vessels more resistant to abrasions (Rice 2015:418). Burnishing is a relatively common interior finish in both *ollas* (27% complete burnish, 2% incomplete burnish) and necked vessels (23% complete burnish, 0% incomplete burnish), which suggests that impermeability may have been a desirable trait in some cooking and storage vessels.

Bowls are the most common form in the assemblage (n=111) and likely served multiple purposes: serving vessels for both food and drink in both everyday and ritual or special contexts, and as vessels in which to burn incense, herbs, and fat. Roddick (2009) argues that households likely owned both utilitarian bowls for everyday use and finer bowls for more specialized uses. The pastes of bowls in this assemblage support this. While pastes 1 remains the most dominant (42%), bowls were also made from finer pastes, including paste 5 (14%) and paste 6 (5%) (Figure 5.8). There is also one bowl that is made of the very mica rich paste 29. Pastes 2 (11%), 3 (11%), and 18 (14%) were also used to produce bowls. Based on this assemblage, potters do not seem to have favoured particular pastes in the production of particular bowl forms (Table 5.3). Three bowls in this assemblage had carbonization: one had exterior carbonization, and two had both interior and exterior carbonization. The bowl with interior carbonization was paste 1 and may have been used to burn offerings.

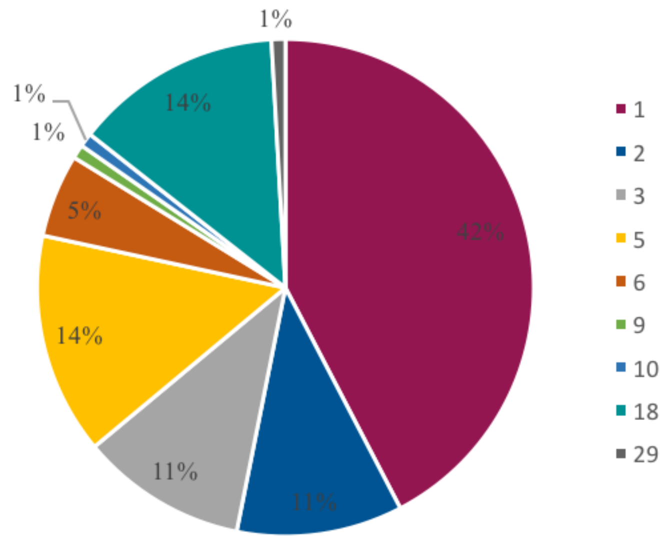

Figure 5.9 Paste distribution in bowls (n=111)

The ubiquity of paste 1 in this assemblage and its high concentration in utilitarian vessels such as *ollas* and necked vessels suggest that this was a common paste likely favoured in the production of domestic pots. Similarly, pastes 5 and 6 were favoured in the production of serving vessels, including bowls and decorated vessels. But these pastes were also used in more utilitarian forms, *ollas* and necked vessels. I can therefore use paste to hint at what a particular vessel may have been used for, but cannot use it as a definitive indicator. Roddick (2009) argues that most Late Formative vessels from the Taraco Peninsula were locally produced and that there was a peninsula-wide "community of practice." He states that it is possible that the compact pastes, 5 and 6, were non-local and "accessed through trade relationships," but that further research on the pastes would be needed to confirm this (Roddick 2009:352).

Based on this ceramic assemblage, I can also speculate about cooking practices at Kala Uyuni. The high density of *ollas* and carbonized sherds in ASD-5 supports previous arguments that the structure was used for cooking activities. This interpretation (discussed in Chapter 2) is based not only on ceramic data, but also on botanical data and architectural style. ASD-9 has a high density of carbonized sherds, though no *ollas*. Research in ASD-9 has not been as extensive as in ASD-5 and there is therefore no other ceramic data or botanical data associated with this structure that could indicate whether this may have been another cooking space. Further research in ASD-9 could shed light on the activities that took place in this space. Cooking methods at Kala Uyuni likely included boiling and possible slower cooking such as simmering. The presence of fiber tempered cooking vessels, and carbonization on bases suggests slow cooking and boiling and simmering. Finally, the interior finishes that decrease permeability might suggest that people cooked strews and soups. This supports previous research (discussed in Chapter 2) that found that soups and stews were common meals in the Late Formative.

5.2.2 Sampled Sherds

Artifact KU-9241-SER015 is a paste 1 sherd from a surface/construction fill inside ASD-9 (B409). The sherd is a flat base with a flared (35-55º) wall. The interior surface had light powder carbonization, while the exterior surface had a light encrustation. Its finish is wiped on the interior and eroded on the exterior. Carbonization suggests that this vessel may have been used for cooking.

Artifact KU-5040/5-SER021 (Figure 5.10) is an almost complete bowl from a clay lens (B22) in ASD-2. It is a flared bowl with two rim scallops. It was produced from paste 1. It has a light encrustation of carbonization on both its interior and exterior, which suggests that it was used in burning activities, though it may not have been used to burn incense. As discussed in Chapter 2, TAP archaeologists interpret ASD-2 as a space where ritual activities took place. It is possible that this bowl was a serving vessel or an incense burner used in ritual activities.

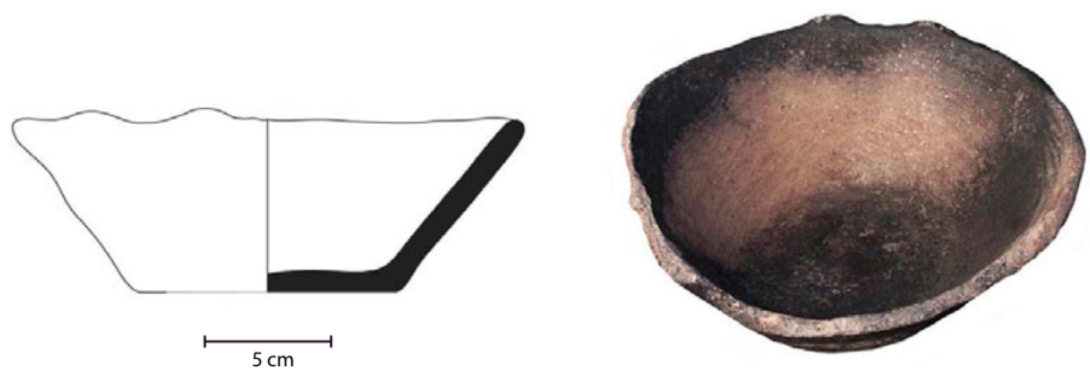

Figure 5.10 Illustration and photo (by Andrew Roddick 2009:349) of KU-5040/5-SER021

Artifact KU-5155-SER028 is a non-diagnostic paste 1 body sherd from a fill below a floor in ASD-2 (B100). Its interior had a heavy encrustation of carbonization, though its exterior had no carbonization. Its finish is wiped on both the interior and exterior. The interior carbonization on this sherd could be from an offering burned in the vessel.

Artifact KU-5318-SER039 (Figure 5.11) is a paste 18 annular base (B81) from a high density midden (B91) in the area west of ASDs 2, 4, and 5. The base had a light encrustation of carbonization on the interior, and no carbonization on the exterior. Roddick (2009:431) suggests that annular bowls were likely used as incense burners in the Late Formative, and were likely precursors to the Tiwanaku IV/V phase *incensarios*.

The interior carbonization on this sherd suggests it is possible that it was the base of a bowl used for incense burning. Its finish is smoothed on the exterior and wiped on the interior.

Artifact KU-7590/5-SER045 (Figure 5.12) was produced using paste 17, and is a flat slightly flared (56-80º) base from the interior occupation surface of ASD-5 (B249). Its finish is incomplete burnish on the exterior and eroded on the interior. There is no carbonization on this sherd. The lack of carbonization paired with the sherd's thick walls (base thickness: 11.8mm; body thickness: 9mm) suggest this vessel may have been used for storage.

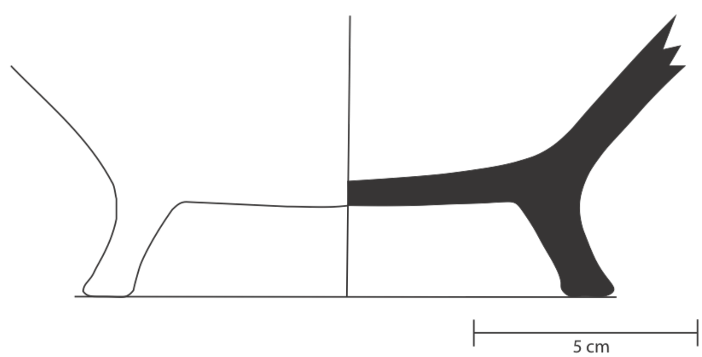

Figure 5.11 Artifact KU-5318-SER039 (image by Sophie Reilly)

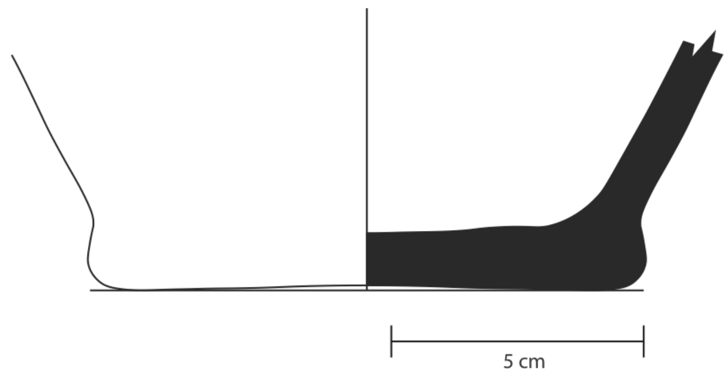

Figure 5.12 Artifact KU-7590/5-SER045 (image by Sophie Reilly)

It is possible that a range of vessel types are represented in the five five Kala Uyuni sherds from which I completed paleoethnobotanical extractions. The assemblage includes: a possible cooking vessel, a bowl, an annular based bowl that may have been used to burn offerings, and a possible storage vessel. The vessels were all made from the most common utilitarian pastes: 1, 17, and 18. However, as, analysis of the broader Kala Uyuni dataset demonstrates, intended vessel use was likely not an exclusive determinant of paste selection. It is therefore possible that some of these five sampled sherds (especially the two sherds from ASD-2 and the annular base) were used in special, non-everyday, contexts.

5.3 Ceramics at Challapata

In this section, I will describe the results of attribute analysis of the six sherds and one clay chunk from Challapata from which I also completed paleoethnobotanical analysis and extractions. Ceramic analysis has not yet been completed on the broader assemblage of Challapata ceramics. As a result, paste groups for this area have not yet been developed and there is no dataset within which to contextualize ceramic results from the site. All sherds Challapata sherds in this study were excavated from the Oqo Qoya Pata ceremonial mound Challapata. There were no traces of carbonization on any sherds from this assemblage.

Artifact OQP-16-SER001 is a non-diagnostic body sherd. Its paste is fiber-tempered homogenous and light-red with very few inclusions. Its finish is eroded on both the interior and exterior. From the same locus, artifact OQP-16-SER004 is the rim of a necked vessel. The rim diameter was estimated to be 11 cm. Paste is compact mineral and fiber tempered with small, white inclusions. The sherd's finish was mostly eroded with some traces of burnishing on both the interior and exterior.

Figure 5.13 OQP-16-SER001 Left: sherd. Right: Paste. Note: There are no scales for photos of paste because photos were taken to achieve extended depth of focus (photos by Sophie Reilly)

Figure 5.14 OQP-16-SER004. Left: sherd. Right: paste (photos by Sophie Reilly)

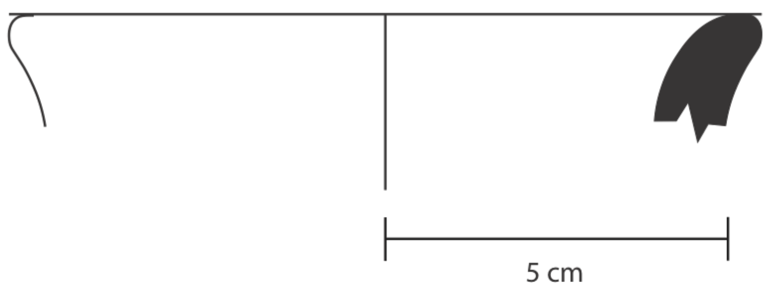

Figure 5.15 Artifact OQP-16-SER004 (image by Sophie Reilly)

Artifact OQP-15-SER002 is a rim from a possible bowl. Its paste is mineral tempered and compact with white and translucent inclusions, and some smaller black inclusion. Its finish is eroded on both the interior and exterior, though both surfaces bear traces of burnishing and a red slip. Dark mica is also visible on the interior and exterior surfaces of the sherd. From the same locus is OQP-15-SER003, a body sherd. Its paste is fairly compact with white and translucent inclusions with some possible traces of fiber. This paste was likely mineral tempered or mineral and fiber tempered. The vessel has an incomplete burnish on the exterior and wiped on the interior.

Figure 5.16 OQP-15-SER002. Left: sherd. Right: paste (photos by Sophie Reilly)

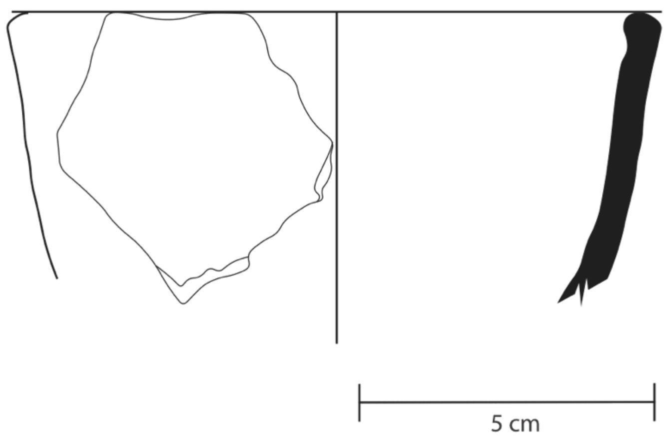

Figure 5.17 Artifact OQP-15-SER002 (image by Sophie Reilly)

The remaining artifacts each come from different loci. Artifact OQP-4-SER005 is a body sherd. Its paste is fiber tempered with small white inclusions. Its finish is a complete burnish on the exterior and smoothed on the interior. There is a dark brown slip on the exterior. Artifact OQP-17-SER006 is likely not a vessel sherd, but a chunk of clay. It is likely the same red homogenous paste with very few inclusions as artifact OQP-16-SER001. Its surfaces are all eroded. Artifact OQP-3-SER007 is likely a handle. Its paste has a high density of large black and grey inclusions. The sherd's interior and exterior finishes are eroded though there are some possible traces of a light red slip on them.

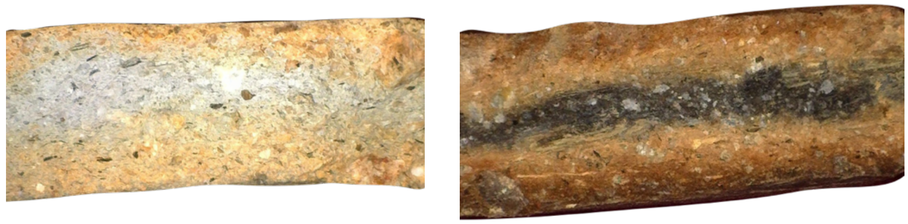

Figure 5.18 Left: Paste of artifact OQP-15-SER003; Right: Paste of artifact OQP-4-SER005 (photos by Sophie Reilly)

Figure 5.19 Left: Paste of artifact OQP-17-SER006; Right: Paste of artifact OQP-3-SER007 (photos by Sophie Reilly)

Without a broader dataset within which to contextualize these sherds, interpretation is difficult. The sherds' provenience from the Oqo Qoya Pata mound could indicate that they had ceremonial uses. It is likely that the bowl was a serving vessel, possibly indicating that the consumption of food and drink were among the practices that took place on the mound. No sherds had carbonization residues. However, the sample size is so small that this does not mean that no burning practices took place in the area, nor that no cooking vessels were present on the mound. Pastes were mostly fairly compact and mineral tempered, though some sherds had mineral and fiber temper.

5.4 Ceramic Offerings at Chiripa

In this section, I will discuss the five ceramic vessels that were recovered in the Tiwanaku IV/V period burial at Chiripa. Based on Janusek's (2003) Tiwanaku ceramic typology, these vessels can be sorted into two general categories: *vasijas* or jars, and bowls.

5.4.1 *Vasijas* (jars)

Three vessels from this burial are *vasijas* (CH-SER005, CH-SER008, and CH-SER009), though each of them is a different variation on the form. *Vasijas* were common serving vessels in Tiwanaku IV/V phases, often used to pour liquids (Janusek 2003:67). *Vasijas* were common offerings included in Tiwanaku IV/V burial (Janusek 2003:67). Interestingly, Janusek notes that *keros* and *tazones*, both also forms of serving vessels, were common in burial contexts at this time. Neither of these two forms appear in the burial at Chiripa.

Artifact CH-SER005 (Figure 5.19) is the form of *vasija* that Janusek (2003:68) categorizes as a wide jar or restricted bowl. Though this form is bowl-like in shape, it has several characteristics, including body, handle form, unburnished interior, and narrow rim, that Janusek argues makes them more *vasija* than bowl. Bennett (1934:417, 422) identifies this form as a round base open bowl with a flaring rim. This form begins to appear in Tiwanaku IV contexts, but is most common in Tiwanaku V. Vessels of this form are among the most common Tiwanaku forms to appear at Lukurmata (Bermann 1994:212). Janusek (2003:68) identifies two main sub-variants of this form. The first is generally unslipped or lightly slipped in red, orange, or cream and has pendant semi-circle or volute motifs. Variant 1 vessels often have interior or exterior carbonization, suggesting they may have been used in cooking activities. Variant 2 vessels are more elaborate and are always slipped in reddish-brown or reddish-orange. Motifs are also semi-circular or volute, though some also have condor or feline motifs. None of the Variant 2 vessels have charring, though roughly 50% are caked in hard white precipitate. Janusek (2003:69) suggests these vessels may have been used to process *chicha*.

Figure 5.20 Wide mouth *vasija* CH-SER005 (photo by Kathleen Huggins)

Artifact CH-SER005 has a red slip, black volute motif on the body, and cream circle motif on the exterior of the rim. The interior of the rim has a black pendant semi-circle motif. It is likely Variant 2 of the form. The vessel was made from TAP paste 11, a mineral tempered compact paste with medium sized translucent and opaque white and red inclusions. Both the interior and exterior of the vessel were completely burnished. There was not charring on either the interior or the exterior of the vessel, nor was there any white residue that Janusek describes.

Artifact CH-SER009 (Figure 5.20) is a small, globular jar, with a narrow neck and a zoomorphic handle categorized as a globular, narrow-necked *vasija*. Janusek (2003:67) divides globular *vasijas* into two categories: unslipped and slipped. Unslipped were likely domestic vessels, possibly used for special household activities. Slipped *vasijas* were more elaborate and likely used for pouring water and fermented drinks. Artifact CH-SER009 belongs to the slipped category of these vessels. Its exterior has a light-brown slip, and a black and cream geometric design. Most of the interior of the vessel was not visible, though there was a black semi-circle pendant motif on the interior of the rim, similar to that of CH-SER005. This motif was common globular *vasija* rim interiors (Janusek 2003:67). The handle of this vessel is zoomorphic, likely a bird or a snake. Bennett (1934:418) categorizes this form as an animal effigy handle, and states that they are common in the Cochabamba collection of decadent Tiwanaku ceramics. Janusek (2003:68) found that both raptor and lake birds were often linked with *vasijas* through iconography and that ducks were commonly represented in effigy *vasijas*. The link between birds and *vasijas* is so strong that Janusek (2003:68) suggests that "*vasijas* were metaphorical birds." The handle could also be in the form of a serpent. Janusek (2003:75) states that white star motifs are often depicted on serpent bodies and are likely linked with Cochabamba ceramic style. There are white marks on this handle that could be the remains of an eroded star motif.

Artifact CH-SER008 (Figure 5.21) is an effigy *vasija* in the form of a reclining llama. Resting llamas are a common form for effigy *vasijas*, along with ducks (Janusek 2003:68). Zoomorphic effigy vasijas often had spouts (Janusek 2003:68), as is visible on this artifact. This is a blackware vessel with a black slip. Both zoomorphic effigy vasijas and blackware *vasijas* appeared in Tiwanaku IV and were uncommon during Tiwanaku V (Janusek 2003:68).

Figure 5.21 Effigy handle *vasija*, artifact CH-SER009 (photo by Kathleen Huggins)

Figure 5.22 Llama effigy *vasija* artifact CH-SER008 (photo by Sophie Reilly)

5.4.2 Bowls

Two bowls were also included as offerings in this burial. As previously mentioned, Tiwanaku phase burials often included serving vessels in the form of *keros* and *tazones*. Bowls, however, were less common during this period, especially at the site of Tiwanaku itself. It is possible that the bowls in this burial were included as serving vessel offerings in the place of *keros* and *tazones*. They may be local variants of serving vessels. They may also represent connections between Chiripa and other (non-Tiwanaku) communities, as bowls present at Lukurmata during Tiwanaku IV/V may have been linked to the eastern valleys (Janusek 2003:67).

Figure 5.23 *Cuenco* artifact CH-SER006 (photo by Kathleen Huggins)

Artifact CH-SER006 (Figure 5.22) is a *cuenco* bowl. Janusek (2003:66) states that *cuencos* were rare at Tiwanaku during the Tiwanaku IV/V phases, though the form did continue to be present at sites in the Katari Valley, specifically at Lukurmata. The Tiwanaku IV/V phase *cuencos* at Lukurmata were decorated in non-Tiwanaku style that Janusek (2003:67) speculates may be connected to the eastern valleys. This is a shift from the Late Formative period, when bowls were common at Tiwanaku. The bowl has a light brown slip, similar to that of CH-SER005 and CH-SER009. The exterior is undecorated, though the interior of the rim has a semi-circular pattern, also similar to that on the interior of the rims of CH-SER005 and CH-SER009. The paste of this bowl could not be definitively identified, though it's small black inclusions and subcompact texture were similar to those of TAP paste 13.

Figure 5.24 Bowl artifact CH-SER007 (photo by Sophie Reilly)

The form of artifact CH-SER007 (Figure 5.23) is not included in Janusek's (2003) typology, but the vessel can be categorized as a thick-walled bowl based on Bermann (1994:186). Bermann recovered this form of bowl in two Tiwanaku IV/V phase structures at Lukurmata, in which sherds of this form make up the majority of ceramics. Bermann (1994:194) was unable to determine the use of these two structures, though suggested they may have been used for storage or for controlled activities. Similarly, he does not provide potential uses for these vessels. Though Bermann suggests that the structures in which this form has been recovered may have been used for storage, it is unlikely that these were storage vessels because of their wide mouth. The vessel in the burial was very eroded, though paste was tentatively identified as TAP paste 3, which was common in cooking vessels in Late Formative II. There was no carbonization in the vessel.

Based on these ceramic offerings, it is possible that this was the burial of a high status or important person. In their analysis of thirteen Tiwanaku IV/V period graves at Chiripa, Blom and Bandy's (1999) found that most ceramic goods were plainware *ollas*, *keros*, and *tazones*. This grave, however, had mostly decorated sherds, setting apart from the other burials. It is also interesting that serving vessels in those burials conformed to the Tiwanaku forms of *keros* and *tazones*, whereas this burial included a *cuenco*. The burial analysed in this thesis is also in a different area of the site than the thirteen included in Blom and Bandy's analysis. Bermann (1994:204) found that at Tiwanaku IV/V period Lukurmata, there was social differentiation in the placement of burials as well as in associated grave goods. This burial's differentiation from others in both its offerings and placement make it likely that it was for someone important.

5.5 Summary

Each of the ceramic datasets that I analysed was unique: at Kala Uyuni, I was able to contextualize the paleoethnobotanical sampled artifacts within a broader dataset and previous research, though the high fragmentation rates of sherds made it difficult to determine use; at Challapata, I used only analysed sherds from which I completed botanical extractions as there was no other ceramic data from the site to aid in the interpretation of the seven sherds I analysed; and at Chiripa, I had access to full vessels, most of which were forms that had been recorded and categorized in previous research. Several of these sherds and vessels were used in likely non-domestic, possibly ritual activities. This includes not only the burial offerings from Chiripa, but also possible incense burners from Kala Uyuni, and serving vessels from Challapata. This is not uncommon, especially in the Late Formative period, where the lines between domestic and ritual spaces and practices are quite blurred (Roddick and Hastorf 2010:159). I will turn now to my analysis of the botanical remains recovered from these vessels, which will contribute to a better understanding of what these vessels may have been used for.

Chapter 6
Botanical Findings

In this chapter, I present and interpret my paleoethnobotanical findings. I first discuss the taphonomy of phytoliths and starch grains in order to contextualize my results. I then provide an overview of the plant families, genera, or species that I identified associated with each artifact. The majority of microbotanical remains across all samples were phytoliths from the Poaceae family of wild grasses. I have categorized these into one of seven forms (simple, conical, rondel base, square/rectangle base, lobed base, saddle base, or other) based on the typology developed by Logan (2006). I also encountered unknown forms of phytoliths and starch grains, some of which are categorized based on morphology in results tables. However, in the description of paleoethnobotanical results, I generally lump these together as unknown phytoliths or unknown starch grains. I do, however, discuss unknown damaged starch grains because damage can be indicative of cooking methods.

6.1 A Note on Taphonomy

Understanding taphonomy is important in order to contextualize and interpret abundance microbotanical remains. There are several processes that can affect the preservation of phytoliths and starch grains: 1) plant uses in the past, 2) depositional environment, and 3) treatment of artifacts during and following excavation. While archaeologists often report findings when they do identify microbotanical remains, it is rare for studies to report negative results, which has limited paleoethnobotanists' understanding of taphonomy (Barton and Matthews 2006:79). However, an increase in experimental archaeology in the past decade has contributed to better understandings of the ways in which microbotanicals – especially starch grains – do, or do not, preserve in the archaeological record (Crowther 2012; Henry et al. 2009; Raviele 2011; Thoms et al. 2015)

The ways in which people used and processed plants in the past can affect the conditions and preservation rates of starch grains. Experimental archaeology projects (Babot 2003; Chandler-Ezell et al. 2006; Henry et al. 2008) have demonstrated not only that starch grains are susceptible to damage from various cooking techniques, but also that different cooking techniques damage starch grains in different ways. It may therefore be possible to identify the ways in which people cooked their food based on starch grain damage. Boiling and baking cause swelling, distortion, and occasionally the loss of the extinction cross (Henry et al. 2008:918). Dehydration can flatten starch grains, or cause them to become encrusted with small particles. In some species, including *Solanum tuberosum* (potato), dehydration can also cause the loss of lamellae (Babot 2003). Grinding plants can cause starch grains to appear incomplete, collapsed, or burst and can damage lamellae and accentuate fissures (Babot 2003:76-77). When grinding is combined with fermentation, starch grains can appear hollow with an undamaged outer edge (Henry et al. 2003:921). Given practices outlined in the ethnohistoric and ethnographic literature (outlined in Chapter 3), it is expected that dehydration, roasting, and milling to make flour were common food preparation practices in the Lake Titicaca Basin.

However, aging and natural decomposition can damage starch grains in similar ways to cooking (Collins 2011). These forms of damage should therefore not be used as definitive indications of cooking methods. Damage can also prevent the secure identification of starch grains by obscuring diagnostic features. For example, in Logan's (2006) study of microbotanical remains in the Southern Titicaca basin, she recovered a damaged tuber starch grain. The damage was indicative of milling, but prevented her from identifying the species of the starch grain.

Phytoliths are more durable than starch grains and are therefore less easily damaged by food processing. In fact, phytoliths can withstand temperatures up to 1,000° C without sustaining damage (Piperno 2006:106). Human action and processing techniques can nonetheless determine what phytoliths appear in the archaeological record. Raviele's (2011) experimental study of maize microbotanical preservation demonstrates that processing techniques can impact relative abundance of phytoliths and starch grains. She found that a high count of all forms of maize phytoliths (rondel and cross) likely indicates that people processed whole units of maize, whereas starch grains are more abundant when people cooked maize kernels. Piperno (2006:21) notes that the majority of phytoliths in archaeological assemblages represent plants that people used. Some phytoliths can enter the archaeological record incidentally, especially those representing plants that grow on the periphery of sites. However, these make up a "much smaller proportion" of the archaeological assemblage (Piperno 2006:21).

Depositional environment can also impact the preservation of microbotanical remains. Starch grains are subject to post-deposition degradation in soils due to organisms such as bacteria that consume high energy food sources. Plant cellulose and artifacts can protect starch grains from these organisms (Barton and Mathews 2006:83-84; Fullagar 2006:177). Post-depositional exposure to oxygen, due to activities such as tilling, can re-expose starch grains to bacteria and increases chances of degradation. Damaged starch grains are more vulnerable to bacteria and are therefore less likely to preserve (Barton and Mathews 2006:85). Starches from unprocessed whole plants, on the other hand, are more likely to preserve and to adhere to artifacts (Williamson 2006:89). Following deposition, starch grains are unlikely to move from soil to artifact (Barton and Mathews 2006:88), which means paleoethnobotanists can securely associate starch grains recovered from artifacts with artifact use. Given the cooking practices outlined in previous chapters, such as freeze drying and fermentation, it is likely that starch grains at these three sites would have been susceptible to damage and subsequent degradation.

There are two main factors that influence phytolith preservation following deposition: the type of phytolith, and the condition of the soil (Piperno 2006a: 21, 108). Phytoliths from grass leaves and seed bracts, and from Cucurbitaceae family are among the most durable phytoliths. Smaller phytoliths, with less surface area, are less susceptible to dissolution. Phytoliths are more likely to dissolve in alkaline soils (pH levels above 9), though phytoliths that have been blackened due to firing are more likely to survive these conditions. In their study of raised fields in the Titicaca Basin, Smith et al. (1968:359-360) found that soil pH levels in the northern basin generally range between 6.8 and 8.5 and that and closer to Lake Titicaca has higher pH levels, often above 8. Smith and colleagues do not qualify how close soils must be to the Lake to have higher pH levels.

Soil studies on the Taraco Peninsula found that pH levels range from 7.28 to 9.25 at Chiripa (Bettencourt 2010:87) and from 7.07 to 8.7 at Kumi Kipa (Peterson 2007:81). These results suggest that, generally, pH levels in Titicaca Basin soils are not high enough to prevent phytolith preservation.

Finally, phytoliths generally preserve in the archaeological record in proportion to their production (Piperno 2006a:104). In other words, paleoethnobotanists are more likely to recover higher counts of phytoliths from plants that produce more phytoliths, which can cause the over-representation or under-representation of plants in the archaeological record. Generally, plants in the Poaceae (grass) family, Marantaceae (arrowroot) family, and Cucurbitaceae (squash) family produce high abundances of phytoliths (Piperno 2006a:7)

At the time of recovery, the actions of archaeologists during and following excavations can impact the recoverability of phytoliths and starch grains. Frequent handling of artifacts, especially with bare hands, can remove microbotanical remains and expose artifacts to contamination (Fullagar 2006:191). Washing artifacts, especially with acidic or alkaline compounds, before paleoethnobotanical extractions can also harm, destroy, or remove microbotanical residues (Fullagar 2006:195). It is therefore preferable for archaeologists to isolate and set aside artifacts for paleoethnobotanical analysis and to carry out other forms of analysis on those artifacts once the paleoethnobotanical extractions have been completed.

6.2 Kala Uyuni

I analysed the sonicated washes of five Kala Uyuni samples. All Kala Uyuni ceramic sherds were washed before I completed paleoethnobotanical extractions, which may have removed phytoliths and starch grains from the artifacts. However, the artifacts were washed only in water, not with any alkaline or acidic compound (Andrew Roddick, personal communication 2017), which reduces the likelihood that microbotanical remains were damaged during this process. The artifacts' extended exposure to open air and oxygen post-excavation may have degraded starch grains. To increase the likelihood of recovering microbotanical residues from these samples, I analysed samples with the highest concentration of residue visible to the naked eye. Grass phytoliths and arboreal sphere phytoliths dominate this assemblage. Three of the samples also included starch grains, though I was unable to identify any of them due to their small size and/or damage.

			Phytolith Data														**Starch Data**				
Sample #	**Wash**	**# of Slides**	Poaceae conical	cf. Poaceae conical	Poaceae rondel	cf. Poaceae rondel	Poaceae square/rectangle	Poaceae lobbed	cf. Poaceae lobbed	Poaceae saddle	Nodular Sphere	cf. Nodular Sphere	Arboreal sphere	cf. Arboreal sphere	Unknown	**Total Phytoliths**	Unknown - small, round, 90◦ cross	Unknown - damaged	Unknown	**Total Starch Grains**	**Grand Total**
KU-9241-SER015-SW	Sonicated	2	0	1	0	0	0	1	1	1	2	2	1	0	0	**9**	6	0	0	**6**	**15**
KU-5040/5-SER021-SW	Sonicated	2	7	0	2	0	2	0	0	0	0	0	0	3	7	**21**	0	0	0	**0**	**21**
KU-5155-SER028-SW	Sonicated	1	0	1	0	1	0	0	0	0	0	0	1	0	0	**3**	0	0	1	**1**	**4**
KU-5318-SER039-SW	Sonicated	1	0	1	0	2	0	0	0	0	0	0	3	3	0	**9**	0	1	0	**1**	**10**
KU-7590/5-SER045-SW	Sonicated	2	1	1	0	0	0	0	2	0	0	0	0	4	2	**10**	0	0	0	**0**	**10**
Total		**8**	**8**	**4**	**2**	**3**	**2**	**1**	**3**	**1**	**2**	**2**	**5**	**10**	**9**	**52**	**6**	**1**	**1**	**8**	**60**

Table 6.1 Kala Uyuni botanical results

I analysed two slides from artifact KU-9241-SER015, which is a flat base sherd from ASD-9, a structure where cooking may have taken place. There were nine phytoliths and six starch grains on these slides. Poaceae grass phytolith (n=4) forms included conical (cf. n=1), lobed (n=1, cf. n=1), and saddle (n=1). Other phytoliths in this sample were nodular spheres (n=2, cf. n=2) and an arboreal sphere (n=1). The starch grains (n=6) from this sample were clustered together and all the same unknown form – spheres with a 90° extinction cross – and were clustered together. It is likely that these starch grains are all from the same plant, though, unfortunately, I was unable to identify the plants' family, genus, or species.

Artifact KU-5040/5-SER021is an almost complete bowl from ASD-2. I analysed two slides from the sample, which included 21 phytoliths and no starch grains. Most of the phytoliths were from Poaceae grasses (n=11), and their forms included conical (n=7), rondel (n=2), and square/rectangle (n=2). The sample also included cf. arboreal spheres (n=3) and unknown phytoliths (n=7). Artifact KU-5155-SER028, a body sherd with a heavy encrustation of interior carbonization, is also from ASD-2. I analysed one slide from this sample, on which there were three phytoliths and one starch grain. Two phytoliths were from Poaceae grasses – conical (cf. n=1) and rondel (cf. n=1) – and one was an arboreal sphere. The starch grain was unidentifiable, with a large Y-shaped fissure that may have been accentuated due to damage.

I analysed one slide from artifact KU-5318-SER039, an annular base with interior carbonization from event B91 the high density midden. The slide included nine phytoliths and one starch grain. Poaceae grass phytoliths (n=3) on this slide were conical (cf. n=1), and rondel (cf. n=2) forms. There was also a relatively high concentration of arboreal spheres (n=3, cf. n=3). As discussed in Chapter 5, this sherd's form and carbonization patterns indicate that it was used to burn offerings. The high concentration of arboreal spheres in this sample suggests that people may have used wood as fuel to burn offerings. The starch grain on this slide was ovate to round but unidentifiable due to damage consistent with boiling. The extinction cross on this starch grain was not visible.

The final artifact from Kala Uyuni that I analysed was KU-7590/5-SER045, a flat base from an interior occupation surface of ASD-5. I analysed two slides from this artifact, on which I recovered phytoliths (n=10) and no starch grains. Pocaeae grass phytolith (n=4) forms from this sample include conical (n=1, cf. n=1), and lobed (cf. n=2). Other phytoliths are arboreal sphere (cf. n=4), and unidentifiable (n=2).

Overall, the Kala Uyuni samples had low densities of plant remains. All identifiable plant remains from these samples are Poaceae grasses and arboreal spheres; it is unlikely that any of these are food remains. As mentioned above, if soil pH levels at Kala Uyuni should not prevent the preservation of microbotanical remains. While the low density of phytoliths and starch grains is likely due, at least in part, to the fact that the sherds were washed prior to paleoethnobotanical extractions, there may also be other causes for the paucity of microbotanical remains in these samples. First, it is possible that none of the analysed vessels were used for food storage, preparation, or consumption. It is also possible that food processing techniques damaged or destroyed starch grains representative of food remains. The few starch grains that were recovered in this sample were damaged, which suggests it is possible that most food starch grains were damaged during food processing and therefore degraded following the vessels' discard. The arboreal phytoliths in this assemblage could also indicate that the vessels came into contact with wood fires, possibly during cooking or burning activities. This could account, at least in part, for the low number of starch grains given that starch grains are susceptible to heat damage and are more likely to degrade once they have been damaged. However, it would not explain the low counts of phytoliths because phytoliths can withstand high temperatures. Low phytolith counts could be attributed to the fact that plant parts that produce phytoliths, such as maize leaves and cupules, are generally discarded rather than eaten and are therefore less likely to be recovered in ceramic vessels. Finally, it is possible that people washed these vessels between uses, wiping away food remains.

6.3 Challapata

Samples from the first two analysed Challapata sherds – OQP-16-SER001 and OQP-15-SER002 – had very few phytoliths and starch grains. To enable the recovery of higher counts of microbotanical remains from subsequent Challapata samples, I completed heavy liquid flotation on select samples from the remaining Challapata samples (table in methods chapter). I did not complete heavy liquid flotation on samples that had very low volumes of residue. I analysed two slides from all samples that did not undergo heavy liquid flotation, and one slide from all samples that did. Overall, the heavy liquid flotation was very beneficial, with floated samples having higher densities of phytoliths and starch grains.

I analysed two slides for each wash from the body sherd OQP-16-SER001, all of which had relatively low counts of microbotanical remains and were dominated by Poaceae grasses. The majority of sonicated wash (SW) microbotanical remains were Poaceae grass phytoliths (83% n=9). Their forms were simple (n=2), conical (n=3), and rondel (n=4). The sample also included a nodular sphere phytolith (n=1) and an unknown starch grain (n=1). Poaceae grass phytoliths dominated the wet wash (WW) (88% n=15). Forms included conical (n=2, cf. n=1), rondel (n=6, cf. n=1), square/rectangle (n=1), and lobed (n=4). The only other phytoliths were unknown (n=3). There were no starch grains in this sample. The dry wash (DW) contained the fewest microbotanical remains of the washes. Seventy-one percent of the sample (n=5) was Poaceae grass phytoliths, including simple (n=1), square/rectangle (n=3), and lobed (n=1). Other phytoliths in the sample were nodular spheres (n=2).

Samples from artifact OQP-15-SER002, the rim of a possible bowl, also had fairly low counts of microbotanical remains. I analysed two slides from each wash. The sonicated wash included grass phytoliths (n=5) and a nodular sphere phytolith (n=1). Grass forms included conical (n=2), rondel (n=1, cf. n=1), and lobed (n=1). In the wet wash, Poaceae grass phytoliths (92% n=23) forms included conical (n=1), rondel (n=14), square/rectangle (n=5), and lobed (n=2, cf. n=1). The WW also included a cf. *zea mays* narrow elongate rondel (n=1), and an unknown starch grain (n=1). The dry wash only included grass phytoliths (n=5), all of which were rondels (n=3, cf. n=2).

			Phytolith Data																										Starch Data										
Sample #	**Wash**	**# of Slides**	*Zea mays* Narrow elongate rondel	cf. *Zea mays* Narrow elongate rondel	Poaceae simple	Poaceae conical	cf. Poaceae conical	Poaceae rondel	cf. Poaceae rondel	Poaceae square/rectangle	cf. Poaceae square/rectangle	Poaceae lobed	cf. Poaceae lobed	Poaceae saddle	cf. Poaceae saddle	Poaceae other	Nodular sphere	cf. Nodular sphere	Arboreal sphere	cf. Arboreal sphere	cf. Fabaeceae hooked	UNKN rectangle with curved end	Unknown rectangle	Unknown lobed	Unknown sinuous base	Unknown sphere	Unknown	**Total Phytoliths**	cf. *Ullucus tuberosus* ovate	*Ipomoea batatas* polygonal	cf. *Ipomoea batatas* polygonal	cf. *Manihot esculenta* bell	*Maranta arundinacea* ovular, dented	cf. *Zea mays* blocky	cf. *Zea mays* smooth sphere	Unknown damaged blocky sphere	Unknown	**Total Starch Grains**	**Grand Total**
OQP-16-SER001-SW	Sonicated	2	0	0	2	3	0	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	1	**1**	**11**
OQP-16-SER001-WW	Wet	2	0	0	0	2	1	6	1	1	0	4	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	**18**	0	0	0	0	0	0	0	0	0	**0**	**18**
OQP-16-SER001-DW	Dry	2	0	0	1	0	0	0	0	3	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	**7**	0	0	0	0	0	0	0	0	0	**0**	**7**
OQP-15-SER002-SW	Sonicated	2	0	0	0	2	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**6**	0	0	0	0	0	0	0	0	0	**0**	**6**
OQP-15-SER002-WW	Wet	2	0	1	0	1	0	14	0	5	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**24**	0	0	0	0	0	0	0	1	0	**1**	**25**
OQP-15-SER002-DW	Dry	2	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**	0	0	0	0	0	0	0	0	0	**0**	**5**
OQP-15-SER003-SW	Sonicated	2	0	0	2	1	0	4	0	0	0	1	0	0	0	0	1	1	0	0	0	0	2	0	0	0	0	**12**	0	0	0	0	0	0	0	0	0	**0**	**12**
OQP-15-SER003-WW	Wet	2	0	0	0	3	0	2	2	2	1	1	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	**15**	0	0	0	1	0	0	0	0	0	**1**	**16**
OQP-15-SER003-DW	Dry	1	0	2	0	7	0	27	0	4	0	16	0	0	0	0	0	0	0	2	0	1	6	0	0	0	3	**68**	0	0	0	0	0	0	0	0	0	**0**	**68**
OQP-16-SER004-SW	Sonicated	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	**3**	0	0	0	0	0	0	0	0	0	**0**	**3**
OQP-16-SER004-WW	Wet	1	1	0	0	8	0	40	9	8	1	6	1	1	0	0	0	0	3	4	0	2	2	0	1	0	7	**94**	0	0	0	0	1	0	0	0	0	**1**	**95**
OQP-16-SER004-DW	Dry	1	0	0	2	9	4	22	8	12	0	8	0	0	1	0	0	0	2	0	2	0	0	3	6	0	9	**88**	0	0	0	0	0	0	0	0	0	**0**	**88**
OQP-4-SER005-SW	Sonicated	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**
OQP-4-SER005-WW	Wet	2	0	0	2	0	0	4	0	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	1	0	0	**1**	**11**
OQP-4-SER005-DW	Dry	1	0	0	0	4	0	13	2	6	0	3	1	0	0	0	0	0	0	1	0	0	0	3	0	1	2	**36**	0	1	1	0	0	0	0	0	0	**2**	**38**
OQP-17-SER006-SW	Sonicated	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	0	0	0	**7**	0	0	0	0	0	0	0	0	0	**0**	**7**
OQP-17-SER006-WW	Wet	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**
OQP-17-SER006-DW	Dry	1	0	0	1	8	3	34	5	16	2	12	2	1	0	0	0	0	0	0	0	0	1	0	7	0	8	**100**	0	0	0	0	0	0	0	0	0	**0**	**100**
OQP-3-SER007-SW	Sonicated	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	**0**	**0**
OQP-3-SER007-WW	Wet	2	0	0	0	0	0	3	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**6**	1	0	0	0	0	0	0	0	0	**1**	**7**
OQP-3-SER007-DW	Dry	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	3	0	**5**	0	0	0	0	0	1	0	0	0	**1**	**6**
Total		**33**	**1**	**3**	**10**	**48**	**8**	**178**	**30**	**60**	**4**	**56**	**6**	**2**	**1**	**2**	**5**	**2**	**12**	**11**	**3**	**3**	**15**	**6**	**15**	**4**	**29**	**514**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**9**	**523**

Table 6.2 Challapata botanical results

I analysed two slides from the SW and the WW, and one slide from the DW from the body sherd OQP-15-SER003. The SW had low counts of phytoliths (n=12) and no starch grains. Grass phytolith forms included simple (n=2), conical (n=1), rondel (n=4), and lobed (n=1). Other phytoliths in this sample were nodular spheres (n=1, cf. n=1) and an unknown rectangle form (n=2). Grasses also dominated the WW (66% n=11), and included conical (cf. n=3), rondel (n=2, cf. n=2), square/rectangle (n=2, cf. n=1), and lobed (n=1). Other phytoliths in this sample were a nodular sphere (cf. n=1), a hooked form identified as likely representing the Fabaceae family (n=1), and unknown phytoliths (n=2). The sample included a single starch grain, identified as cf. *Manihot esculenta* (manioc) (Figure 6.1 i, j). I identified this starch grain as potential manioc based on its morphology: it is semi-spherical with two distinct pressure facets at the base. At 10 μm long, it is at the smaller end of manioc starch grain size range. The starch grain also exhibited damage consistent with milling, including an enlarged circular fissure and an obscured extinction cross (Chandler-Ezell et al. 2006:109-110). The DW had significantly higher counts of phytoliths than either the SW or the WW, though it did not include any starch grains. Seventy-nine percent of phytoliths in the DW were grasses (n=54). Grass phytolith forms were conical (n=7), rondel (n=27), square/rectangle (n=4), and lobed (n=16). The sample also included cf. *Zea mays* narrow elongate rondels (n=2) (Figure 6.1 s, t), cf. arboreal spheres (n=2), and unknown phytoliths (n=10).

I analysed one slide for each wash of artifact OQP-16-SER004, the rim of a necked vessel. The SW had only three phytoliths and no starch grains. The phytoliths were a Poaceae grass rondel (n=1) and arboreal spheres (n=2). The WW contained much higher counts of phytoliths as well as a starch grain. Poaceae grass phytoliths (78% n=74) included conical (n=8), rondel (n=40, cf. n=9), square/rectangle (n=8, cf. n=1), lobed (n=6, cf. n=1), and saddle (n=1). Other phytoliths were a *Zea mays* (maize) narrow elongate rondel (n=1), arboreal spheres (n=3, cf. n=4), and unknown forms (n=12). There was a single starch grain in the WW sample, identified as *Maranta arundinacea* (arrowroot) (Figure 6.1 g, h). This starch grain was lenticular with an eccentric hilum and a distinct linear fissure. It was roughly 10 μm long. While the lamellae on this starch grain were not as distinct as is typical of arrowroot starch grains, its general morphology was consistent with arrowroot. The DW had high counts of phytoliths and was dominated by gasses (78% n=66). Grass phytolith forms include simple (n=2), conical (n=9, cf. n=4), rondel (n=22, cf. n=8), square/rectangle (n=12), lobed (n=8), and saddle (cf. n=1). Other phytoliths in the sample were arboreal spheres (n=2), the cf. Fabaeceae hooked form (n=2), and unknown forms (n=18).

I analysed two slides for the SW and WW, and one slide for the DW of artifact OQP-4-SER005, which was a body sherd. The SW did not contain any phytoliths or starch grains. Phytoliths from the WW were all grasses (n=10), and included simple (n=2), rondel (n=4), square/rectangle (n=1), lobed (n=1) and other (n=2). The WW also had a cf. *Zea mays* starch grain (n=1) (Figure 6.1 c, d). This was a smooth, spherical starch grain with a crisp 90° extinction cross and a roughly 10 μm diameter. At its center, the starch grain had a star-shaped fissure, damage that is consistent with roasting (Babot 2003:72-73). Though all the starch grain's features are consistent with maize, it would not rotate on the slide so I was unable to ascertain its 3-dimensional morphology. I therefore identified it as probable maize. The DW had higher counts of microbotanicals and greater richness of taxa, though grass phytoliths nonetheless dominate the sample (67% n=29), at seventy-six percent. Grass phytolith forms in this sampled include conical (n=4), rondel (n=13, cf. n=2), square/rectangle (n=6), and lobed (n=3, cf. n=1). Other phytoliths in the DW were a single cf. arboreal sphere, and unknown forms (n=6). This sample also included *Ipomoea batatas* (sweet potato) starch grains (n=1, cf. n=1). The first starch grain (Figure 6.1 e, f), which I securely identify as sweet potato, had distinct pressure facets and ridges, which were especially visible when rotating the starch grain. The second, which I tentatively identify as sweet potato also had pressure facets, though its ridges were less distinctive. The extinction crosses of both of these starch grains were right-angled and, though their arms were not thicker at the starches' edges (Reichart 1913:884), they strongly resemble the right-angled extinction crosses of the sweet potato starch grains I studied in the MPERF's reference collection (Figure 4.3).

I analysed two slides from the SW and one slide from the WW and DW of artifact OQP-17-SER006, the artifact that was likely not a sherd but a clump of clay. The SW contained seven phytoliths, which I identified as arboreal spheres (n=4, cf. n=3). The WW did not contain any phytoliths or starch grains. The DW contained high counts of phytoliths (n=100) but no starch grains. Poaceae grass phytoliths dominate the DW (84% n=84) and included simple (n=1), conical (n=8, cf. n=3), rondel (n=34, cf. n=5), square/rectangle (n=16, cf. n=2), lobed (n=12, cf. n=2), and saddle (n=1). The remaining phytoliths in this sample were unknown forms (n=16).

I analysed one slide from the SW and the DW, and two slides from the WW of artifact OQP-3-SER007. The SW did not contain any phytoliths or starch grains. The WW contained grass phytoliths (n=6), in the forms of rondel (n=3), square/rectangle (n=2), and lobed (cf. n=1). It also contained a cf. *Ullucus tuberosus* (ulluco) starch grain (n=1) (Figure 6.1 k, j). At 9 μm by 7 μm, this starch grain falls just outside the range that Logan (2006:55) identifies for ulluco starch grains (13x8μm to 45x23 μm). However, the starch grain's ovular shape, linear fissure, and narrow extinction cross with bent arms are all consistent with ulluco. The WW for this sample also had relatively low counts of microbotanicals and did not contain any grasses. Phytoliths in this sample were arboreal spheres (n=1, cf. n=1), and unknown forms (n=3). The sample also included a cf. *Zea mays* starch grain (n=1) (Figure 6.1 a, b). This starch grain was blocky and slightly faceted, with the diagnostic crisp right-angled extinction cross. Its hilum was central, with a small linear fissure that could be indicative of dehydration (Babot 2003:72).

Overall, SW samples from the Challapata assemblage had lower densities of microbotanical remains and lower richness of represented taxa. Interestingly, no remains associated with food were identified in any of the sonicated wash samples. This could be attributed to the types of Challapata sherds that I had access to. The three diagnostic sherds that I sampled included two rims and one handle, areas of a pot that are least likely to accumulate plant residue associated with use.

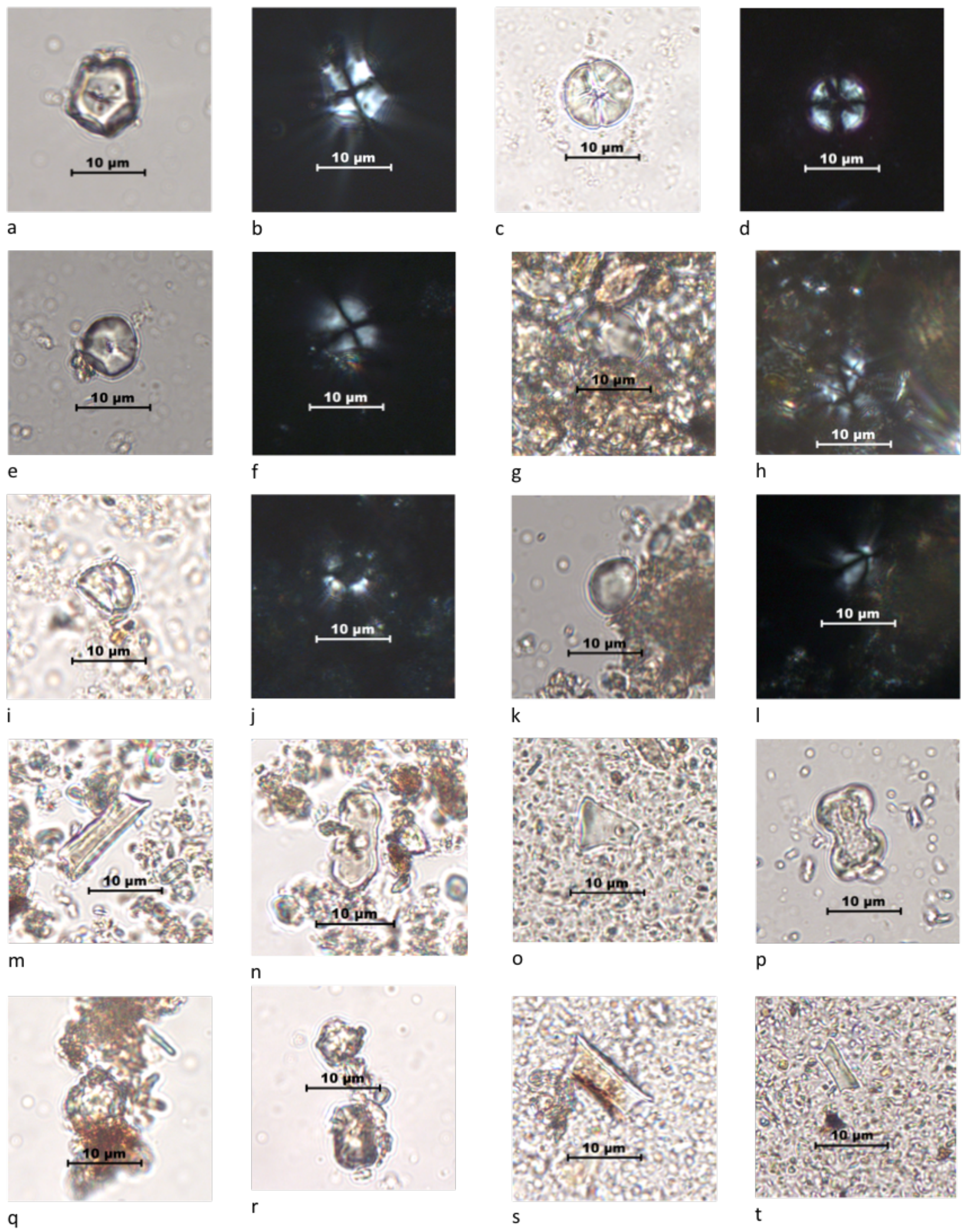

Figure 6.1 Microbotanical remains from Challapata sherds. a) Zea mays starch grain from OQP-3-SER007-DW; b) under polarized light; c) cf. Zea mays starch grain from OQP-4-SER005-WW; d) under polarized light; e) Ipomoea batatas starch grain from OQP-4-SER005-DW; f) under polarized light; g) *Maranta arundinacea* starch grain from OQP-16-SER004-WW; h) under polarized light; i) cf. *Manihot esculenta* starch grain from OQP-15-SER003-WW; j) under polarized light; k) cf. *Ullucus tuberosus* starch grain from OQP-3-SER007-WW; l) under polarized light; m) Poaceae narrow elongate rondel confuser from OQP-4-SER005-WW; n) view of base; o) Poaceae conical phytolith from OQP-15-SER003-DW; p) Poaceae lobed phytolith from OQP-16-SER004-DW; q and r) arboreal spheres from OQP-17-SER006-SW; s and t) cf. *Zea mays* narrow elongate rondels from OQP-15-SER003-DW

This assemblage, however, included several plants that cannot be cultivated at the high elevations of the Lake Titicaca Basin: *Ipomoea batatas* (sweet potato), *Manihot esculenta* (manioc), and *Maranta arundinacae* (arrowroot). As will be discussed in Chapter 7, this suggests likely trade relationships between communities in the eastern Lake Titicaca basin, and communities in the lowland valleys to the east of the basin as early as the Late Formative period. The *Zea mays* (maize) in this assemblage could have been grown in the Lake Titicaca basin or have been acquired from the eastern valleys. Highland plants are also represented in this assemblage by an *Ullucus tuberosus* (ullucu) starch grain.

6.4 Chiripa

I analysed paleoethnobotanical samples from three of the five artifacts from the Chiripa burial: the wide open mouth *vasija*, CH-SER005; the bowl, CH-SER006; and the llama effigy vasija, CH-SER008. As with the other two assemblages, Poaceae grass phytoliths were dominant. The samples also contained starch grains that likely represent prepared food.

			Phytolith Data																			Starch Data						
Sample #	**Wash**	**# of Slides**	cf. *Zea mays* Narrow elongate rondel	Poaceae simple	Poaceae conical	cf. Poaceae conical	Poaceae rondel	cf. Poaceae rondel	Poaceae square/rectangle	cf. Poaceae square/rectangle	Poaceae lobed	cf. Poaceae lobed	Poaceae saddle	cf. Poaceae saddle	Panicoid sphere	Nodular sphere	cf. Nodular sphere	UNKW rectangular with curved end	Unknown lobed	Unidentifiable	**Total Phytoliths**	cf. *Manihot esculenta* bell	cf. *Zea mays* blocky	*Solanum tuberosum* ovate	cf. *Solanum tuberosum*	Unidentifiable	**Total Starch Grains**	**Grand Total**
CH-SER005-SW	Sonicated	2	0	0	6	2	21	7	5	0	6	2	0	0	0	1	1	0	0	6	**57**	0	0	1	0	0	**1**	**58**
CH-SER005-DW	Dry	4	0	2	2	2	9	7	2	1	9	1	0	2	3	2	2	0	0	6	**50**	0	0	0	1	0	**1**	**51**
CH-SER006-SW	Sonicated	2	0	4	1	0	5	4	1	2	6	4	0	0	0	0	0	0	0	6	**33**	2	0	0	0	5	**7**	**40**
CH-SER006-	Dry	1	3	2	2	1	28	6	6	1	40	8	1	0	0	0	0	3	0	4	**105**	0	0	0	0	0	**0**	**105**
CH-SER008-SW	Sonicated	2	0	1	0	2	4	2	2	2	1	4	0	0	0	0	2	0	1	0	**21**	0	1	0	0	2	**3**	**24**
Total		**11**	**3**	**9**	**11**	**7**	**67**	**26**	**16**	**6**	**62**	**19**	**1**	**2**	**3**	**3**	**5**	**3**	**1**	**22**	**266**	**2**	**1**	**1**	**1**	**7**	**12**	**278**

Table 6.3 Chiripa botanical results

I analysed two slides from the sonicated wash (SW) and four from the dry wash (DW) of artifact CH-SER005, the wide jar. Poaceae grass phytoliths dominate the SW sample as well (85% n=49). Forms included conical (n=6, cf. n=2), rondel (n=21; cf. n=7), square/rectangle (n=5), and lobed (n=6, cf. n=2). Other microbotanical remains included nodular sphere phytoliths (n=1, cf. n=1), unknown phytoliths (n=6), and a *Solanum tuberosum* (potato) starch grain (n=1) (Figure 6.2 e, f). This starch grain was ovate and round when rotated, with pronounced lamellae that are diagnostic to *Solanum tuberosum*. It measured 16 μm by 12 μm, which is smaller that typical *Solanum* starch grains (Logan 2006:55), but morphology otherwise its morphology is consistent with potato. It had some damage in the form of a linear fissure, some erosion at its edges, and a bent extinction cross arm. The fissure and extinction cross damage are consistent with *chuño* processing or milling (Babot 2003:74-78). I added a quarter teaspoon of hydrogen peroxide to two DW slides before mounting them to disperse the sediment and facilitate detection and identification of phytoliths and starch grains (Pearsall 2015:282). The DW contained high counts of Poaceae grass phytoliths (78% n=40). Forms included simple (n=2), conical (n=2; cf. n=2), rondel (n=9; c.f n=7), square/rectangular (n=2, cf. n=1), lobed (n=9, cf. n=1), saddle (cf. n=2), and spheres that are diagnostic to the panicoid subfamily (n=3). Other phytoliths from this sample include nodular spheres (n=2, cf. n=2), and unknown phytoliths (n=6). The DW sample also included a single starch grain that I identified as cf. *Solanum tuberosum* (potato) (Figure 6.2 g, h). This starch grain was ovular and round when rotated with a narrow and straight-armed extinction cross. Its lamellae were visible, though finer than is typical of potato starch grains, which can be indicative of dehydration (Babot 2003:72). This starch grain was smaller than is typical of potato starches, at 12 μm by 10 μm. The starch grain had some small fissures at its edges, damage consistent with *chuño* production or milling.

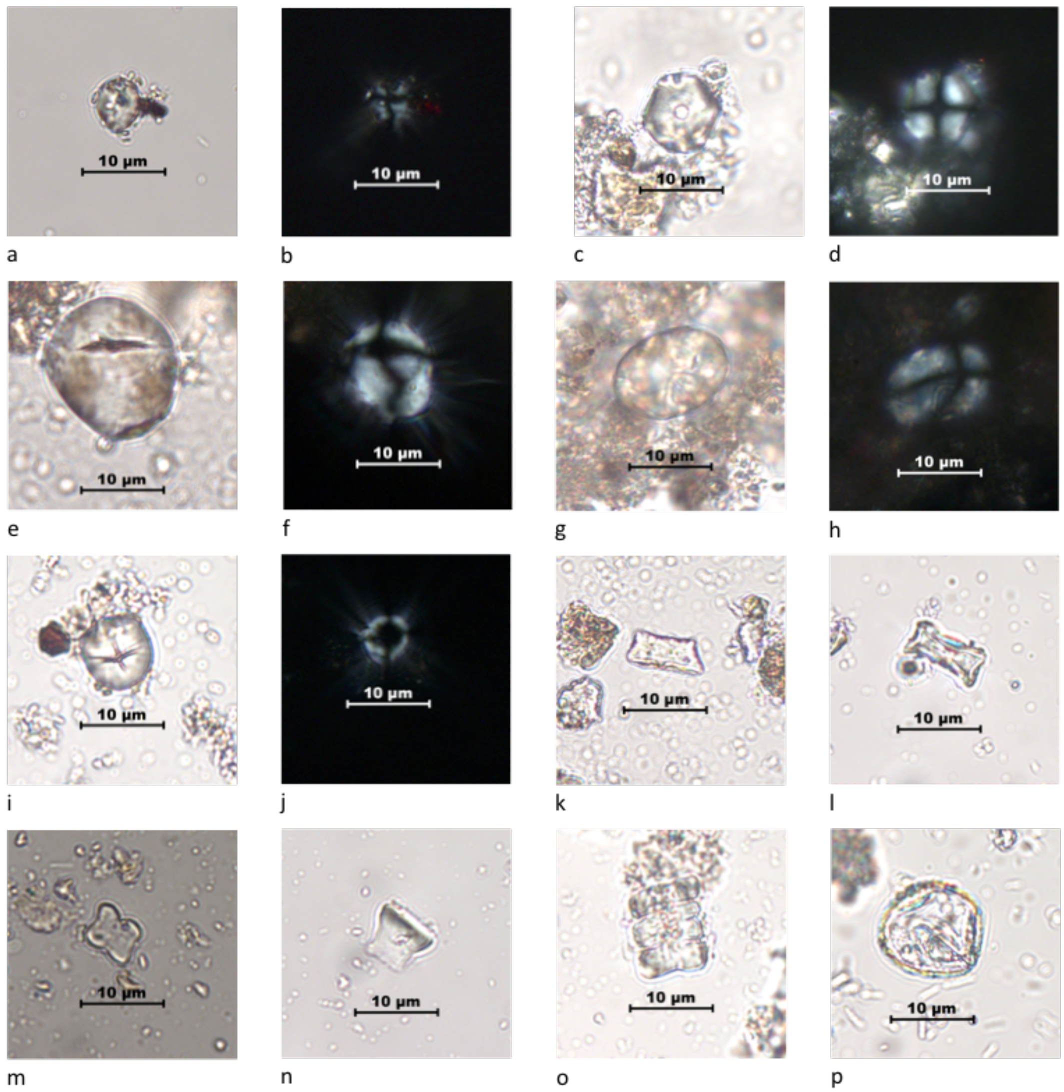

Figure 6.2 Microbotanical remains from Kala Uyuni and Chiripa sherds: a) unidentifiable damaged starch grain from KU-5318-SER039-SW; b) under polarized light; c) cf.Zea mays starch grain from CH-SER008-SW; d) under polarized light; e) *Solanum tuberosum* starch grain from CH-SER005-SW; f) under polarized light; g) cf. *Solanum tuberosum* starch grain from CH-SER005-DW; h) under polarized light; i) cf. *Manihot esculenta* starch grain from CH-SER006-SW; j) under polarized light; k) cf. *Zea mays* narrow elongate rondel from CH-SER006-DW; l) Poaceae rondel from CH-SER005-DW; m) Poaceae lobed from CH-SER005-SW; n) Poaceae rondel from CH-SER005-SW; o) cf. Poaceae rondels from CH-SER008-SW; p) Panicoid sphere from CH-SER005-DW

I analysed one slide from the DW and two from the SW from the *cuenco*, artifact CH-SER006. Grass phytoliths dominate the SW (67% n=27) and forms include simple (n=4), conical (n=1), rondel (n=5, cf. n=4), square/rectangle (n=1, cf. n=2), and lobed (n=6, cf. n=4). The sample also included unknown phytoliths (n=6), cf. *Manihot esculenta* (manioc) starch grains (n=2), and unidentifiable starch grains (n=5). There was a high count of Poaceae grass phytoliths in the DW (90% n=95). Poaceae forms in this sample included simple (n=2), conical (n=2, cf. n=1), rondel (n=28, cf. n=6), square/rectangle (n=6, cf. n=1), lobed (n=40, cf. n=8), and saddle (n=1). The DW sample also included cf. *Zea mays* (maize) (n=3), and unknown phytoliths (n=7). There were no starch grains recorded for the DW.

The first manioc starch grain (Figure 6.2 i, j) has several characteristics consistent with manioc, including its bell-like shape, distinct basal pressure facets, and central X-shaped fissure. The extinction cross is damaged, which could be indication of grinding or soaking (Chandler-Ezell et al. 2006:109-110). I consulted with Dr. Neil Duncan (University of Central Florida) to identify this starch grain and he commented that its morphology and small size (9 μm by 8 μm) are also consistent *Pouteria lucuma* (lucuma) starch grains (personal communication 2017). However, I also consulted with Dr. Christine Hastorf (University of California Berkley), who commented that manioc was a much more likely import to the Titicaca Basin than lucuma (personal communication 2017). This starch grain also has some morphological consistency with damaged maize starch grains (Neil Duncan personal communication 2017). Based on these exchanges and on my work with the McMaster Paleoethnobotany Research Facility's reference collection, I identify this starch grain as probably manioc. The second cf. manioc starch grain in this sample was bell-shaped with distinct pressure facets. However, the starch grain would not rotate on the slide and I was unable to ascertain 3-D morphology. A final starch grain in this sample, classified as unidentifiable, had some traits consistent with *Manihot*, including the distinctive pressure facets. However, the starch grain's general morphology (semi-spherical and semi-flat) and some potential damage prevent me from identifying the starch grain as *Manihot*.

There was a high count of Poaceae grass phytoliths in the DW of CH-SER006 (90% n=95). Poaceae forms in this sample included simple (n=2), conical (n=2, cf. n=1), rondel (n=28, cf. n=6), square/rectangle (n=6, cf. n=1), lobed (n=40, cf. n=8), and saddle (n=1). This sample also included cf. *Zea mays* (maize) (n=3), and unknown phytoliths (n=7). There were no starch grains recorded for the DW.

I analysed two slides from of the SW of the llama effigy *vasija* CH-SER008, but no slides from the artifact's DW. Poaceae grass (75% n=18) forms included simple (n=4), conical (cf. n=2), rondel (n=4, cf. n=2), square/rectangle (n=2, cf. n=2), and lobed (n=1, cf. n=4). The sample also included cf. nodular sphere phytoliths (n=2), unknown phytoliths (n=1), cf. *Zea mays* starch grain (n=1), and unidentifiable starch grains (n=2). The maize starch grain (Figure 6.2 c, d) was blocky and faceted, with a right-angled extinction cross. There was a circular hole at the hilum of this starch grain, which could indicate either dehydration or milling (Babot 2003:76-78).

Samples from each of the analyzed artifacts at Chiripa contained likely food remains: potato, ullucu, maize, and manioc. Several of these plant remains were identified in SW samples, which indicates they were associated with vessel use. I propose that food and/or drink may have been placed in these vessels as offerings prior to their interment in the burial. Potatoes have been recorded in offering contexts at the Akapana in Tiwanaku IV/V phases, and maize, generally in the form of *chicha*, is known to have been an important part of ritual during this time (Wright et al. 2003). The maize starch grain's location in the llama effigy *vasija* could indicate that *chicha* included in the offering because *vasijas* were often used to serve liquids. Manioc, which cannot be grown in the Lake Titicaca basin, may have been a valuable addition to the offering as a non-local good.

The potato starch grains in these samples were both relatively undamaged, which could indicate that they underwent minimal processing. Babot (2003:74) observes that larger potato starch grains are more susceptible to damage that smaller ones. It is therefore also possible that the small size of the starch grains in this sample account for their relative lack of damage. Figure 6.2 e-h shows photos of the *Solanum tuberosum* starch grains from artifact CH-SER005, while figure 6.3 is a photo of a damaged tuber starch grain recovered by Logan (2006). The starch grains from CH-SER005 are in significantly better condition than the one that Logan (2006) recovered. As previously mentioned, in an experimental study of starch grain preservation, Williamson (2006) found that when whole plants are placed in artifacts, their starch grains are more likely to adhere to the artifact than when small pieces of plants are placed in artifacts. It is possible that the tubers in the *vasija* CH-SER005 were placed in the artifact whole and unprocessed. The food remains in these vessels suggest that people may have included foods in the offering as a way to feed the dead, a practice which has been recorded at Wari sites, in Inca times, and ethnographically in modern Andean communities (Allen 2002 [1988]:41; Hastorf 2003b:547).

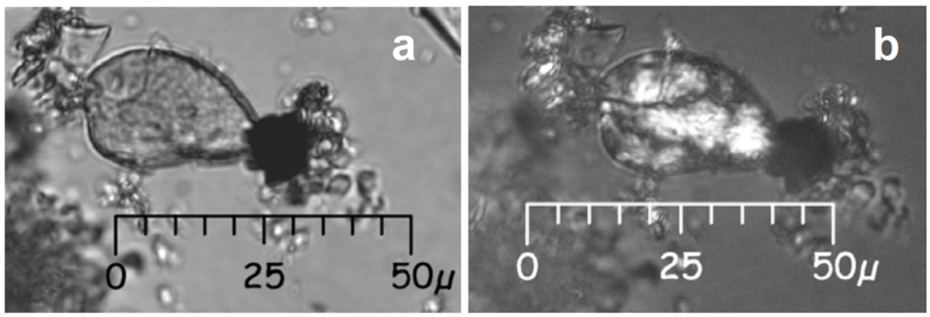

Figure 6.3 Damaged unidentifiable tuber starch grain from Logan (2006:57)

6.5 Discussion

There are several trends in my results that occur across the three assemblages. First, Poaceae grasses are overwhelmingly dominant across most washes of each analysed artifact. Below, I will consider whether these phytoliths may have entered the archaeological record incidentally or due to deliberate human actions. Second, *Zea mays* occurs in relatively low quantities in all three assemblages. Given the importance of maize in Andean foodways in general and at Tiwanaku specifically (discussed in Chapter 3), this pattern is surprising. While this could mean that maize was not consumed in high densities at these sites, it could also be an indication of the kinds of activities that took place in the contexts that I sampled from, or an indicator of processing techniques that obliterated maize starch grains. Finally, the presence of lowland plants at Late Formative Challapata and in the Tiwanaku IV/V vessels at Chiripa suggest the circulation and possible exchange of goods between lowland communities and highland Titicaca Basin communities. I will address this final point in Chapter 6, when I consider both plant and ceramic data.

6.5.1 Where did the grass come from?

Poaceae grass phytoliths dominate in all three assemblages, comprising 40% of microbotanical remains at Kala Uyuni, 77% at Challapata, and 83% at Chiripa. Because paleoenvironment was not the focus of this thesis, I did not identify Poaceae phytoliths as forms specific enough for subfamily, genus, or species identification. However, the higher density of rondel phytoliths (Figure 6.4) across the assemblages suggests that festucoid (pooid) grasses, which are generally associated with high elevations, were most common at these sites they produce higher counts of rondel based grass phytoliths (Piperno 2006a:28; Twiss et al. 1969). Square and rectangle based phytoliths are also associated with the festucoid subfamily. The panicoid subfamily, generally tall tropical grasses, is represented in the three panicoid spheres from Chiripa, and possibly by the high count of lobed phytoliths (Piperno 2006a:28).

There are several possibilities that could explain the high density of grasses across these three assemblages. The first, possibly most obvious, is that grasses were present at all three of these sites. Poaceae plants produce a high number of very durable and diagnostic phytoliths (Piperno 2006a) and it is therefore not surprising that they would be abundant in the archaeological record. However, as Piperno (2006a:21) notes, while it is possible for phytoliths representing plants that people did not use to appear in the archaeological record, these generally form a small percent of the microbotanical assemblage. Analysing soil samples from areas outside of occupation and activity could shed light on whether grass phytoliths are present in higher densities in occupation areas.

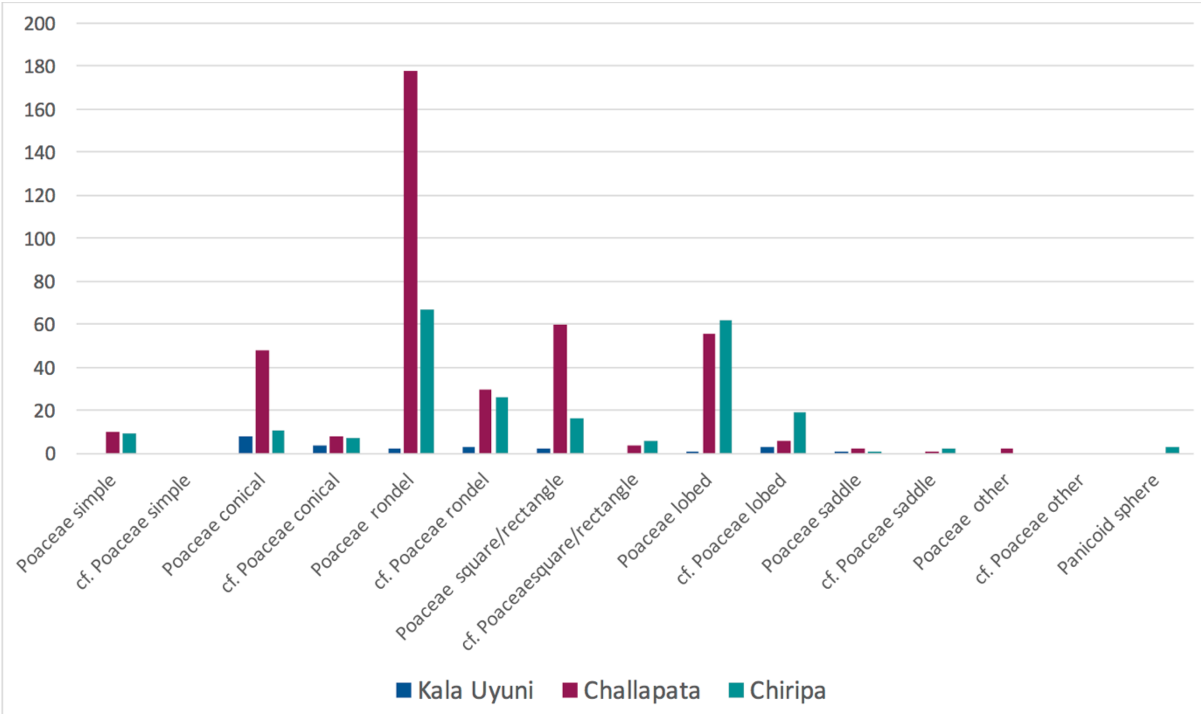

Figure 6.4 Number of Poaceae phytoliths of each form identified at each site

It is possible that people deliberately used grasses at Kala Uyuni, Challapata, and Chiripa in a number of ways. Poaceae phytoliths in these assemblages may be the remains of fuel. Bruno (2008:211-212) finds that straw, wood, and dung are the most common fuels in modern hearths and ceramic fires on the Taraco peninsula and it is likely that past communities used these fuel sources as well. People collect wild species of grass to use as kindling in fires, while wood and dung burn for longer periods. Poaceae phytoliths could have entered the archaeological record through the use of these grasses as kindling. The phytoliths could also represent dung of grazing animals that consumed the grass, such as camelids. It is most likely that the DW and WW samples contain Poaceae phytoliths representing fuel. It is also possible that Poaceae phytoliths in SW samples are the remains of fuel used burn offerings in the vessels. However, Bruno (2008:211) notes that external fuel sources were likely unnecessary in the case of burned offerings because the offerings themselves could act as fuel. Grasses may also have been used for other purposes, such as to wrap offerings that were placed in vessels. The presence of arboreal spheres some some analysed samples could also represent the use of wood as fuel.

Poaceae phytoliths in the SW could also represent grasses that potters used to temper pastes, or may represent grasses growing and depositing in areas of clay collection. I will return to consider this possibility, specifically the correlation between fiber tempered pastes and the density of Poaceae grass phytoliths in Chapter 7.

6.5.2 Where is the Maize?

Table 6.4 presents the contexts from which maize was recovered in these assemblages. Though I did not identify maize in any Kala Uyuni samples, there is evidence that maize was present at Late Formative Kala Uyuni. Logan (2006:106) identified maize phytoliths in soil samples from events B12 (floor in ASD-2), B22 (clay lens in ASD-2), and B91 (high density midden), and Bruno (2008:440) identified two maize kernels in event B48 (pit fill). The earliest evidence for maize on the Taraco Peninsula is in Middle Formative period ritual contexts at Kala Uyuni and Chiripa (Logan et al. 2012). Logan and colleagues (2012) argue that maize was likely served as *chicha* during rituals at this time. In Tiwanaku phases, maize remained ritually important as feasts involving *chicha* were an important part of Tiwanaku statecraft (Goldstein 2003).

		Phytoliths		**Starches**	
Sample #	**Wash**	*Zea mays* Narrow elongate rondel	cf. *Zea mays* Narrow elongate rondel	cf. *Zea mays* blocky	cf. *Zea mays* smooth sphere
Challapata					
OQP-15-SER002-WW	Wet		1		
OQP-15-SER003-DW	Dry		2		
OQP-16-SER004-WW	Wet	1			
OQP-4-SER005-WW	Wet				1
OQP-3-SER007-DW	Dry			1	
Chiripa					
CH-B-SER006-DW	Dry		3		
CH-B-SER008-SW	Sonicated			1	

Table 6.4 Maize phytoliths and starch grains across the assemblages

I only recovered maize in non-domestic, possibly ritual contexts: on the Oqo Qoya Pata mound at Challapata and in the burial at Chiripa. However, non-domestic and possibly ritual contexts are also the only contexts in which I recovered any food remains. Evidence for maize recorded in this thesis therefore suggests that maize was part of specialized activities in the eastern Titicaca Basin, and supports the argument that it had ritual significance in the southern Basin during Tiwanaku phases.

I recovered maize starch grains, which are produced in the plant's kernels, and maize narrow elongate rondel phytoliths, which are produced in cupules. These microremains were recovered from the WW samples of a potential bowl (OQP-16-SER002), a potential necked vessel (OQP-16-SER004), and from a body sherd (OQP-4-SER005) as well as from the DW associated with body sherds (OQP-15-SER003, OQP-3-

SER007) at Challapata. At Chiripa, I identified maize in the SW of the llama effigy *vasija* (CH-SER008), and the DW of the *cuenco* (CH-SER006). Logan (2006) found that maize cobs produce narrow elongate rondel phytoliths in high abundance. Based on Piperno's (2006a) finding that phytoliths occur in the archaeological record in proportion to the abundance of their production, it is surprising that I found relatively low counts of narrow elongate rondels. Their low counts in these assemblages suggest that the analysed contexts were not areas where maize was processed. The presence of starch grains likely indicates that these were contexts in which people consumed (rather than processed) maize. *Chicha* is produced from maize flour, which is made of ground maize kernels (Jennings 2005:244). It is therefore possible that the maize kernel starch grains are the remains of *chicha*. At both Challapata and Chiripa, I did not analyse any domestic contexts and there is therefore no way to determine whether maize only occurs in these specialized contexts.

6.6 Summary

In this chapter, I presented my paleoethnobotanical findings from ceramic sherd and vessel extractions. While phytolith and starch grain counts in some contexts were low, heavy liquid flotation proved to be a useful process in concentrating microbotanical remains for several Challapata samples. Across all three analysed assemblages, Poaceae phytoliths (grasses) were dominant. While this could be due to the mere presence of grass at these three sites, I argue that their high density could also indicate that people were using grasses as fuel. I will explore the question of whether these grass phytoliths may also represent fiber temper used in pastes in the next chapter, when I consider both ceramic and paleoethnobotanical data. Maize was present in relatively low abundances across contexts, which was surprising given that many of these contexts are non-domestic. It is possible that these vessels contained *chicha*, which could explain the low abundance of narrow elongate rondel phytoliths (which represent maize cobs), and the presence of starch grains (which represent maize kernels). I identified starch grains of various roots and tubers at both Challapata and Chiripa, which complements previous research suggested that these were staple foods in the Titicaca Basin. It also demonstrates that microbotanical analysis can be an effective means to identify these plants, the macrobotanical remains of which are subject to poor preservation. Finally, several starch grains exhibited damage indicative of milling, roasting, and dehydrating, which suggests that people at Challapata and Chiripa may have employed a wide range of food preparation techniques.

Chapter 7
Discussion: Considering Ceramics and Botanicals

In this chapter, I consider my ceramic and botanical results and their relationship to ancient foodways in the Lake Titicaca Basin. The specific goal of this chapter is to address my second research question: how might the analysed artifacts have been used and what does this tell us about Titicaca Basin foodways? Although I did not identify food remains at Kala Uyuni, I did recover phytoliths and starch grains from Challapata and Chiripa that are likely food remains. Food remains from both of these sites included lowland crops such as maize (*Zea mays*), manioc (*Manihot esculenta*), sweet potato *(Ipomoea batatas*), and arrowroot (*Maranta arundinacea*). I consider how these data contribute to archaeological understandings of exchange in the Titicaca Basin. I also discuss recovered plants, their associated contexts, and the ceramic vessels from which they were extracted. These data hint at how people consumed these plants. Finally, I discuss the implications of these foods having been recovered from contexts where ceremonies may have taken place and consider whether they may represent luxury foods (sensu Hastorf 2003b). Following my discussion of foodways in the Lake Titicaca Basin, I return to my discussion of grasses (see Chapter 6), to examine whether the high densities of grass phytoliths might represent temper or whether it is more likely that they are associated with vessel use, cleaning, or discard.

7.1 Meals in Motion: The Circulation of Goods in the Titicaca Basin

I identified both highland and lowland food crops in samples from Challapata and Chiripa. Highland crops in the Challapata samples included ulluco (*Ullucus tuberosus*) and Fabaceae that might be the remains of legumes, such as the common bean (*Phaseolus*) or lupine bean (*Lupinus*). Lowland crops from the Challapata samples included sweet potato (*Ipomoea batatas*), manioc (*Manihot esculenta*), arrowroot (*Maranta arundinacea*), and maize (*Zea mays*). In Chiripa samples, highland crops were potato (*Solanum tuberosum*), and lowland crops included manioc and maize. Samples from Kala Uyuni did not contain any identifiable food remains.

As discussed in Chapters 2 and 3, Tiwanaku archaeologists argue that the acquisition and consumption of non-local goods was an important part of Tiwanaku statecraft. Bandy (2005:95) argues that Southern Titicaca Basin communities were engaged in long-distance trade as early as the Early Formative period (Bandy 2005:95). However, the low densities of exotic goods such as sodalite beads, obisidian, and seashells, recovered from Early Formative contexts at Chiripa suggest that trade was sporadic at this time (Bandy 2005:95). In the Middle Formative, trade within the Titicaca Basin and between the Basin and its surrounding regions intensified, while long distance trade remained active (Bandy 2005:95). Bandy (2005) argues that from the Middle Formative period onwards, elite members of “transit communities” situated on trade routes would have had access to exotic goods. These goods would enable elites to accrue wealth and social capital, thereby solidifying their high status within the community as well as the community’s high status within the region. Bandy (2005:106) argues that Kala

Uyuni was one such transit community, which enabled its expansion in the Late Formative.

Tiwanaku elites' desire for non-local goods was a continuation of Formative period practices and values that associated exotic goods with wealth and power. As discussed in Chapter 3, non-local foods, such as maize, were involved in ritual practices during these periods. Browman's (1981, 1984) investigations at Tiwanaku demonstrate that long-distance exchange and the acquisition of exotic goods, including plants, lithics, and metals, were important parts of Tiwanaku statecraft. However, he that argues that not only elites, but also average Altiplano inhabitants were engaged in these networks of exchange, and acquired everyday "consumable" goods such as food and ceramics (Browman 1984:122). There remains debate about the nature of Tiwanaku expansion and the ways in which people acquired these goods. While some scholars argue that Tiwanaku exerted political control in the regions from which it acquired goods (Kolata 2003; Kolata and Ponce Sanguinés 1992; Stanish 2002; Vaughn 2006) others contend that Tiwanaku political integration was limited to the Tiwanaku heartland or to the city itself (Browman 1984; Dillehay and Nuñez 1988; Smith and Janusek 2014). Tenets of this second model contend that Tiwanaku engaged with and may have expanded or formalized pre-existing trade routes, but that Tiwanaku did not take control of sites along these trade networks.

In their investigation of Tiwanaku period exchange in the Upper Desaguadero Valley, Smith and Janusek (2014:15) found that Tiwanaku did not exert "continuous political control" in the region. Rather, Tiwanaku presence in the area was rooted in "local level interests and fluid politico-religious networks" (Smith and Janusek 2014:15).

Smith and Janusek (2014:15) argue that sites in the Upper Desaguadero Valley were engaged in long-distance exchange in the Formative Period, and that Tiwanaku merely formalized these pre-existing networks. The study also demonstrates that studying sites located on exchange networks is a useful way to investigate Tiwanaku's engagement in these networks. Data from this thesis neither supports nor contradicts either of these models for Tiwanaku expansion and exchange. Rather, my research offers new data about what plants were circulating in the Titicaca Basin and about where people may have acquired these plants. My results also suggest that future research at Challapata could eventually contribute to these debates.

Archaeologists working in the eastern Titicaca Basin have argued that Late Formative sites such as Challapata and Titimani were nodes in trade networks that connected the Basin with lowland Amazonian valleys to the east (Portugal Ortiz et al. 1993; Stanish 2003:154). In 2013, surveys in the area surrounding Challapata found a pre-Columbian road that likely connected the Titicaca Basin with sites in the eastern valleys (Janusek et al. 2014). The presence of lowland crops at Challapata suggests that goods were circulating between these two regions as early as the Late Formative period. Botanical studies at Salvatierra (1200-1400 AD) in the department of Beni, Bolivia have found that people at the site consumed maize in high quantities, as well as manioc and possibly sweet potatoes (Bruno 2010; Dickau et al. 2012). Neither Bruno (2010) nor Dickau and colleagues (2012) report recovering microbotanical or macrobotanical remains of arrowroot from sites in Beni.

The maize and manioc from the Tiwanaku phased samples at Chiripa are evidence for the circulation of goods between Chiripa and lowland communities. As discussed above, archaeologists have argued that Tiwanaku elites established long-distance trade networks and/or colonies in lowland areas in order to gain access to non-local goods (Anderson 2009, 2013; Browman 1984; Dillehay and Nuñez 1988; Hastorf et al. 2006). One of these desirable non-local goods was maize. Maize kernels recovered from Tiwanaku IV/V contexts at the site of Tiwanaku appear to originate from the Moquegua Valley, the Cochabamba Valley, and at least one other unknown source (Hastorf et al. 2006).

Were the lowland valleys to the east of Challapata one of these unknown sources? My work with Challapata samples suggests that maize and manioc were moving into the eastern basin from at least the Late Formative period. Future macrobotanical studies of maize morphology from Challapata and sites in the eastern valleys would complement Hastorf and colleagues' (2006) study to investigate whether the eastern valleys were, in fact, another source of Tiwanaku maize. The presence of manioc at both Challapata and Chiripa is the strongest evidence for trade between the two sites. As of yet, manioc has not been recovered from Tiwanaku period contexts in Moquegua or Cochabamba, although little botanical research has been completed in either region. Manioc domestication occurred by 2000 BC in the Amazon to the north and east of the Lake Titicaca Basin (Duncan et al. 2009:13204; Piperno 2006b:47). I propose that, by the Late Formative, it reached highland sites on the eastern shores of Lake Titicaca. In Tiwanaku IV/V phases, Tiwanaku was engaging in long distance trade networks to acquire goods such as maize. At this time, Tiwanaku may have expanded trade networks into the eastern Titicaca Basin or formalized pre-existing networks that connected the two regions, enabling people in the southern Titicaca Basin to acquire the lowland crops that Challapata already had access to.

Other than maize, all the lowland crops that I identified at Challapata and Chiripa are tubers. As discussed in Chapter 3, highland tubers such as potato, oca, and ulluco were important parts of Titicaca Basin diets in the Formative and Tiwanaku phases. Tubers were likely included as ingredients in soups and stews, freeze dried as *chuño* or *tunta*, and served as side dishes. They may also have been ground to make flour or porridges. It is possible that the pervasiveness of potatoes, oca, and ulluco in highland diets made lowland tubers like manioc, sweet potato, and arrowroot desirable to Titicaca Basin communities.

Stahl (2002) discusses the ways in which foreign objects can be accepted into communities and integrated into local practices. She argues that pre-existing practices and local contexts "shape the reception of new objects" (Stahl 2002:834). Stahl specifically explores the reception of foreign objects in colonial periods in Banda, Ghana, where beads were objects that were both locally produced and imported. Stahl (2002:841) explains that the "desirability of imported [bead] forms was likely predicated on the existing practices or taste for beads." It is possible that the reception of lowland tubers in Titicaca Basin communities occurred in a similar way and that the familiarity of tubers made them desirable. Stahl (2002:841) notes that the incorporation of foreign yet familiar goods can also transform local practices. Further investigations of lowland crops at

Titicaca Basin sites could shed light on the ways in which these foods were incorporated into and potentially transformed local foodways and practices.

Smith and Janusek's (2014) study of networks of exchange during Late Formative and Tiwanaku phases in the Upper Desaguadero Valley demonstrates the utility of investigating the nature of Tiwanaku period exchange from a localized perspective. Similarly, Roddick et al. (2014) demonstrate that studying local processes and everyday practices is a valuable means through which to investigate broader regional patterns. Continued research at Challapata adopting a similar "from the ground-up" approach could shed light on the ways in which people at Challapata acquired non-local goods and on how these goods may have also continued along trade networks to the southern Titicaca Basin. Such research should consider not only botanical remains, but also other goods, such as ceramics and lithics, that are known to have been circulating in the Titicaca Basin during Formative and Tiwanaku periods. This kind of study could inform us about daily life at Challapata, the nature of the relationship between the eastern Titicaca Basin and communities in the lowland eastern valleys, and the nature of exchange in the Titicaca Basin during Tiwanaku IV/V periods.

While the botanical results from the Chiripa burial suggest a possible connection with the eastern Titicaca Basin, the decoration style of three of the ceramic vessels from the burial are associated with the Cochabamba valley. The *cuenco* (CH-SER006), wide restricted jar (CH-SER005), and effigy-handle *vasija* (CH-SER009) appear to form a set. All three vessels have a similar dark reddish brown slip and pendant semi-circle motifs on their rim interiors (Figures 7.1, 7.2). Bennett (1934) argues that effigy handles on *vasijas* are a Cochabamba decoration style. As discussed in Chapter 5, the vessel's handle could depict either a snake or a bird. If it is, in fact, a snake, this would represent another stylistic connection to Cochabamba ceramics (Janusek 2003:75). The pendant cross motif on the effigy handle *vasija* is also a decoration style associated with the Cochabamba valley (Janusek 2003:75). Similarly, the *cuenco* form is not common at Tiwanaku during IV/V phases, and Janusek (2003:66) argues that the form may be connected to the Cochabamba valley. For instance, cuencos recovered from Lukurmata were decorated in Cochabamba styles (Janusek 2003:67; Figure 7.3). The volute motif on this illustration is similar to that of the wide mouth jar (CH-SER005).

Despite the apparent connection between these vessels and the Cochabamba valley, it is unlikely that the manioc that I identified in samples associated with the *cuenco* is from the Cochabamba valley. Manioc grows best at elevations ranging from 1,500 to 2,000 masl (Towle 1961:61), whereas elevations in the Cochabamba valley range from 2,400 to 2,600 masl (La Lone and La Lone 1987:50). This demonstrates the complexity of the circulation of goods during Tiwanaku IV/V phases, and that objects (and potentially practices) from multiple regions could come together in a single space. Within this single burial at Chiripa, I identified remains of local crops (potatoes), remains of possible Amazonian crops (manioc), and ceramics that are linked to the Cochabamba valley. I turn now to a discussion of food consumption, considering how the ceramic and plant data might hint at the ways in which people prepared and served foods at Challapata and Chiripa.

Figure 7.1 Left: *cuenco* CH-SER006; Right: Effigy handle *vasija* CH-SER009; Notice the similar patterns on the interior of the artifacts' rims (photos by Kathleen Huggins)

Figure 7.2 Wide mouth *vasija* artifact, with similar rim semi-circle motif as CH-SER006 and CH-SER009 (photo by Kathleen Huggins)

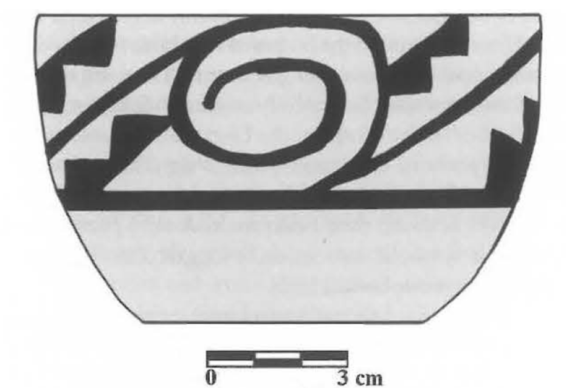

Figure 7.3 *Cuenco* with volute motif similar to CH-SER005 (Figure 3.53 from Janusek 2003:67)

7.2 Hints of Food Consumption and Meaning

In certain cases, the recovery contexts of food remains allow me to speculate about the ways in which people at Challapata and Chiripa may have prepared or consumed food. Examining food preparation and consumption is a first step towards understanding the ways in which culinary practices are entangled with crafting practices within a broader taskscape (Logan and Cruz 2014; Roddick 2013). All Challapata samples were from public, possibly ceremonial spaces on the Oqo Qoya Pata mound. No food remains were recovered from sonicated wash (SW) samples, which means that I cannot securely link any foods with vessel use. As discussed in Chapter 6, this could be because I only had access to small body sherds, and rim and handle sherds, to which plants do not easily adhere. Maize, manioc, arrowroot, bean family, and ulluco were recovered in wet wash (WW) samples, which I tentatively link with vessel use. I also recovered maize, bean family, and sweet potato in dry wash (DW) samples, which indicates that these plants were present in the sediment surrounding the sherds. While it is sometimes possible for WW samples include microbotanical remains from the surrounding sediment, this is more likely the case when there is overlap in taxon between WW and DW samples. However, in these samples, there was no overlap in food taxa between the WW and DW of a single sherd.

I identified maize cupule phytoliths in the WW samples from the rim of a possible bowl (OQP-15-SER002) and the rim of a necked vessel (OQP-16-SER004), and a maize kernel starch grain from the WW of a body sherd (OQP-4-SER005). Bowls are useful vessels for consuming liquids such as beverages, while necked vessels are useful for storing and pouring beverages (Janusek 2003:358). The presence of maize remains in liquid-serving vessels recovered from Oqo Qoya Pata, a space where public rituals appear to have taken place (Janusek et al.2014:7), suggests that the plant may have been consumed as *chicha*. Logan and colleagues (2012) have demonstrated that people likely consumed maize as *chicha* in Middle and Late Formative feasting contexts at sites in the southern Titicaca Basin. However, it is also important to consider alternative ways in which maize may have been consumed. As was seen in Chapter 3, it appears that people in the Titicaca Basin consumed several kinds of liquid-based dishes in the Formative, including soups, stews, and possibly porridges. The presence of maize remains in a bowl and necked vessel could therefore also indicate that it was included as an ingredient in such dishes. Further investigations of food production tools and spaces at Challapata could show how maize was prepared at the site. For example, excavations at Cerro Baúl in the Moquegua Valley have uncovered a Wari brewery that enabled a better understanding of *chicha* production and drinking rituals at the site (Goldstein et al. 2005).

I also recovered arrowroot from the WW of the necked vessel rim (OQP-16-SER004). There are several possibilities that could account for the presence of both maize and arrowroot in the same vessel. First, it is likely that this necked vessel was used over a long period of time to serve multiple meals. It is therefore possible that these are the remains of two separate dishes that were served from the same vessel at different times. However, it is also possible that maize and arrowroot were cooked as part of a same dish or beverage. Meals such as soups and stews are likely to have included multiple ingredients and it is possible that people may have included maize and arrowroot in such dishes. If the maize phytolith recovered from this artifact is *chicha* residue, the arrowroot starch grain suggests that people at Challapata may have included arrowroot in their *chicha*. As Goldstein et al. (2009:136-139) note, *chicha* was not produced exclusively from maize. In some cases, plants other than maize, such as manioc or pink peppercorn (*Schinus molle*) berries, were used as the primary ingredient in *chicha*. People also used multiple plants in order to create a single fermented beverage. It may be that people included arrowroot in their production of *chicha* at Challapata.

I also recovered a bean family phytolith and a manioc starch grain in the WW of artifact OQP-15-SER003. As with the maize and arrowroot, this could suggest that people prepared beans and manioc as part of a single dish, or that the two kinds of plants were consumed in the same vessel as part of different dishes or meals. It is interesting to note that Fabaceae plants are likely local while manioc is a non-local crop. The occurrence of these two crops in the same vessel and possibly as part of the same dish suggests that people at Challapata may have cooked local and non-local plants together, or at least that they did not use separate vessels to serve local and non-local foods. Lyons and D'Andrea (2003:517) argue that using familiar technologies to prepare and serve new or non-local foods can facilitate the normalization of the new foods, making them seem edible. Morell-Hart (2011:23) similarly argues that people adopt new foods by associating them with and/or using them to replace known foods.

It is possible that serving non-local foods in the same dishes and/or vessels as local foods acts in a similar way. The limited available ceramic data from Challapata does not allow me to assess whether OQP-15-SER003 was a local or non-local ceramic style. Further research at Challapata that investigates the species of plant remains that are recovered in the same contexts as well as the ceramic vessels from which they are recovered could shed more light on the relationship between different foods, including local and non-local plants at the site.

The cf. Fabaceae phytoliths from the WW of the body sherd OQP-15-SER003 and from the DW of the rim sherd OQP-16-SER004 could represent a variety of species. These phytoliths could be the remains of beans, such as the common bean (*Phaseolus vulgaris*), the lima bean (*Phaseolus lunatus*), and the lupine bean (*Lupinus mutabilis*), which may have been included in meals such as soups and stews. The Fabaceae family also includes some genera and species that grow in the lowlands. For example, algarrobo pods and fruit (*Prosopis alba*) can be used as sweeteners (Hyashida 2008: 171). The phytoliths could also be remains of vilca (*Anadenanthera colubrina*), a hallucinogenic plant that people used for snuff in the Andes (Logan 2006:62). Based on comparative studies, Logan (2006:65) identified a phytolith form that is diagnostic to vilca. I did not recover any of these diagnostic vilva phytoliths at Challapata. Future botanical research at Challapata identifying particular genera or species of Fabaceae would be necessary to further investigate the ways in which bean family plants were used and consumed at the site.

Overall, results from Challapata suggest that feasting may have taken place on the Oqo Qoya Pata mound. Feasts are "public ritual activity centered around the communal consumption of food and drink" that are "symbolically differentiated from everyday activities" (Dietler 2001:67). Surveys at Challapata have identified monumental architecture and carved stones at Oqo Qoya Pata (Janusek et al. 2014:7). Mounds with such architecture, including Montículo at Chiripa, are known to have been locales of public rituals and feasts in the Titicaca Basin throughout the Formative period (Hastorf 2003a). The presence of food remains in samples from the mound suggest that food related activities did take place at Oqo Qoya Pata. Because my research at Challapata only encompassed samples from Oqo Qoya Pata, I am unable to determine the extent to which activities on the mound were differentiated from everyday practices. However, this data nonetheless suggests that feasts may have been among the activities that took place at Oqo Qoya Pata.

Samples from Chiripa also contained probable food remains: the wide restricted jar (CH-SER005) contained potato starch grains in its SW and DW samples, the *cuenco* (CH-SER006) contained manioc starch grains in its SW and maize cob phytoliths in its DW, and the llama effigy *vasija* (CH-SER008) contained a maize kernel starch grain in its sonicated wash. As discussed in Chapter 7, the relative lack of damage on the starch grains from these samples, especially the potato starch grains, suggests that these plants were minimally processed and placed in the vessels as part of the offerings. The starch grains could also be the remains of foods that were consumed from these vessels before the vessels were placed in the burial as part of the offering. The maize cob phytoliths from the DW sample of of the *cuenco* indicate that maize was present in the sediment surrounding the vessels, which suggests people may have placed maize cobs in the burial as part of an offering as well.

It is possible that the manioc I identified in the *cuenco* was consumed as *chicha*. Both colonial accounts and ethnoarchaeological research indicate that manioc *chicha* was and remains a preferred beverage in lowland Amazonian communities (Bowser 2000; Castillo 1670 in Dickau et al. 2012; Weismantel 2009:257). As Mills (2016) and Stahl (2002) demonstrate, it is not only objects that circulate within networks of exchange, but also their associated meanings and uses. It is therefore possible that people in highland communities that acquired manioc from Amazonian communities adopted some Amazonian drinking practices and consumed the plant as *chicha*. As discussed in Chapter 3, maize *chicha* was an important part of rituals in the southern Titicaca Basin during Middle and Late Formative periods, and it was an integral part of Tiwanaku statecraft. It is possible that manioc's use in *chicha* made it desirable to Tiwanaku elites. The presence of manioc starch in a *cuenco*, a form that is useful for serving liquids, suggests that people may have consumed the plant as *chicha* at Chiripa during Tiwanaku IV/V periods.

Other food remains from the Chiripa vessels include maize and potato starch grains. The maize kernel starch grain is from the SW of the blackware llama effigy *vasija*, a form that Janusek (2003:67) argues was likely used to pour drinks. This vessel may have been used to serve maize *chicha*, or maize *chicha* may have been included in the vessel as part of the burial offering. In her zooarchaeological study of culinary practices at Tiwanaku, Vallières (2012) argues that maize was an emblem of the non-local while llamas were emblematic of the local. Vallières (2012) reports that llamas were an important part of everyday diet at Tiwanaku, but were also parts of rituals as they were sacrificed and used as dedicatory offerings. She argues that llamas were socially valued markers of a regional altiplano identity and that serving them alongside maize *chicha* at feasts would have connected Tiwanaku to the exotic while grounding it in the local (Vallières 2012:334-335). Serving maize *chicha* in a llama effigy *vasija* likely created a similar symbolic link between the local and exotic. The possible inclusion of potatoes in the offering in the Chiripa burial is also an example of the value that people placed on local foods.

All plants that I identified as food remains in this study were from non-domestic contexts. As discussed above, it is possible that plants identified in Oqo Qoya Pata contexts at Challapata are the remains of foods consumed at public feasts. Because the Chiripa vessels were offerings, it is likely that they were ritually significant, though the practices surrounding these objects' inclusion in the burial could have been either public or private. It is possible that some of the plants from these contexts were luxury foods. Luxury foods are desirable, difficult to acquire foods, the possession or consumption of which can construct and mark social power (See Chapter 3; Hastorf 2003b; Van Der Veen 2003). Maize is known to have been a luxury food in the southern Titicaca Basin during

Middle Formative, Late Formative, and Tiwanaku phases. It was difficult to obtain because it was non-local and desirable because of its use in *chicha* (Hastorf 2003b; Hastorf et al. 2006; Logan et a. 2012). During Tiwanaku IV/V phases, it seems to have also become a status marker as it was available in higher quantities to elites (Berryman 2010).

The other non-highland crops that I identified – manioc, arrowroot, and sweet potato – would similarly have been difficult to obtain and potentially desirable to highland communities. Manioc, like maize, can be used to produce *chicha*, which may have made it valuable in the Lake Titicaca Basin, especially at Tiwanaku where the beverage was ritually and politically important. It is likely that manioc was also consumed in forms other than as *chicha*. Dickau et al. (2012) state that manioc was likely a staple food at sites in Beni, while Duncan et al. (2009) report recovering manioc starch grains in feasting contexts on coastal Peru. However, neither of these articles discuss how manioc may have been prepared or consumed, other than as *chicha*. Further investigations at Challapata that investigate both domestic and public spaces could shed more light on the place of the non-local crops in the community's foodways.

However, my research suggests that it was not only exotic goods that Titicaca Basin communities valued and included in potentially ritual practices. The presence of highland crops (potato, ulluco, and possibly beans) and of imagery that may have been emblematic of an altiplano identity (the llama effigy *vasija*) in these non-domestic contexts indicates that people valued the local as well. As discussed in Chapter 3, previous investigations of foodways in the southern Titicaca Basin indicate that people consumed local foods, including potatoes, chenopodium, and camelids, in ceremonial contexts from the Middle Formative through Tiwanaku IV/V phases (Bruno 2008; Hastorf 2012; Miller 2005; Vallières 2012; Wright et al. 2003). Scholars analyzing macrobotanical remains from Tiwanaku also found that potatoes were included in offerings at the Akapana mound (Wright et al. 2003). Data from this thesis contributes to the evidence for the ceremonial importance of local crops and imagery in the southern Titicaca Basin. Roddick and Hastorf (2012:172-173) argue that southern Titicaca Basin communities drew on pre-existing feasting practices in order to build communal memories, which would promote social cohesion. Consuming local foods at feasts and including local foods and imagery in offerings was likely one of the ways in which Titicaca Basin communities continued pre-existing traditions.

7.3 Grasses and Ceramic Production

Culinary practices and craft production are part of a same taskscape (Logan and Cruz 2014). Some practices and technologies used in the production of ceramics and the preparation of meals overlap with one another (Logan and Cruz 2014; Sillar 1996). Just as ceramics are used in order to prepare and cook plant foods, plants are also used to produce ceramic vessels. As discussed in Chapters 4 and 5, potters in the Lake Titicaca Basin use grasses, or fiber, to temper clays. Here I will discuss the use of grasses in the ceramic production sequence and evaluate whether data from this thesis could contribute to our understandings of ceramic production.

As part of her study of Chiripa ceramics, Mohr (1966:188-191) collaborated with the botanist Christiane Vignale to study the morphology of fiber imprints in ceramic sherds. Vignale determined Chiripa potters used grasses from the Poaceae family (specifically belonging to the festucoid and panicoid subfamilies) to temper their clays. Potters used between nine and fifteen different species of grasses to temper their clays (Mohr 1966:190). *Stipa ichu* is the only species that Vignale identified. This grass belongs to the festucoid subfamily and grows in high abundance in the altiplano.

Figure 7.4 *Stipa ichu* grass (photo by Andrew Roddick)

Given the high percentage of grass phytoliths in these samples, it is worthwhile to consider whether any of these phytoliths may be from the grasses that potters used as temper. I specifically consider phytoliths from SW samples because these samples are most associated with vessel use rather than with surrounding sediments. The goal of sonication is, in part, to dislodge and access microbotanical remains from vessel pores. It is therefore most likely that phytoliths representing temper would be in the SW samples.

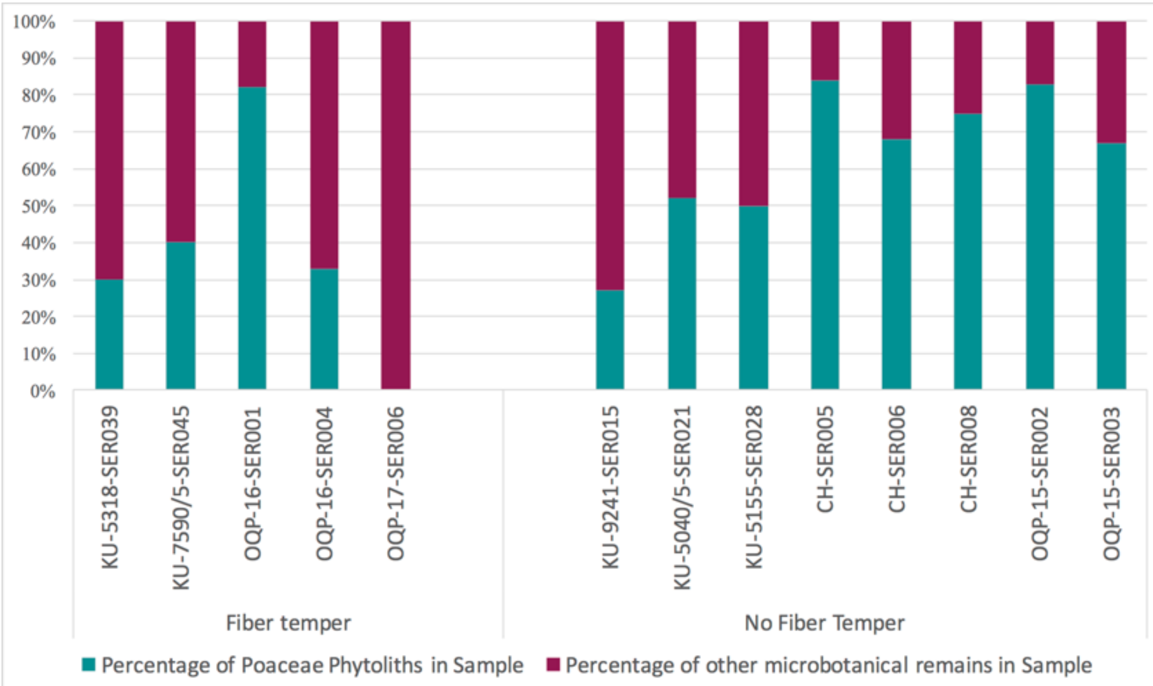

Figure 7.5 Poaceae phytolith densities in SW samples of fiber tempered and mineral tempered vessels from Kala Uyuni, Challapata, and Chiripa. Note that OQP-4-SER005 and OQP-3-SER007 from Challapata are not included in this figure because SW samples associated with these sherds did not have any phytoliths or starch grains

There is no apparent correlation between fiber temper and the density of phytoliths in SW samples (Figure 7.5). In fact, overall, mineral tempered sherds have higher densities of grass phytoliths: 63% of microbotanical remains from all mineral tempered sherds are Poaceae phytoliths, whereas Poaceae phytoliths make up only 37% of microbotanical remains from fiber tempered sherds. This suggests that the Poaceae phytoliths in this assemblage likely do not represent temper. Using botanical data from SW samples associated with ceramic sherds appears to not be an effective means by which to study tempering practices. The phytoliths from these samples may still be the remains of grasses that came into contact with the ceramic vessels through deliberate uses, in cleaning, or after discard. As discussed in Chapter 6, people may have used grasses as kindling in fires. These phytoliths may also be the remains of grasses that came into contact with with the vessels incidentally. Alternatively, they may be the remains of grasses that came into contact with the clay before it was collected by potters for vessel production.

7.4 Summary

In this chapter, I discussed how my findings contribute to archaeological understandings of Titicaca Basin foodways. These results offer new evidence for the circulation of goods between lowland communities and communities in the Lake Titicaca Basin during both Late Formative and Tiwanaku phases. My results also suggest that lowland Amazonian valleys to the east of the Lake Titicaca Basin may have been a third source of Tiwanaku maize. Future research at Challapata could shed light on the ways in which exchange affected daily life at the site, include how non-local plants and ceramics may have been integrated into local foodways. Such research could also contribute to ongoing debates in Tiwanaku archaeology about the nature of Tiwanaku exchange and expansion. My results related to food consumption suggest that people at Challapata and Chiripa included both exotic and local foods in the potentially ceremonial feasting practices and in offerings. This supports previous research that maize was a luxury food in the Titicaca Basin and suggests that other non-local foods, such as manioc, sweet potato, and arrowroot may also have been luxury foods.

Nevertheless, the presence of local crops in these feasting and offering contexts indicates that people valued the local as well as the non-local. Following Roddick and Hastorf (2010), I argue that the consumption of local foods in potentially ceremonial events is evidence for continuity of traditions in the Titicaca Basin. Such practices may have strengthened collective memory and promoted community cohesion.

Finally, I considered the non-food related uses of plants and how my results might contribute to research about the production of ceramics in the Titicaca Basin. While I did identify high densities of Poaceae grass phytoliths the majority of botanical samples, these do not appear to be related to ceramic tempers. It is more likely that grasses entered the archaeological record incidentally or as a result of non-temper related uses, such as fuel.

Chapter 8
Conclusions and Future Directions

In this chapter, I address my final research question: what are the benefits and challenges of studying ceramic and plant data together? I first summarize my results, and discuss the benefits of combining these two datasets, highlighting interpretations that would not have been possible had I only studied ceramics *or* plants. I then discuss the methodological challenges of analyzing each assemblage. I argue that the benefits of pairing ceramic and botanical data outweigh the limitations associated with each, ultimately revealing a richer understanding of past foodways. I then propose recommendations for future research. I close this chapter by returning to the five ways in which craft and culinary practices intersect and discuss how researchers can continue to investigate these intersections.

8.1 Summary of Results: Benefits of Pairing Ceramic and Botanical Data

8.1.1 Kala Uyuni

I analysed 5 ceramic sherds from Late Formative contexts at Kala Uyuni. For this assemblage, I had access to detailed contextual information, including results from previous ceramic and macrobotanical analysis. I was able to target specific contexts at the site to include both domestic and non-domestic spaces. However, all Kala Uyuni sherds had been washed shortly after their excavation and I therefore recovered only low densities of phytoliths and starch grains and no identifiable food remains. I was left with a detailed site history and a rich ceramic dataset, but no botanical data that would enable me to address my main research questions surrounding foodways.

The five Kala Uyuni sherds that I analysed were from four different contexts: ASD-2, a probable ritual space; ASD-5, a domestic space where food preparation likely occurred; ASD-9, a possible domestic space; and a high density midden. I analysed a complete bowl (KU-5040/5-SER021) and a body sherd (KU-5155-SER028) from ASD-2. The bowl had interior and exterior carbonization, which indicate that it may have been used in burning activities as well as a serving vessel in ceremonial practices. The body sherd had a high density of interior carbonization and no exterior carbonization, which indicates it may have been a vessel used to burn offerings. The sonicated wash (SW) sample associated with this sherd contained a starch grain that had damage consistent with milling, which could indicate that the vessel was used for cooking or that processed plants were burned in offerings.

I analysed a base sherd (KU-7590/5-SER045) from ASD-5 that had no carbonization on the external or internal surface. This sherd’s relatively thick walls and lack of carbonization indicate it may have been a storage jar. Botanical data associated with this sherd does not shed light on its potential uses. The base sherd (KU-9241-SER015) that I analysed from this context had interior carbonization but no associated botanical data that hints at cooking practices. The final Kala Uyuni sherd that I analysed was an annular base sherd (KU-5318-SER039) from a high density midden. This sherd had interior carbonization and no exterior carbonization. The sherd’s form and carbonization patterns suggest that it was used to burn offerings. I identified a high density of arboreal spheres (60%) in the sherd's SW sample, indicating that wood may have been used as fuel to burn offerings in the bowl. As with artifact KU-5155-SER028, the sample associated with this annular base sherd included a damaged starch grain.

Overall, findings from Kala Uyuni support the argument (Janusek 2003:42; Roddick 2009:348; Steadman 2007:95) that annular based bowls were used for burning activities and suggest that people may have used wood to burn offerings. My findings also suggest that ASD-9 may have been a domestic space where burning activities may have taken place. Further ceramic and botanical research in ASD-9 contexts could address this issue further. Results from Kala Uyuni also indicate that studying the botanical remains from previously washed ceramic sherds is not an effective method to study foodways in this region. I will address this further below, when I discuss the limitations of pairing ceramic and botanical datasets and propose means to facilitate this kind of research.

8.1.2 Challapata

The Challapata assemblage presented a distinct challenge to that of the Kala Uyuni assemblage. During the 2016 field season, excavators placed ceramic sherds in individual sealed bags immediately upon their excavation. I therefore had secure contexts from which to complete botanical extractions. However, the ceramic dataset from this site was not robust because extensive ceramic analysis has yet to be carried out at Challapata. As a result, the only ceramic data I had access to from the site was the data from the six sherds and one clay clump from which I completed microbotanical extractions. This limited my ability to interpret Challapata ceramic data because there was no dataset within which to contextualize ceramic results. The only available sherds from Challapata were the Oqo Qoya Pata mound, a public space where communal consumption events and rituals may have taken place. I did not analyse any samples from domestic spaces or production areas at this site.

I identified phytoliths and starch grains that are diagnostic of food remains in Challapata samples: sweet potato (*Ipomoea batatas*), manioc (*Manihot esculenta*), arrowroot (*Maranta arundinacea*), maize (*Zea mays*), ulluco (*Ullucus tuberosus*), and possible beans (Fabaceae). I was unable to securely connect any food remains with vessel use because no sonicated wash samples contained food remains. However, I tentatively linked food remains from wet wash (WW) samples to vessel use. I recovered maize in the WW samples of the rim of a possible bowl (OQP-15-SER002), the rim of a necked vessel (OQP-16-SER004), and a body sherd (OQP-4-SER005). The presence of maize in samples associated with forms that are useful for serving liquids – a bowl and a necked vessel – suggest that it was consumed as *chicha* or as a liquid-based foods at Challapata. I also identified arrowroot in the WW sample of the necked vessel rim. This could indicate that arrowroot was prepared in the same dish or beverage as maize, or that that the two plants were part of separate dishes that were served from the same vessel. Similarly, I identified manioc and a Fabaceae phytolith that could represent beans in the WW sample associated with the body sherd OQP-15-SER003, which suggests that these plants may have been prepared together or served from the same vessel as part of separate dishes. I identified ulluco in the WW of a handle (OQP-3-SER007). I also identified two sweet potato starch grains, a maize starch grain, and two Fabaceae phytoliths in dry wash (DW) samples, which indicates that these plants were also present at Challapata.

Overall, Challapata results indicate that lowland crops were entering the eastern Titicaca Basin as early as the Late Formative period. People likely consumed these plants as part of public events that took place on the Oqo Qoya Pata mound. It is possible that the lowland crops that I identified at Challapata were luxury foods. The presence of ulluco and possible beans in these potentially ritual contexts suggests that people also consumed local plants at feasts. Pairing botanical and ceramic datasets to study the Challapata assemblage enabled me to make arguments about the ways in which people consumed plants at this site. Though ceramic data was scant, knowing the forms of some of these sherds enabled me to suggest that maize may have been consumed as *chicha* at this site. Furthermore, studying botanical samples that were directly associated with vessels enabled me to identify plants that may have been consumed together, or separately but sequentially. In order to develop a stronger and more well-rounded understanding of Challapata foodways, future research at the site should encompass not only public spaces, but also domestic areas. Studying botanical and ceramic data from multiple contexts at Challapata could reveal the ways in which non-local foodways and craft practices were incorporated into daily life at the site.

8.1.3 Chiripa

At Chiripa, I had relatively strong data from both ceramic analysis and botanical analysis. I had access to five complete vessels with forms and decoration styles that have been the subject of previous archaeological research. I was therefore able to discuss other contexts in which these types of vessels have been recovered as well as their links to Tiwanaku culture and potential links to the Cochabamba valley. I also recovered food remains from the three vessels that I analysed from this grave. I was able to associate food remains with specific forms, which allowed me to speculate about how these plants may have been prepared and/or consumed. The presence of non-local foods and Cochabamba decoration style in this grave also enabled me to discuss potential connections between the Southern Titicaca Basin and other regions during Tiwanaku IV/V phases.

Three of the ceramic vessels from the burial at Chiripa – the *cuenco* (CH-SER006), the wide restricted jar (CH-SER005), and the effigy handle *vasija* (CH-SER009) – appear to form a set and have decoration styles that link them to the Cochabamba valley. Microbotanical analysis of samples associated with two of these vessels revealed plant remains of food: I identified manioc starch grains in the sonicated (SW) of the the *cuenco*, and potato starch grains in the sonicated and dry washes of the wide restricted jar. I also identified a maize starch grain in the SW of the blackware llama effigy *vasija* (CH-SER008), a form that is associated with local traditions rather than the Cochabamba valley. The presence of manioc at both Challapata and Chiripa suggest that communities in the southern Titicaca Basin may have engaged in exchange with communities in the eastern Titicaca Basin during Tiwanaku IV/V phases. It is possible that the Amazonian valleys from which Challapata likely acquired its lowland crops are another source of Tiwanaku maize and non-local goods.

The paired botanical and ceramic data hint at the ways plants were processed and how vessels and their associated food remains may have constituted Tiwanaku identity. I argue that manioc's presence in a *cuenco* suggests that people may have consumed manioc *chicha* in the southern Titicaca Basin during Tiwanaku phases. This could be an example of communities in the Tiwanaku heartland adopting non-Tiwanaku drinking practices. Similarly, the presence of a maize starch grain in the llama effigy *vasija* suggests that people consumed maize *chicha* at Tiwanaku IV/V Chiripa and may have filled the vessel with the beverage before placing it in the burial.

8.2 Methodological Challenges and Recommendations

I faced several methodological challenges throughout the course of this project, particularly related to the recovery of microbotanical remains. As discussed in Chapter 6, studying botanical remains recovered from artifacts can be beneficial because artifacts can protect microbotanical remains from degradation in soils (Fullagar 2006:177). However, there are also unique challenges that come with studying microbotanical remains from artifacts. The first, possibly most obvious, methodological challenge that I encountered was that all sherds from the Kala Uyuni assemblage were washed before I completed paleoethnobotanical extractions. I identified very few plant remains and no food remains in this assemblage, likely because the sherds were washed. Based on these results, I recommend that project directors should not to have all excavated artifacts washed. Rather, they should isolate one or two ceramic sherds (and other forms of artifacts) from each excavated locus in order to allow for future botanical research. Such artifacts can still be studied for other forms of analysis to a limited degree if curated in clear plastic bags.

While Challapata sherds were unwashed and immediately isolated upon their excavation, there were still some difficulties extracting and analyzing their associated botanical samples. First, only samples that underwent heavy liquid flotation yielded high densities of phytoliths and starch grains. Several samples, especially from sonicated washes, were not substantial enough to carry out heavy liquid flotation. I attribute this, at least in part, to the form and small size of the ceramic sherds from which I completed microbotanical extractions. While completing extractions, it was difficult to obtain samples that were as large as those from Kala Uyuni and Chiripa extraction. With SW samples especially, I was rarely able to isolate more than 2 ml of aqueous residue, which likely accounts for the low density of microbotanical remains in these samples.

Based on results from Challapata, I suggest that paleoethnobotanists target basal sherds because food residues are more likely to accumulate in a vessel's base. If no base sherds are available, I recommend targeting larger sherds because increasing the targeted surface area could facilitate obtaining larger samples and increase the chances of recovering botanical remains. My results suggest that rim sherds and handles do not yield high densities of botanical remains associated with vessel use. Samples from these kinds of sherds can be used when no better options are available, though I would not recommend specifically targeting rim and handle sherds. Results from Challapata also demonstrate that heavy liquid flotation is a very useful way to concentrate phytoliths and starch grains, thereby enabling their recovery.

I identified high densities of botanical remains from the whole unwashed Chiripa burial vessels and did not need to carry out heavy liquid flotation. While completing extractions for these vessels, I was able to target their bases, which had high concentrations of sediment. This likely enabled the recovery of higher densities of botanical remains. It is also likely that the full vessels helped protect phytoliths and starch grains from degradation. Based on the positive results from the Chiripa burial, I suggest that paleoethnobotanists should target similar sealed contexts, such as burials and offerings. Results from these kinds of contexts can contribute to understandings about the role of plants in ritual practices, while also providing a snapshot of what plants were present at a particular site. While I do not propose that studies encompassing both ceramic and botanical data should only sample from burial contexts, I do argue that these are critical contexts to include in such studies. Following these recommendations, I urge excavators not to immediately wash vessels recovered from burial and offering contexts.

Overall, researchers seeking to study foodways through both ceramic and botanical datasets should target a range of contexts, including both domestic and public spaces. As I explained when discussing my Challapata results, it is not possible to develop a well-rounded understanding of foodways based on results from only public or private spaces. Rather, results need to be considered in relation to one another in order to fully develop interpretations of foodways and culinary practices. If vessel form and/or function is identifiable, I recommend sampling from a range of vessel types including storage, cooking, and serving. Food processing and cooking can damage starch grains, so storage vessels could enable the recovery and identification of higher counts and wider varieties of starch grains. Samples from cooking and serving vessels, on the other hand, can shed light on the kinds of foods that may have been prepared or served together. Damaged starch grains from such vessels can also potentially offer insight to the cooking methods that people used in the past. Almost all food remains that I identified in these samples were starch grains rather than phytoliths. These results indicate that starch grains can yield critical information about culinary practices in Titicaca Basin contexts. Phytolith studies, on the other hand, may be able to address questions about climate and landscape, while also complementing starch grain results about foodways.

8.3 Summary

One of the goals of this thesis was to evaluate the utility of paring ceramic and botanical datasets in order to study the intersections of craft and culinary practices. The summary of my results above demonstrates that this type of analysis does contribute to a better understanding of past foodways. Had I not considered both ceramic and botanical datasets, I would not have been able to draw conclusions about how people processed and consumed plants at Challapata and Chiripa. Combining these datasets also enabled me to access more data about the circulation of goods in the Titicaca Basin. Not only did I identify non-local plants at both Challapata and Chiripa, but I also connected some Chiripa vessels with Cochabamba ceramic styles. Pairing the datasets in the Chiripa burial highlighted the complexities of Tiwanaku networks of exchange and demonstrated the ways in which goods (and possibly practices) from multiple places came together in single events during Tiwanaku IV/V phases. Continued research of ceramics and botanicals at Challapata could similarly shed light on the ways in which non-local goods and practices were integrated to everyday life at the site. This could contribute to ongoing research and debates about the mechanisms of exchange in Formative and Tiwanaku phases, and on the nature Tiwanaku's involvement in trade networks.

In Chapter 1, I outlined five ways in which craft and culinary practices intersect related to both production and consumption. My discussion of production, however, was limited because most contexts that I studied were public spaces where craft and food production do not seem to taken place. While my research did take into account the production of ceramics in relation to the vessels' potential intended uses, I was unable to explore two other areas in which the production of ceramics and preparation of foods intersect. Specifically, I was unable to address the overlap methods and technologies involved in ceramic production and food preparation, or the ways in which people can perform identities through craft production and food preparation.

However, there is potential for a project that pairs ceramic and botanical datasets to investigate questions related to production. Returning to Ingold's concept of the taskscape (discussed in Chapter 1), it is useful to think of both craft and food production as tasks that are embedded in the landscape and in seasonal, agricultural, and ritual cycles (Roddick 2013). As such, a study focusing on the intersections of craft and culinary practices related to production could focus on the ways in which these practices are connected to landscape. Roddick (2013:298) explains that inhabitants of Taraco Peninsula in the Formative period acquired clay with which to produce pots and surface structures from the same sources. They also used similar paste recipes for these two tasks. As discussed in Chapter 1, craft production and culinary practices share knowledge and techniques in a similar way, as there is crossover between the kinds of tools and the practices that people employ to produce pots and prepare food (Sillar 1996). Investigating botanical remains in areas surrounding clay sources to reconstruct Formative period landscapes could shed light on whether people acquired not only clay but also wild plant resources from these areas. Such investigations could enrich archaeological understandings not only of how crafting and culinary practices intersect, but also of how people made use of and interacted with the landscape as they carried out these tasks.

The intersections of craft production and food preparation could also be considered through the lens of recipes. As discussed in Chapters 5 and 7, Titicaca Basin potters added tempers to clays in order to attain certain desirable ceramic characteristics, such as thermal shock resistance. Such paste recipes could be considered as analogous to food recipes. An investigation of continuities and changes in ceramic and culinary recipes could shed light on the degree to which knowledges and techniques were shared between these two practices in the past. Studying botanical remains extracted directly from ceramic sherds would be critical to such a study because this method can potentially reveal the kinds of foods that people consume together, which can begin to elucidate possible culinary recipes.

To varying degree, I addressed and explored the points of intersection of craft and culinary practices that relate to consumption in this thesis. First, the primary function of many crafts, including of some ceramics, is to store, prepare, or serve food. As such, particular vessels can be produced in order to fulfill certain food related functions.

Exploring attributes related to vessel function in the Titicaca Basin enabled me to speculate about the ways in which particular foods were prepared or served. Specifically, I often used form as a potential indication of vessel use, which in turn hinted at the ways in which plants from a particular vessel may have been served.

Craft and culinary practices are also entangled in political economy as crafts and foods can enable individuals or communities to accrue wealth and prestige. My investigation of non-local foods and ceramics at Challapata and Chiripa contributes to research about the circulation of goods in the Titicaca Basin. Researchers investigating trade in the Formative and Tiwanaku period Titicaca Basin tend to agree that non-local goods played important roles in ritual practices and in enabling elites to solidify their positions. Tiwanaku's access to exotic goods was likely an important part of the site's rise to prominence, though researchers disagree on the ways in which Tiwanaku elite acquired these exotic goods. The presence of non-local plants in possible feasting contexts at Challapata and of non-local plants and ceramic styles in a burial offering at Chiripa support the arguments that exotic goods were ritually important. While my results do not directly contribute to debates about the nature of Tiwanaku's involvement in or control over networks of exchange, they do suggest that further research at Challapata could shed light on the site's relationship with Tiwanaku. This could, in turn, contribute to understandings of Tiwanaku exchange.

The use of particular ceramic styles and consumption of particular foods can contribute to the construction and maintenance of individual or community identity. Results of my research suggest Challapata feasts involved the consumption both local and non-local plants, and that offerings at Chiripa included local and non-local plants and imagery. The apparent value placed on the local, such as ulluco, potatoes, and llamas, in these contexts suggests that people continued to value local traditions alongside new traditions in the Late Formative and Tiwanaku phases. These findings are in line with Roddick and Hastorf's (2010) argument that Titicaca Basin feasts built on pre-existing traditions to promote shared community memories and identity.

This thesis demonstrates the value of pairing ceramic and botanical datasets to study foodways and the intersections of craft and culinary practices. The recommendations I lay out in this chapter will facilitate future projects that investigate the intersections of craft and culinary practices not only as they relate to consumption, but also production. My results contribute to understandings of Titicaca Basin foodways and exchange by demonstrating that several species of lowland plants, especially lowland tubers, were among the goods that circulated in the Titicaca Basin in the Late Formative and Tiwanaku periods. My research also offers additional evidence for the presence of maize and possible consumption of *chicha* in the Titicaca Basin. Despite the introduction of these lowland plants, highland communities continued to value local foods, consuming them at potential feasts and including them in offerings. The inclusion of local foods and imagery at such events may have contributed to the construction of a local community identity and strengthened community cohesion.

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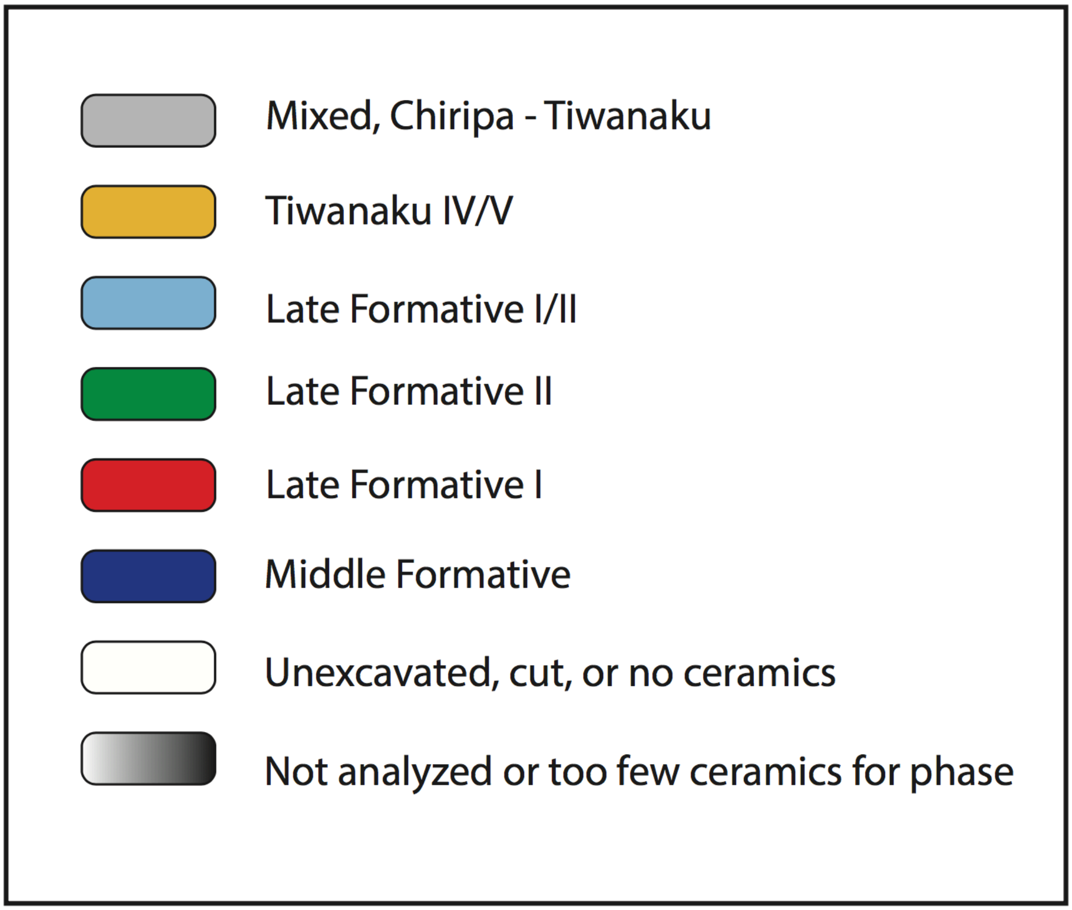
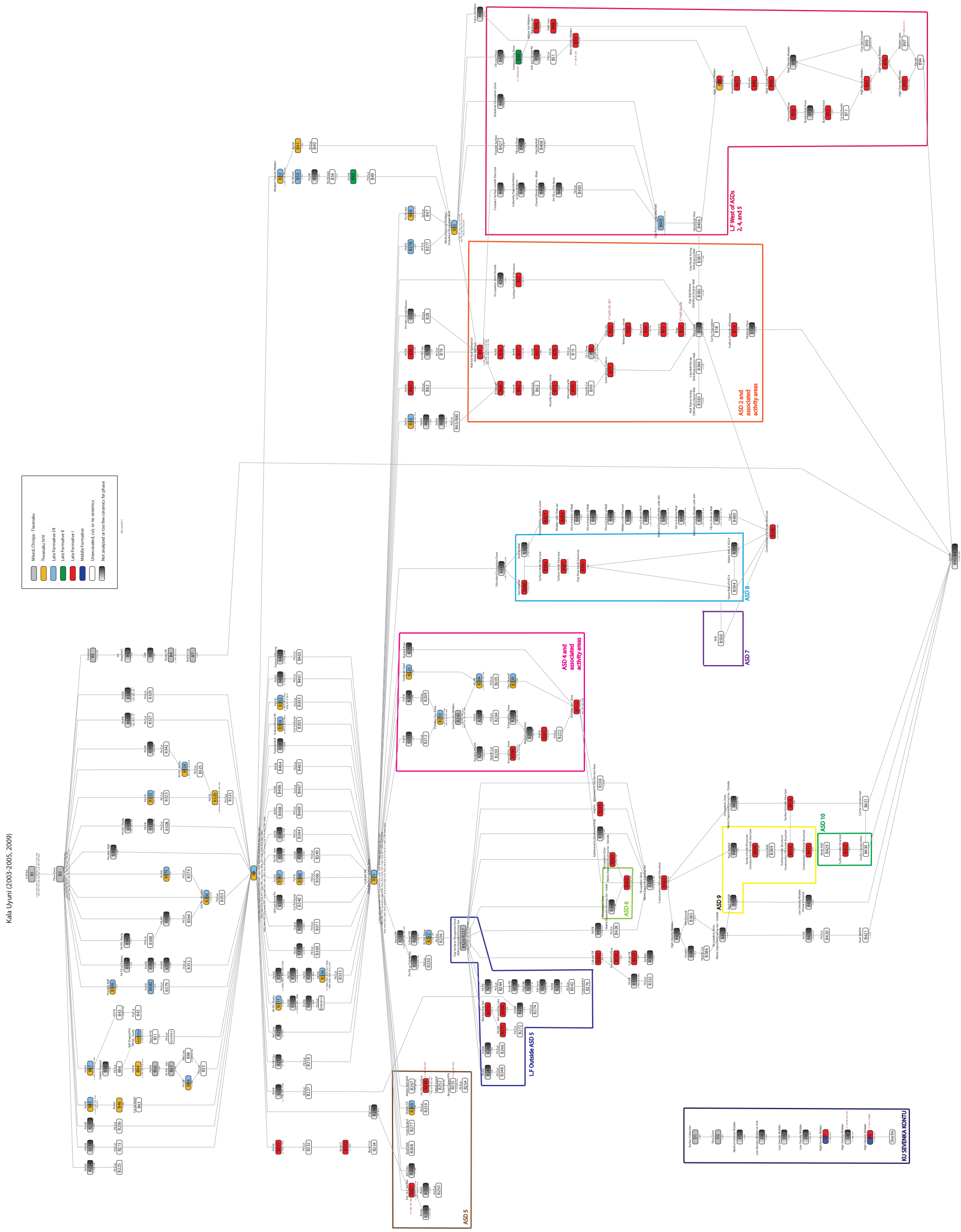
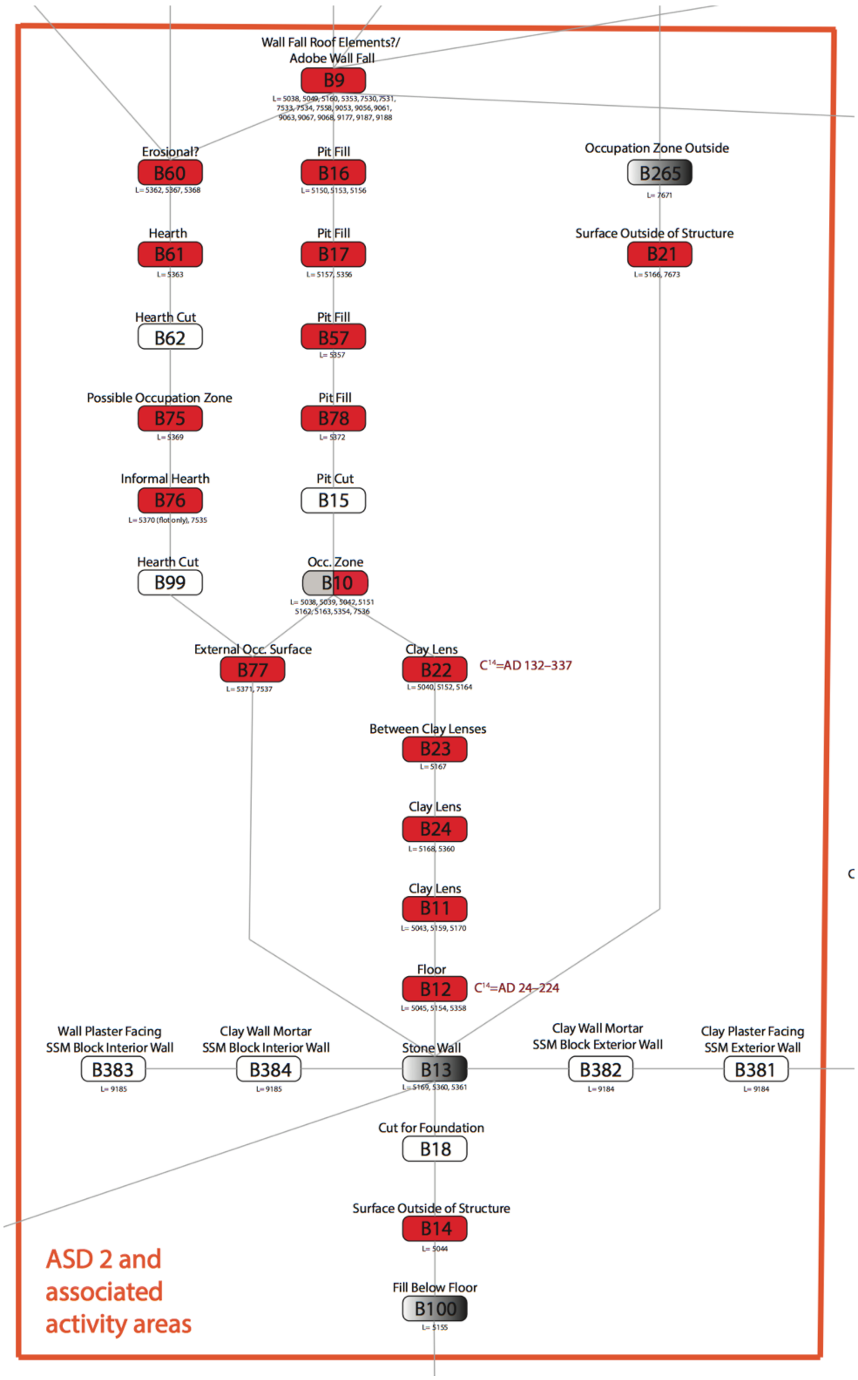
Appendix 1
Kala Uyuni Harris Matrix



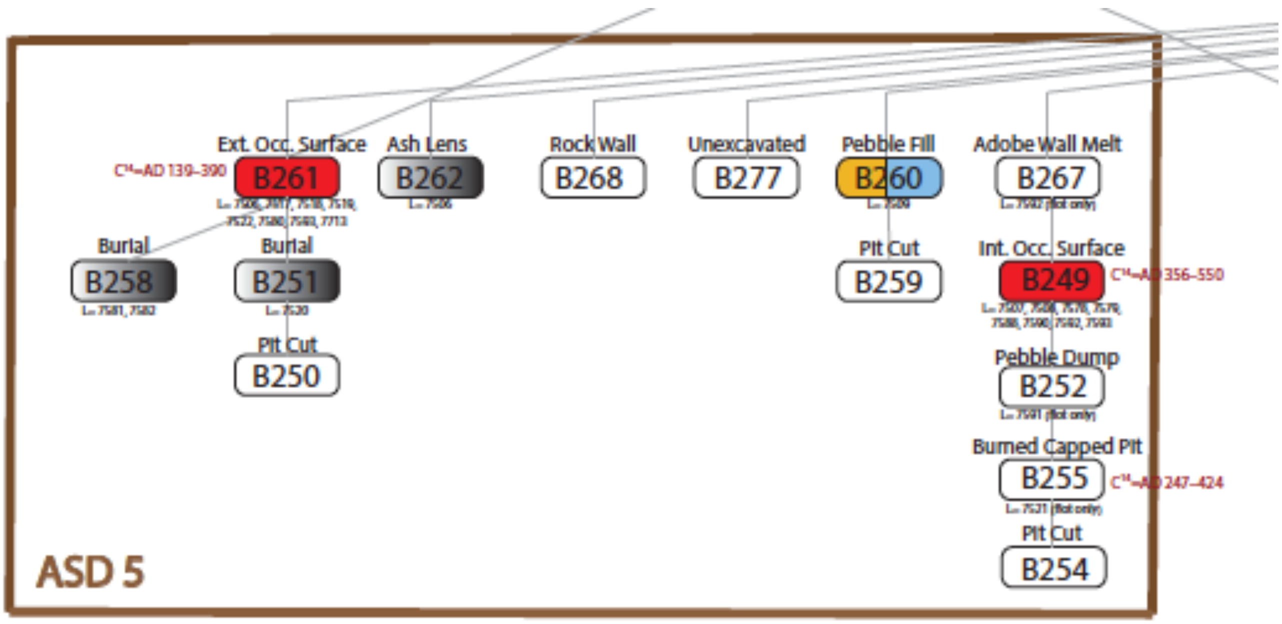
TAP Harris Matrix legend



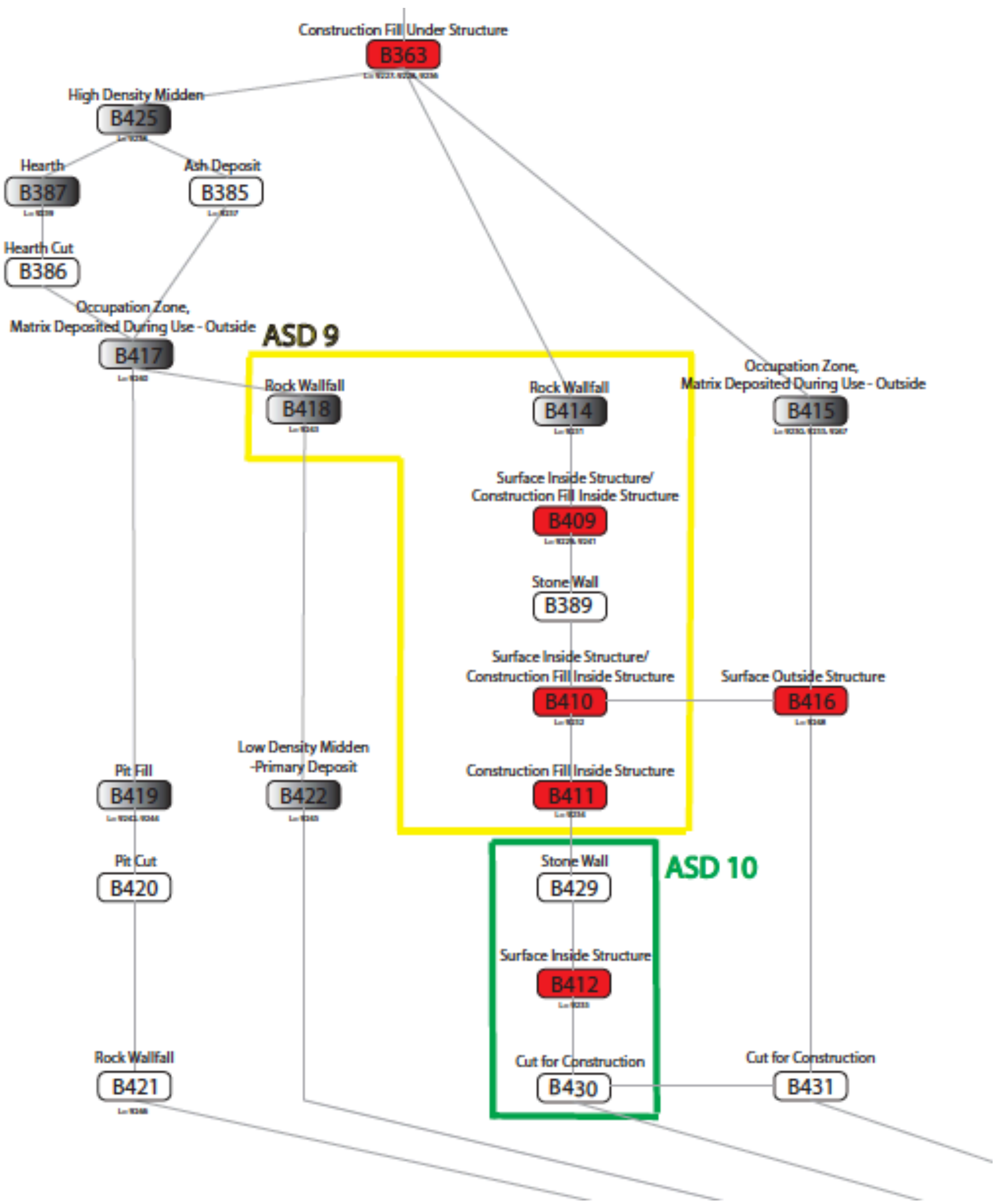
Kala Uyuni Kala Uyuni (KUKU) Harris Matrix



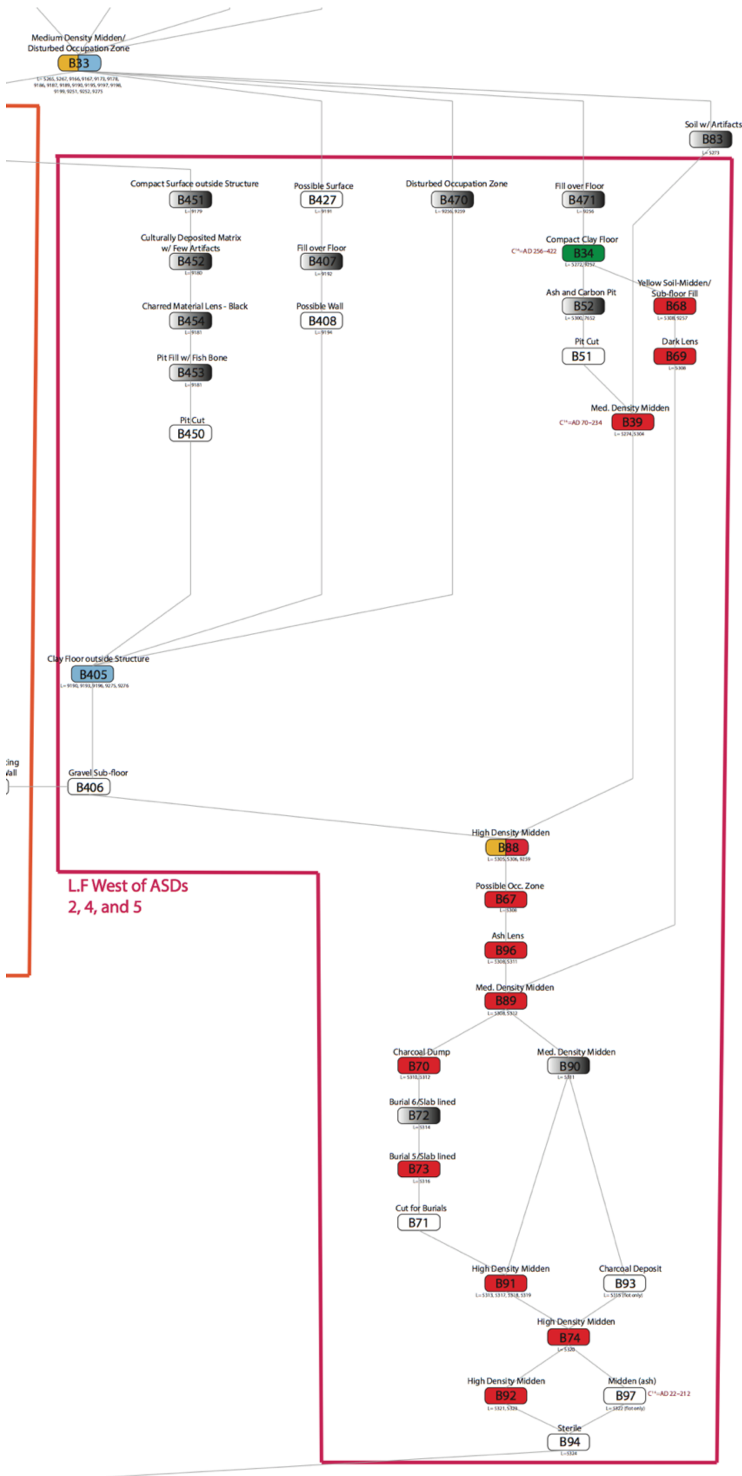
Harris Matrix for KUKU ASD-2



Harris Matrix for KUKU ASD-5



Harris Matrix for KUKU ASD-9 and ASD-10



Harris Matrix for KUKU area to the west of ASD-2, ASD-4, and ASD-5

Appendix 2
Ceramic Data and Analysis Forms

PEB Sample Number	Paste	Finish	Ext. Colour	Ext. Munsel	Ext. Carb	Int. Colour	Int. Munsel	Int. Carb	Firing	Thick	ID	Weight	Count	Analysed by
KU-5155-SER028	1	1	5	7.5YR 6/2	0	2	2.5Y 2.5/1	2.5	1	6	1	5.9	1	Sophie Reilly
OQP-16-SER001	Red, very homogenous paste. Some darker red speckles. No inclusions. Possible fiber tempered?	99	Light red	10R5/8	0	Light red	10R5/8	0	1	7.6	1	10.52	1	Sophie Reilly
OQP-15-SER003	Fairly compact. Few inclusions, some small whites. Possible traces of small fiber.	20	5 & 10	7.5YR6/4	0	5 & 10	10YR5/1	0	NC	5.5	1	14.51	1	Sophie Reilly
OQP-4-SER005	Fiber tempered. Relatively compact. Rounded white inclusions	27	15	5YR4/1	0	1	2.5YR4/2	0	2	5.6	1	5.67	1	Sophie Reilly
OQP-17-SER006	Homogenous. Few inslusions. Slightly porous. Possibly same paste as SER001	99	1	5YR6/6	0	1	5YR6/6	0	1			42.31	1	Sophie Reilly

Ceramic data from analysed non-diagnostic sherds

PEB Sample	Paste	Finish	Fire	Thick	Weight	G. ID	Form	Ext. Colour	Ext. Munsel	Ext. Luster	Ext. Contour	Ext. Mica	Ext. Dir. Finish	Ext. Carb	Int. Colour	Int. Munsel	Int. Luster	Int. Contour	Int. Mica	Int. Dir. Finish	Int. Carb	Rim	Rim / Base Diameter	Base finish	Analysed by
KU-9241-SER015	1	162	14	8	31.8	8	B10	3	2.5Y 3/1	Ma	SI	L	N/A	4	3	2.5Y 3/1	Ma	E	L	N/A	2	N/A	12	Eroded	Sophie Reilly
KU-5040/5-SER021	1	29	1 & 15	6.7	300.4	34	431	5	7.5YR 5/4	H	VE	L	H	2	5	7.5YR 6/4	M	VE	L	H	4	1	Rim: 16; Base: 9	Eroded	Sophie Reilly
KU-5318-SER039	18	8	4	Ring base: 8.7; Base: 8.7; Body: 9.3	155.4	8	B81	5	7.5YR 6/4	Ma	SI	L	H	0	5	7.5YR 6/4	Ma	I	L	D	4	N/A	12	Inside of ring looks smoothed, base eroded	Sophie Reilly
KU-7590/5-SER045	17	131	2	Base: 11.8; Body:9	122.2	8	B20	3	5YR 3/1	M	E	M	V	0	14	7.5YR 4/3	Ma	I	M	N/A	0	N/A	10	Eroded with possible remnants of burnish	Sophie Reilly

Ceramic data from Kala Uyuni diagnostic sherds

PEB Sample Number	Paste	Finish	Fire	Thick	Weight	G. ID	Form	Ext. Colour	Ext. Munsel	Ext. Luster	Ext. Contour	Ext. Mica	Ext. Dir. Finish	Ext. Carb	Int. Colour	Int. Munsel	Int. Luster	Int. Contour	Int. Mica	Int. Dir. Finish	Int. Carb	Rim	Rim / Base Diameter	Base finish	Motif	Analysed by	Notes
CH-SER005	11	25	14		1127		No TAP code - Wide restricted jar	13	2.5YR 4/4	M	VE	0	H	0	13	5YR 5.5/3	M / Ma	VE	0	H	0	29		Slip w/ burnish	Volutes; semi-circles rim interior	Kathleen Huggins	Rim luster: M; Interior luster: Ma. Interior is "peeked" with one "puncture." Kat did the ceramic analysis
CH-SER006	Unidentified. Similar to 13	26	14		342		440	1	5 YR 5/6	M	VE	0	H	0	16 (base); 13 (rim)	5YR 5/4 (base); 5YR 5/6 (Rim)	M / Ma	VE	0	H	0			No burnish	Semi circles rim interior	Kathleen Huggins	High white film encrustation
CH-SER007	3	1	14				No TAP code - Thick-walled bowl	N/A	N/A	Ma	SI	0	N/A	0	N/A	N/A	Ma	SI	0	H	0	3				Kathleen Huggins	Very eroded. Paste: visible thanks to large break, but breaks are eroded. Some blacks, small whites and transluscents, medium texture. Kat did ceramic analysis
CH-SER008	Unidentified. Similar to 13	26	14				No TAP code - llama effigy vasija	Black slip	N/A	H	VE	0	N/A	0	Black slip	N/A	H (rim); Ma (Interior)	VE	0	H	0	2		Slip w/ burnish		Kathleen Huggins	Zoomorphic / effigy vasija (camelid). Paste: spalling on back, paste visible but cannot "clean break." No large inclusions, light grey, some transluscent; fine, subcompact. Kat did ceramic analysis
CH-SER009	Black specks. Some angular transluscent specks; chunky grey angular inclusions in rim break	26	15		397		130	13	5YR 5/6	M	E	No	H	0	Can't see inside	Rim: 5YR 5/6	M/Ma	E	No	H	0	2		Slip w/ burnish	Pendand cross; semi-circles rim interior; effigy handle	Kathleen Huggins	

Ceramic data from Chiripa diagnostic vessels

PEB Sample Number	Paste	Finish	Fire	Thick	Weight	G. ID	Form	Ext. Colour	Ext. Munsel	Ext. Luster	Ext. Contour	Ext. Mica	Ext. Dir. Finish	Ext. Carb	PEB Sample Number	Int. Colour	Int. Munsel	Int. Luster	Int. Contour	Int. Mica	Int. Dir. Finish	Int. Carb	Rim	Rim / Base Diameter	Analysed by	Notes
OQP-15-SER002	Mineral temper. Subcompact. White, grey, transluscent inclusions with some blacks. Very dark mica on surface.	99*	11	Body: 6.2 Rim: 5.5	16.13	7	409	10	7.5R5/6	M	SI	M	H	0	OQP-15-SER002	10	7.5R5/6	M	E	M	H	0	1	11	Sophie Reilly	Finish: Remnants of burnish on both interior and exterior, but unable to tell whether it was complete or incomplete.
OQP-16-SER004	Compact, fairly homogenous. Small white inclusions.	99*	2	Body: 9.9 Rim: 8.1	6.56	7	210	1	10R5/6	H	VE	VS	H	0	OQP-16-SER004	1	10R5/6	H	VE	S	H	0	21	11	Sophie Reilly	Finish: Remnants of burnish on both interior and exterior, but unable to tell whether it was complete or incomplete.
OQP-3-SER007	Porous. Large black and grey inclusions. Some browns. High density of inclusions/	99	1		13.23		H99	1	10R6/6	M	E	0		0	OQP-3-SER007	1	10R5/8	M	SI	0		0			Sophie Reilly	

Ceramic data from Challapata diagnostic sherds

TAP Ceramic Attribute Analysis Forms
All forms from Roddick 2009, Appendix 2

Taraco Archaeological Project
Ceramic catalog

Locus	SL	Sitio	Norte	Este	Tipo de A	# de Diags	Peso	Fecha de A	# de Crpos	Peso	Fecha de A	# de Frgs. P	Peso

TAP Ceramic Catalog Form

Page ______ of ______

Locus:
North:
East:
Analyzed by:
Date:

Paste	Finish	Exterior Color	Exterior Carb	Interior Color	Interior Carb	Fire	Max Thick	ID	Dec	Ware	Weight	Count	Notes

Attribute analysis body sherd form

Taraco Archaeological Project

Site __________
Unit __________
____

Locus ________ Spec # ________ Date ________ Drw. ______ Anl. _______

Paste _______ Finish _______ Fire _______ Form _______ Rim _______ Wght _______
Ext: color ____
luster _________ contour _________ mica _________ dir.fnsh _________ carb ________
notes ____
Int: color ____
luster _________ contour _________ mica _________ dir.fnsh _________ carb ________
notes ____
incisions ____________ base fnsh _____________ motif ________ ware/phase ________
notes ____

Drawn diagnostic form

Taraco Archaeological Project

Site ________ Unit ________ Locus ________ Date ________ Anlyst. ________

Spec# _________ Paste _______ Fnsh _______ Fire _______ G.id _______ Form ________
Ext: color____
luster ________ contour __________ mica __________ dir.fnsh __________ carb _________
Int: color ____
luster ________ contour __________ mica __________ dir.fnsh __________ carb _________
diam _________ % of diam ________ thick: w ________ r/b ________ weight ___________
rim ________ base fnsh ________ dec code _______ motif ________ ware/phase _________
____

Spec# _________ Paste _______ Fnsh _______ Fire _______ G.id _______ Form ________
Ext: color____
luster ________ contour __________ mica __________ dir.fnsh __________ carb _________
Int: color ____
luster ________ contour __________ mica __________ dir.fnsh __________ carb _________
diam _________ % of diam ________ thick: w ________ r/b ________ weight ___________
rim ________ base fnsh ________ dec code _______ motif ________ ware/phase _________
____

Spec# _________ Paste _______ Fnsh _______ Fire _______ G.id _______ Form ________
Ext: color____
luster ________ contour __________ mica __________ dir.fnsh __________ carb _________
Int: color ____
luster ________ contour __________ mica __________ dir.fnsh __________ carb _________
diam _________ % of diam ________ thick: w ________ r/b ________ weight ___________
rim ________ base fnsh ________ dec code _______ motif ________ ware/phase _________
____

Spec# _________ Paste _______ Fnsh _______ Fire _______ G.id _______ Form ________
Ext: color____
luster ________ contour __________ mica __________ dir.fnsh __________ carb _________
Int: color ____
luster ________ contour __________ mica __________ dir.fnsh __________ carb _________
diam _________ % of diam ________ thick: w ________ r/b ________ weight ___________
rim ________ base fnsh ________ dec code _______ motif ________ ware/phase _________
____

Non-drawn diagnostic form

Paste Code	Temper Type	Paste Description
1	Mineral	Medium size, angular and subangular, black, white, translucent. Tends to have a lot of mica, subcompact, and medium texture. Fiber version would be p.18. Inclusions in p.17 finer than p.1
2	Mineral	Translucent subrounded and rounded, subcompact, medium size, medium texture, mica, and some blacks.
3	Mineral	Fine, very fine and medium white opaque, subcompact, and medium texture.
4	Mineral	Medium and fine translucent or gray angular inclusions, medium texture.
5	Mineral	Fine texture paste; fine inclusions, compact/subcompact white translucent and opaque, very few blacks. For fine and semi-nice wares.
6	Mineral	Buff color, fine texture, compact/subcompact. White, translucent, reds, fine size.
7	Mineral	Buff color, fine texture, compact/subcompact. Fine and medium reds.
8	Mineral	Medium texture, subcompact, medium size angular and subangular reds.
9	Mineral	Medium texture, subcompact. Dense translucent subrounded fine and medium size.
10	Mineral	Fine paste, compact, with medium size subangular white opaque and some translucent inclusions.
11	Mineral	Medium Texture, compact/subcompact. Medium size subrounded translucent, some opaque whites, red opaque inclusions.
12	Mineral	Fine paste, compact, fine and very fine white inclusions. For fine ware.
13	Mineral	Fine paste, dense. Very fine white, translucent, a few reds. For fine ware. Generally later than 12, apparently goes into Pacajes period.
29	Mineral	This One is MINERAL TEMPERED. Much much mica. Medium textured, translucent medium subangular incursions. Some black too. Very dense mica. Laminated appearance.

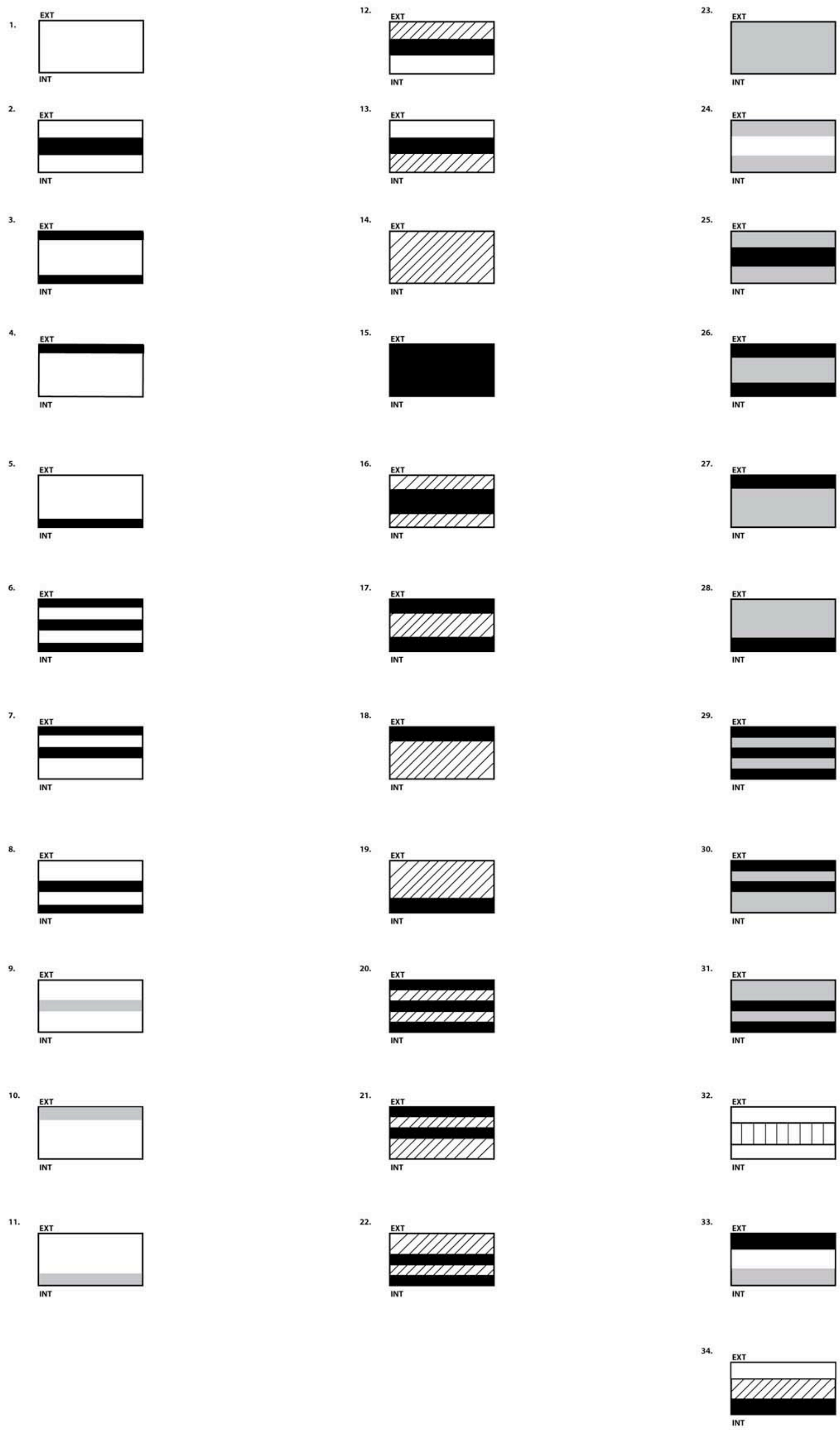
TAP paste codes: Mineral tempered pastes

Paste Code	Temper Type	Paste Description
16	Fiber	Medium texture, subangular, chunky inclusions, blacks, translucent, but predominantly whites. Medium size.
17	Fiber	Medium texture, opaque whites, some translucents, characteristic blacks. Medium size, subrounded, subangular. Tends to have lots of mica.
18	Fiber	Medium texture, chunky, angular and subangular, translucents, whites and blacks in even mix. Similar to 17 but coarser. Less mica than 17
19	Fiber	Medium texture, translucents principally, some others. Medium and fine size, subrounded (like paste 9)
20	Fiber	Medium texture, white principally, some others. Medium and fine size, subrounded. Small matte whites, speckled. Paste 16 is similar but it has large chunky whites.
21	Fiber	Medium texture. Large size angular opaque white inclusions. No mica. Red slipped ones have fewer whites, medium sized inclusions.
22	Fiber	Fine textured, melted, paste. Medium size angular inclusions. Opaque and translucent whites. Large fiber voids on surface.
23	Fiber	Fine textured pastes, very few inclusions. Fine and medium sized translucent subrounded inclusions. Little else. Sometimes, but not often is tink ware. When not tink ware, has a soft look to it, fawnlike.
24	Fiber	Fine textured paste generally, some medium textured. Very fine small white opaque inclusions. Often tink ware. Compact.
25	Fiber	Medium textured. Subangular black-gray inclusions, chunky.
26	Fiber	Medium textured. Medium and sometimes large size round translucent inclusions. Often with many air holes. Sometimes mica. Often tink ware.
27	Fiber	Buff paste fine texture. Fine opaque and translucent whites, fine reds. Little fiber.
28	Fiber	Fine paste, compact. Very fine white inclusions, plus large sized chunky opaque white, dull color (unlike lustrous quality of Paste 21 inclusions). In cases where 02 firing, the core is always gray sintered. Often is tink ware.
30	Fiber	Medium textured, crumbly look. Opaque whites, blacks, grays, distinctively pinking hue opaques. Tends to have mica.

TAP paste codes: Fiber tempered pastes

Code/Description					
1	body sherd	24	polishing tool	47	b. sherd with repair hole
2	too small b. sherd	25	possible polish. Tool	49	miniature vessel
3	b. sherd for scraping	26	figurine	50	b. sherd with basket imp.
4	adobe/tierra quemada	27	trumpet	51	very eroded sherd, no phase
5	tile	28	complete pot, or almost	52	appliqué fillet
6	dec. body sherd	29	foot	53	clay disk
7	rim	30	b. sherd with broken off handle	54	ceramic bead
8	base	31	bottle neck	55	neck with broken off handle
9	lug	32	nubbin	56	b. sherd with appliqué and vertical handle
10	rim and base	33	b. sherd wall near base	57	neck with lug
11	rim and horiz. Handle	34	more than 60% of vessel	58	base with lug
12	rim and vert. handle	35	modeled vessel	59	b. sherd with broken horiz. Handle
13	base and horiz. Handle	36	rim and lug	60	b. sherd with broken vertical handle
14	base and vert. handle	37	b. sherd flat part of base	61	carinated sherd
15	rim, base and horiz handle	38	hemispherical object	62	sherd from incensario
16	rim, base and vert. handle	39	mix shapes for plow zone and C analysis	63	ear plug
17	rim, base and lug	40	scallop	64	lip plug
18	horiz. Handle	41	possible carination angle	65	neck with broken off vertical handle
19	vertical handle	42	less than 60% of vessel	66	Decorated Rim Sherd
20	handle (no orientation)	43	curved body. Glob. Vessel	67	Decorated body sherd with repair hole
21	neck	44	pierced rim scallop	98	non ceramic given a cat # by mistake
22	spindle whorl	45	rim loop, no rim	99	unknown
23	blank spindle whorl	46	rim sherd with loop		

TAP ceramic ID codes



TAP ceramic firing codes: black=black, white=red-brown, gray=light brown, diagonal hatch= brown, vertical lines=purple

Code/Ext Surface/Interior Surface		
1	Wiped	Wiped
2	Wiped	Smoothed
3	Wiped	Rubbed
4	Wiped	Incomplete Burnish
5	Wiped	Complete Burnish
6	Grainy Wipe	Wiped
7	Smoothed	Smoothed
8	Smoothed	Wiped
9	Smoothed	Rubbed
10	Smoothed	Incomplete Burnish
11	Smoothed	Complete Burnish
12	Smoothed	Retocado
13	Incomplete Smoothed over Grainy Surface	Wiped
14	Rubbed	Rubbed
15	Rubbed	Wiped
16	Rubbed	Smoothed
17	Rubbed	Incomplete Burnish
18	Rubbed	Complete burnish
19	Incomplete Burnish	Incomplete Burnish
20	Incomplete Burnish	Wiped
21	Incomplete Burnish	Smoothed
22	Incomplete Burnish	Rubbed
23	Incomplete Burnish	Complete Burnish
24	Incomplete Burnish over grainy surface	Wiped
25	Complete Burnish	Complete Burnish

TAP surface finish codes

Code/Ext Surface/Interior Surface		
26	Complete Burnish	Wiped
27	Complete Burnish	Smoothed
28	Complete Burnish	Rubbed
29	Complete Burnish	Incomplete Burnish
30	Stucco	Wiped
31	Stucco	Smoothed/Worn
32	Stucco	Rubbed
33	Stucco	Incomplete Burnish
34	Stucco	Complete Burnish
35	Very Fine Complete Burnish	Very fine Complete Burnish
36	Very Fine Complete Burnish	Wiped
37	Very Fine Complete Burnish	Fine Wipe
38	Very Fine Complete Burnish	Smoothed
39	Smoothed	Very fine Complete Burnish
40	Very Fine Complete Burnish	Complete Burnish
41	Complete Burnish	Retocado
42	Complete Burnish	Very fine Complete Burnish
43	Fine Line Scrape	Fine Line Scrape
44	Smoothed	Fine Line Scrape
45	Striate Burnish	Striate Burnish
46	Stucco	Striate Burnish
47	Fine Line Scrape	Smoothed
48	Striate Burnish	Incomplete Burnish
49	Rubbed	Striate Burnish
50	Wiped	Striate Burnish

TAP surface finish codes

Code/Ext Surface/Interior Surface		
51	Grainy Wipe	Incomplete Burnish
52	Complete Burnish	Striate Burnish
53	Incomplete Burnish	Fine Line Scrape
54	Striate Burnish	Fine Line Scrape
55	Incomplete Burnish	Retocado
56	Incomplete Burnish	Striate Burnish
57	Smoothed	Striate Burnish
58	Grainy Wipe	Smoothed
59	Grainy Wipe	Complete Burnish
60	Complete Burnish	Stucco
61	Stucco	Stucco
99	Eroded	Eroded
100	Wiped	Not recorded
101	Wiped	Eroded
110	Smoothed	Not recorded
111	Smoothed	Eroded
120	Complete Burnish	Not Recorded
121	Complete Burnish	Eroded
130	Incomplete Burnish	Not Recorded
131	Incomplete Burnish	Eroded
140	Stucco	Not Recorded
141	Stucco	Eroded
150	Rubbed	Not Recorded
151	Rubbed	Eroded
160	Very Fine Complete Burnish	Not Recorded
161	Very Fine Complete Burnish	Eroded

TAP surface finish codes

Munsell/ Color Description					
7.5R 3/6	Red Slip	10R 4/5	Red Slip	10R 4.5/6	Light Red Slip
7.5R 3/6.5	Red Slip	10R4.5/5	Red Slip	10R 4.5/7	Light Red Slip
7.5R 3/7	Red Slip	10R 4/6	Red Slip	10R 4.5/8	Light Red Slip
7.5R 3/7.5	Red Slip	10R 4.5/4	Red Slip	10R 5/5	Light Red Slip
7.5R 3/8	Red Slip	10R 5/4	Red Slip	10R 5/6	Light Red Slip
7.5R 3.5/4	Red Slip	7.5R 3/4	Dark Red Slip	10R 5/7	Light Red Slip
7.5R 3.5/5	Red Slip	7.5R 3/5	Dark Red Slip	10R 5/8	Light Red Slip
7.5R 3.5/6	Red Slip	7.5R 3.5/2	Dark Red Slip	2.5YR 3/4	Red Brown Slip
7.5R 4/4	Red Slip	10R 3/2	Dark Red Slip	2.5YR 3/5	Red Brown Slip
7.5R 4/5	Red Slip	10R 3/3	Dark Red Slip	2.5YR 3/6	Red Brown Slip
7.5R 4/6	Red Slip	10R 3/4	Dark Red Slip	2.5YR 3.5/4	Red Brown Slip
10R 3/6	Red Slip	10R 3/5	Dark Red Slip	2.5YR 3.5/5	Red Brown Slip
10R 3/7	Red Slip	10R 3.5/2	Dark Red Slip	2.5YR 3.5/6	Red Brown Slip
10R 3/8	Red Slip	10R 3.5/3	Dark Red Slip	2.5YR 4/2	Red Brown Slip
10R 3.5/4	Red Slip	7.5R 4/7	Light Red Slip	2.5YR 4/3	Red Brown Slip
10R 3.5/5	Red Slip	7.5R 4/8	Light Red Slip	2.5YR 4/4	Red Brown Slip
10R 3.5/6	Red Slip	7.5R 4.5/6	Light Red Slip	2.5YR 4/5	Red Brown Slip
10R 3.5/7	Red Slip	7.5R 4.5/7	Light Red Slip	2.5YR 4/6	Red Brown Slip
10R 3.5/8	Red Slip	7.5R 4.5/8	Light Red Slip	2.5YR 4.5/4	Red Brown Slip
10R 4/3	Red Slip	10R 4/7	Light Red Slip	2.5YR 4.5/5	Red Brown Slip
10R 4/4	Red Slip	10R 4/8	Light Red Slip	2.5YR 4.5/6	Red Brown Slip

TAP Munsell: colour categorization

Munsell/ Color Description					
2.5YR 4.5/7	Red Brown Slip	5YR 4/3	Brown Slip	10YR 3/3	Brown Slip
2.5YR 5/4	Red Brown Slip	5YR 4/4	Brown Slip	10YR 4/2.5	Brown Slip
2.5YR 5/5	Red Brown Slip	5YR 4/5	Brown Slip	10YR 4/3	Brown Slip
2.5YR 5/6	Red Brown Slip	5YR 4/6	Brown Slip	10YR 4/4	Brown Slip
2.5YR 2.5/2	Drk Red Brown Slip	5YR 4.5/3	Brown Slip	10YR 4.5/3	Brown Slip
2.5YR 3/2	Drk Red Brown Slip	5YR 4.5/4	Brown Slip	5YR 2.5/2	Drk Brown Slip
2.5YR 3/3	Drk Red Brown Slip	5YR 4.5/5	Brown Slip	5YR 2.5/3	Drk Brown Slip
2.5YR 3.5/2	Drk Red Brown Slip	5YR 4.5/6	Brown Slip	5YR 3/2	Drk Brown Slip
2.5YR 3.5/3	Drk Red Brown Slip	7.5YR 3/3	Brown Slip	5YR 3/2.5	Drk Brown Slip
5YR 3/3	Brown Slip	7.5YR 3/4	Brown Slip	5YR 3.5/2	Drk Brown Slip
5YR 3/4	Brown Slip	7.5YR 3.5/3	Brown Slip	7.5YR 2/2	Drk Brown Slip
5YR 3.5/3	Brown Slip	7.5YR 3.5/4	Brown Slip	7.5YR 2/3	Drk Brown Slip
5YR 3.5/4	Brown Slip	7.5YR 4/2	Brown Slip	7.5YR 3/2	Drk Brown Slip
5YR 3.5/5	Brown Slip	7.5YR 4/3	Brown Slip	7.5YR 3/2.5	Drk Brown Slip
5YR 3.5/6	Brown Slip	7.5YR 4/4	Brown Slip	7.5YR 3.5/2	Drk Brown Slip
5YR 4/1.5	Brown Slip	7.5YR 4.5/3	Brown Slip	10YR 3/1.5	Drk Brown Slip
5YR 4/2	Brown Slip	7.5YR 4.5/4	Brown Slip	10YR 3/2	Drk Brown Slip

TAP Munsell: colour categorization

Munsell/ Color Description					
10YR 4/1.5	Drk Brown Slip	7.5YR 6/3	Lt Brown Slip	7.5YR 2.75/0	Black Slip
5YR 5/3	Lt Brown Slip	7.5YR 6/4	Lt Brown Slip	10YR 2/1	Black Slip
5YR 5/4	Lt Brown Slip	7.5YR 6/5	Lt Brown Slip	2.5Y 2/0	Black Slip
5YR 5/5	Lt Brown Slip	10YR 5/3	Lt Brown Slip	2.5YR 4/0	Gray Brown Slip
5YR 5/6	Lt Brown Slip	10YR 5/4	Lt Brown Slip	5YR 3/1	Gray Brown Slip
5YR 5.5/4	Lt Brown Slip	10YR 5/5	Lt Brown Slip	5YR 3.5/1	Gray Brown Slip
5YR 5.5/5	Lt Brown Slip	10YR 5.5/2	Lt Brown Slip	5YR 4/1.5	Gray Brown Slip
5YR 5.5/6	Lt Brown Slip	10YR 5.5/3	Lt Brown Slip	5YR 4.5/1	Gray Brown Slip
5YR 6/4	Lt Brown Slip	10YR 5.5/4	Lt Brown Slip	7.5YR 3/1	Gray Brown Slip
5YR 6/5	Lt Brown Slip	10YR 6/2.5	Lt Brown Slip	7.5YR 4/1	Gray Brown Slip
7.5YR 5/2	Lt Brown Slip	10YR 6/3	Lt Brown Slip	10YR 3/1	Gray Brown Slip
7.5YR 5/3	Lt Brown Slip	10YR 6/4	Lt Brown Slip	10YR 4/1	Gray Brown Slip
7.5YR 5/4	Lt Brown Slip	10YR 6/5	Lt Brown Slip	5YR 8/3	White Slip
7.5YR 5/5	Lt Brown Slip	5YR 6/3	Lt Brown Slip	7.5YR 8/2	White Slip
7.5YR 5/6	Lt Brown Slip	2.5YR 2/0	Black Slip	7.5YR 8/3	White Slip
7.5YR 5.5/2	Lt Brown Slip	2.5YR 2.5/0	Black Slip	10YR 7/2	White Slip
7.5YR 5.5/3	Lt Brown Slip	5YR 2/1	Black Slip	10YR 8/2	White Slip
7.5YR 5.5/4	Lt Brown Slip	5YR 2.75/1	Black Slip	10YR 8/3	White Slip
7.5YR 6/2.5	Lt Brown Slip	7.5YR 2.5/0	Black Slip	5YR 7/3	Cream Slip

TAP Munsell: colour categorization

Munsell/ Color Description					
5YR 7/4	Cream Slip	10YR 7.5/4	Cream Slip	2.5YR 3/4	Red brown Unslipped
7.5YR 6/5	Cream Slip	10YR 8/4	Cream Slip	2.5YR 3/5	Red brown Unslipped
7.5YR 6.5/4	Cream Slip	7.5YR 6/7	Yellow Slip	2.5YR 3/6	Red brown Unslipped
7.5YR 6.5/5	Cream Slip	7.5YR 7/7	Yellow Slip	2.5YR 4/4	Red brown Unslipped
7.5YR 7/3	Cream Slip	10YR 6.5/6	Yellow Slip	2.5YR 4/5	Red brown Unslipped
7.5YR 7/4	Cream Slip	10YR 7/6	Yellow Slip	2.5YR 4/6	Red brown Unslipped
7.5YR 7/5	Cream Slip	7.5YR 5.5/6	Yellow Cream Slip	2.5YR 5/4	Red brown Unslipped
7.5YR 8/4	Cream Slip	7.5YR 6/6	Yellow Cream Slip	2.5YR 5/5	Red brown Unslipped
7.5YR 8/5	Cream Slip	7.5YR 7/6	Yellow Cream Slip	2.5YR 5/6	Red brown Unslipped
10YR 6.5/2	Cream Slip	5YR 6/6	Yellow Orange Slip	2.5YR 4/3	Red brown Unslipped
10YR 6.5/3	Cream Slip	5YR 6/7	Yellow Orange Slip	2.5YR 6/5	Red brown Unslipped
10YR 6.5/4	Cream Slip	5YR 6.5/6	Yellow Orange Slip	5YR 4/4	Red brown Unslipped
10YR 7/2.5	Cream Slip	5YR 7/6	Yellow Orange Slip	5YR 4/5	Red brown Unslipped
10YR 7/3	Cream Slip	2.5YR 4.5/8	Orange Slip	5YR 4/6	Red brown Unslipped
10YR 7/4	Cream Slip	2.5YR 5/7	Orange Slip	5YR 4.5/4	Red brown Unslipped
10YR 7/5	Cream Slip	2.5YR 6/7	Orange Slip	5YR 4.5/5	Red brown Unslipped
10YR 7.5/3	Cream Slip	5YR 5.5/8	Orange Slip	5YR 4.5/6	Red brown Unslipped

TAP Munsell: colour categorization

Munsell/ Color Description					
5YR 5/3.5	Red brown Unslipped	5YR 3.5/4	Brown Unslipped	10YR 3/2	Brown Unslipped
5YR 5/4	Red brown Unslipped	5YR 4/2	Brown Unslipped	10YR 4/2	Brown Unslipped
5YR 5/5	Red brown Unslipped	5YR 4/3	Brown Unslipped	10YR 4/3	Brown Unslipped
5YR 5/6	Red brown Unslipped	5YR 4/3.5	Brown Unslipped	10YR 4/4	Brown Unslipped
5YR 6/6	Red brown Unslipped	7.5YR 3/2	Brown Unslipped	5YR 5/2	Light Brown Unslipped
5YR 5.5/6	Red brown Unslipped	7.5YR 3/3	Brown Unslipped	5YR 5/3	Light Brown Unslipped
2.5YR 4/7	Red/Orange Unslipped	7.5YR 3/4	Brown Unslipped	5YR 5.5/2	Light Brown Unslipped
2.5YR 5/7	Red/Orange Unslipped	7.5YR 3.5/2	Brown Unslipped	5YR 5.5/3	Light Brown Unslipped
2.5YR 6/6	Red/Orange Unslipped	7.5YR 3.5/3	Brown Unslipped	5YR 5.5/4	Light Brown Unslipped
10R 4.5/8	Red/Orange Unslipped	7.5YR 3.5/4	Brown Unslipped	5YR 5.5/5	Light Brown Unslipped
2.5YR 3/2	Brown Unslipped	7.5YR 4/2	Brown Unslipped	5YR 6/4	Light Brown Unslipped
5YR 3/1.5	Brown Unslipped	7.5YR 4/3	Brown Unslipped	5YR 6/5	Light Brown Unslipped
5YR 3/2	Brown Unslipped	7.5YR 4/4	Brown Unslipped	5YR 7/4	Light Brown Unslipped
5YR 3/3	Brown Unslipped	7.5YR 4.5/2	Brown Unslipped	5YR 7/5	Light Brown Unslipped
5YR 3/4	Brown Unslipped	7.5YR 4.5/3	Brown Unslipped	7.5YR 5/2	Light Brown Unslipped
5YR 3.5/2	Brown Unslipped	7.5YR 4.5/4	Brown Unslipped	7.5YR 5/3	Light Brown Unslipped
5YR 3.5/3	Brown Unslipped	10YR 3/1.5	Brown Unslipped	7.5YR 5/4	Light Brown Unslipped

TAP Munsell: colour categorization

Munsell/ Color Description			
7.5YR 5/5	Light Brown Unslipped	7.5YR 2.5/0	Black Unslipped
7.5YR 5.5/4	Light Brown Unslipped	2.5Y 2/0	Black Unslipped
7.5YR 6/4	Light Brown Unslipped	2.5YR 3/0	Gray/Gray Brown Unslipped
7.5YR 6/5	Light Brown Unslipped	2.5YR 4/0	Gray/Gray Brown Unslipped
7.5YR 6.5/4	Light Brown Unslipped	5YR 2.75/1	Gray/Gray Brown Unslipped
7.5YR 6.5/5	Light Brown Unslipped	5YR 3/1	Gray/Gray Brown Unslipped
7.5YR 6.5/6	Light Brown Unslipped	5YR 3.5/1	Gray/Gray Brown Unslipped
10YR 5/2	Light Brown Unslipped	5YR 4/1	Gray/Gray Brown Unslipped
10YR 5.5/6	Light Brown Unslipped	5YR 4/1.5	Gray/Gray Brown Unslipped
10YR 5.5/3	Light Brown Unslipped	7.5YR 2/2	Gray/Gray Brown Unslipped
10YR 6/3	Light Brown Unslipped	7.5YR 3/0	Gray/Gray Brown Unslipped
7.5YR 6/3	Light Brown Unslipped	7.5YR 3.5/0	Gray/Gray Brown Unslipped
10YR 6/4	Light Brown Unslipped	10YR 3/1	Gray/Gray Brown Unslipped
2.5YR 2.5/0	Black Unslipped	10YR 4/1	Gray/Gray Brown Unslipped
5YR 2/1	Black Unslipped	2.5Y 3/0	Gray/Gray Brown Unslipped
5YR 2.5/1	Black Unslipped	2.5Y 4.5/0	Gray/Gray Brown Unslipped
7.5YR 2/0	Black Unslipped	2.5Y 4/0	Gray/Gray Brown Unslipped

TAP Munsell: colour categorization

Code/Exterior Color			
1	red brown	25	yellow cream on red
2	black	26	yellow orange on red
3	gray, gray brown	27	black on cream
4	brown	28	orange on red
5	light brown	29	cream on brown
6	mottled black, brown and red brown	30	cream on red
7	mottled brown and red brown	31	cream on red brown
8	red orange	32	black on red
9	mottled black and brown	33	black on red brown
10	red slip	34	black and cream on red
11	dark red slip	35	black and cream on red brown
12	light red slip	36	cream on dark red
13	red brown slip	37	cream on light red
14	brown slip	38	black on dark red
15	dark brown slip	39	black on light red
16	light brown slip	40	black and cream on dark red
17	cream slip	41	black and cream on light red
18		42	black and red on cream
19	gray brown slip	43	dark brown and cream on red
20	dark red brown slip	44	dark brown and cream on red brown
21	yellow orange slip	45	dark brown and cream on unslipped red brown
22	orange slip	46	black and red on unslipped red brown
23	yellow orange on dark red	47	black and red on light brown
24	white on red	48	dark brown and red on light brown

TAP ceramic colour codes

Code/Exterior Color			
49	red on yellow orange	76	cream on unslipped red brown
50	red on light brown	77	light brown on red
51	red on cream	78	light brown on light red
52	light red on cream	79	light brown on uslipped brown
53	dark red on cream	80	dark brown on red
54	red on brown	81	dark brown on light red
55	dark red on light brown	82	dark brown on dark red
56	red on yellow orange	83	dark brown on cream
57	red on yellow cream	84	dark brown on unslipped red brown with red rim
58	light red on light brown	85	balck on light brown
59	red on orange	86	dark brown on light brown
60	red on unslipped red brown	87	dark brown on cream with red rim
61	dark red on unslipped light brown	88	dark brown on orange
62	red on unslipped brown	89	light brown on r/b
63	red on unslipped black	90	red brown and orange on unslipped brown
64	red on unslipped mottled	91	white and black and yellow/orange on red
65	red brown on unslipped red brown	92	black and white and cream on brown
66	red brown on unslipped brown	93	black and orange on red
67	red brown on unslipped black	94	black and cream on brown
68	red brown on unslipped mottled	95	black and yellow cream on red
69	red on unslipped light brown	96	black and light brown on red
70	brown on unslipped red brown	97	black and cream on unslipped red brown
71	brown on unslipped brown	98	dark brown and light brown on red
72	brown on unslipped black	99	misc.
73	dark red on unslipped red brown	100	yellow on red
74	black on unslipped red brown	101	red brown on light brown
75	brown on unslipped gray		

TAP ceramic colour codes

Code/Exterior Color			
102	yellow cream on red brown	116	light red on unslipped red orange
103	red on red brown	117	black on brown
104	dark brown and red on unslipped red brown	118	brown on u/s l.brown
105	red brown on unslipped light brown	119	orange on dark red
106	black on unslipped light brown	120	d. brown + red on u/s l. brown
107	red brown on brown	121	black + l.red + white on u/s light brown
108	light red on unslipped light brown	122	yellow orange on light red
109	light red on unslipped red brown	123	cream on dark brown with red rim
110	black and red on unslipped light brown	124	black and yellow cream on red brown
111	black and light red on unslipped light brown	125	red brown on cream
112	light red on orange	126	red on yellow
113	dark brown and red brown on unslipped red brown	127	dark brown and red on cream
114	light red on red brown	128	red on dark brown
115	black and light red on unslipped red brown	129	cream on brown with red brown rim

TAP ceramic colour codes

Code/Slip Location	
1	All over sherd
2	neck only ext
3	neck only int
4	neck only both int and ext
5	on top of rim only
6	ext all over and int. neck only
7	dec on u/s background
8	top of rim and a bit on int.
9	ext all over and a few cm down int.
10	ext wall, but not as far down as base (or in band)
11	ext wall in band, int wall in band
12	underside of base
13	interior only in band
14	ext band on body (not rim), int. in band

TAP slip location codes

Code/ DecType			
1	Chiripa Cream on red	21	Chiripa black/dark brown with red rim (Qaluyu copy)
2	Chiripa black and cream on red	22	Chiripa dark brown on red (Qaluyu copy)
3	Chiripa black on red, (Could be some cream somewhere)	23	Chiripa misc. one color on unslipped
4	Chiripa black on red (Fairly certain no cream)	24	Early Chiripa/Middle Chiripa bi-level raised areas
5	Chiripa single color wide line incised	25	Chiripa black and cream on red modeled
6	Chiripa single color incised	26	Chiripa black on red modeled
7	Chiripa black and cream on red incised	27	Chiripa cream on brown with red rim
8	Chiripa red on cream	28	Chiripa modeled + incised (single color slip)
9	Chiripa modeled (Single color slip)	29	Chiripa red on cream modeled
10	Chiripa dark brown on cream	30	Chiripa miscellaneous
11	Chiriap cream on red modeled	31	Chiripa red on cream modeled + incised
12	Chiripa cream on red incised	32	EC/MC red on cream with bi-level raised areas
13	Chiripa cream on red modeled and incised	40	Tiwanaku I/III red banded bowl
14	Chiripa black/dark brown and cream with red (Qaluyu copy)	41	Tiwanaku I black and red on light brown incised
15	Chiripa applique fillet/ridge	42	Tiwanaku I black and red and unslipped red brown or light brown incised
16	Chiripa black on red incised	43	Tiwanaku I black and red on light brown
17	Chiripa cream on brown	44	Tiwanaku I black and red and unslipped
18	Chirpa cream on red and applique fillet	45	Tiwanaku I single color incised
19	Chiripa black on red modeled and incised	46	Tiwanaku I black and unslipped incised
20	Chiripa misc. two colors painted		

TAP ceramic decoration codes

Code/ DecType			
47	Tiwanaku I modeled (single color slip)	60	Tiwanaku III balck and orange on light brown
48	Tiwanaku I black and red and light brown incised	61	Tiwanaku III black on unslipped red brown
49	Tiwanaku I applique fillet, ridge, band	62	Tiwanaku III black on unslipped light brown
50	Tiwanaku I black and red incised	63	Tiwanaku III black on light brown
51	Tiwanaku I red and unslipped	64	Tiwanaku III single color incised
52	Tiwanaku I black on red brown	65	Tiwanaku III black and red on unslipped light brown
53	Tiwanaku I red banded and incised lug	66	Tiwanaku III black and cream on red
54	Tiwanaku I applique fillet, ridge, band incised	67	Tiwanaku I/III rim scalloops
55	Tiwanaku I red banded and applique fillet, ridge, band	68	Tiwanaku III black + red + white on u/s l.brown
56	Tiwanaku I red and unslipped incised	96	Modern Decorated
57	Tiwanku I black on light brown incised	97	Pacajes decorated
58	Tiwanaku I black on red	98	Tiwanaku I/III decorated (From before had other codes)
59	Tiwanaku I red banded + lug	99	Tiwanaku IV/V decorated

TAP ceramic decoration codes

Code/Decoration Type			
1	Painted in 2 colors	15	Painted in 1 color on unslipped background
2	Painted in 3 colors	16	Incised and 1 slip color and post-fire
3	Painted in 4 colors	17	Painted in 2 colors with unslipped areas
4	Incised on unslipped	18	painted 1 slip color with raised areas
5	incised and 1 slip color	19	modeled and 3 slip areas
6	Incised and 2 slip colors	20	incised and 2 slip colors with unslipped areas
7	Incised and 3 slip colors	21	post-fire on unslipped (no incision)
8	Incised, unslipped area and 1 slip color	22	incised applique, lug or fillet
9	Modeled unslipped	23	painted in 2 colors + post-fire
10	modeled and 1 slip colors	90	Simple band of color on rim or neck
11	Modeled and 2 slip colors	91	Slipped base, when wall is unslipped
12	Modeled and Incised and 1 slip color	92	band of color and incised lug, fillet or applique
13	Modeled and incised and 2 slip color	93	band of color plus incision

TAP decoration type codes

Code/Decoration location	
1	ext. wall
2	ext. globular body of necked vessel
3	exterior neck or neck joint of necked vessel
4	exterior wall, bowl, to just under base
5	exterior wall, bowl, to joint with base
6	interior wall, bowl, to joint with base
7	exterior wall, bowl, to just above base
8	exerior wall, bowl, to just under rim and int. coming down from rim
9	ext and int. wall
10	int wall, bowl, coming down from rim
11	top of rim
12	ext. wall, bowl, to joint with base and int. wall
13	ext wall on wide band of thick at rim
14	on handle
15	ext wall and int bottom of vessel

TAP decoration location codes

Code/General Category/Specific Form		
100	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Medium Necked Jar (No angle, but have neck height)
101	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Same as 100, with vertical Rim to Body Handle
102	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Same as 100, with vertical Handle just below rim
109	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Possible Medium Necked Jar (no angle, no neck height)
110	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall Necked Jar, No Angle
111	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall or Medium Jar, No Angle
112	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall or Medium Jar, sl. Flared, (Not olla, as is over 4)
113	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall or Medium Jar, flared (definitely not olla)
114	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall or Medium Jar, Straight
115	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall or Medium Jar, Straight, with lug on neck
116	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall or Medium Jar, Sl. Flared, vertical handle t below rim
119	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Possible Tall necked jar
120	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Medium Necked Very Flared Jar (<35)
130	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Medium Necked Flared Jar (35-55_
131	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Same as 130, with vertical handle rim to body
140	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Medium Necked Slightly Flared Jar (56-77)
141	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Same as 140, with vertical rim to body handle
142	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Same as 140, with vertical just below rim to body handle
150	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Medium Necked straight Jar (78-94)
151	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Same as 150, with Vertical rim to body handle
152	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Same as 150, with Vertical handle just below rim
160	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall necked very flared jar
170	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall Necked Flared Jar
180	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall Necked Slightly Flared jar
181	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Same as 180, with vertical rim to body handle
182	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Same as 180, with vertical handle just below rim
190	Tall (> 6 cm) Medium (4-5.9) Necked Vessels	Tall Necked straight Jar

TAP ceramic form codes: Tall and medium jars

Code/General Category/Specific Form		
200	Necked Vessels (Medium ollas or Jars…no height)	Necked Vessel, No Angle
201	Necked Vessels (Medium ollas or Jars…no height)	Same as 200, with verticle handle just below rim
202	Necked Vessels (Medium ollas or Jars…no height)	Same as 200, with vertical handle just above neck joint
203	Necked Vessels (Medium ollas or Jars…no height)	Same as 200, with vertical handle at rim
209	Necked Vessels (Medium ollas or Jars…no height)	Possible Necked Vessel
210	Necked Vessels (Medium ollas or Jars…no height)	Flared Necked Vessel
220	Necked Vessels (Medium ollas or Jars…no height)	Slightly Flared Necked Vessel
230	Necked Vessels (Medium ollas or Jars…no height)	Straight Necked Vessel
231	Necked Vessels (Medium ollas or Jars…no height)	Same as 230, with vertical handle at rim
240	Necked Vessels (Medium ollas or Jars…no height)	Inclined Necked Vessel
250	Necked Vessels (Medium ollas or Jars…no height)	Neckless Olla, no angle
251	Necked Vessels (Medium ollas or Jars…no height)	Extremely inclined neckless olla, 165-175
252	Necked Vessels (Medium ollas or Jars…no height)	Very inclined neckless olla, 150-164
253	Necked Vessels (Medium ollas or Jars…no height)	Inclined Neckless Olla, 135-149
254	Necked Vessels (Medium ollas or Jars…no height)	Slightly Inclined Neckless Olla, 113-134
255	Necked Vessels (Medium ollas or Jars…no height)	Inclined Neckless Olla with horizontal lug
256	Necked Vessels (Medium ollas or Jars…no height)	Slightly Inclined with horizontal lug

TAP ceramic form codes: Tall and medium necked vessels

Code/General Category/Specific Form		
300	Ollas, Short (<2) and Medium (2.1-3.9)	Short Necked flared olla
310	Ollas, Short (<2) and Medium (2.1-3.9)	Short-Necked Slightly Flared Olla
311	Ollas, Short (<2) and Medium (2.1-3.9)	Same as 310, with rim to body vertical handle
319	Ollas, Short (<2) and Medium (2.1-3.9)	Possible Short Necked Olla
320	Ollas, Short (<2) and Medium (2.1-3.9)	Short-Necked Straight Olla
321	Ollas, Short (<2) and Medium (2.1-3.9)	Same as 320 With Horizontal Lug
322	Ollas, Short (<2) and Medium (2.1-3.9)	Same as 320, With Vertical Handle Below Rim
330	Ollas, Short (<2) and Medium (2.1-3.9)	Short-Necked Inclined Olla
339	Ollas, Short (<2) and Medium (2.1-3.9)	Short-Necked Olla, No angle
340	Ollas, Short (<2) and Medium (2.1-3.9)	Medium Necked Flared Olla
349	Ollas, Short (<2) and Medium (2.1-3.9)	Possible Medium Necked Olla
350	Ollas, Short (<2) and Medium (2.1-3.9)	Medium Necked slightly flared olla
351	Ollas, Short (<2) and Medium (2.1-3.9)	Same as 350, with rim to body vertical handle
352	Ollas, Short (<2) and Medium (2.1-3.9)	Same as 350, vertical handle on shoulder
353	Ollas, Short (<2) and Medium (2.1-3.9)	Same as 350, with vertical handle just below rim

TAP ceramic form codes: *Ollas*

Code/General Category/Specific Form		
360	Ollas, Short (<2) and Medium (2.1-3.9)	Medium necked straight olla
361	Ollas, Short (<2) and Medium (2.1-3.9)	Same as 360, with rim to body vertical handle
362	Ollas, Short (<2) and Medium (2.1-3.9)	Same as 360, with vertical handle just below rim
363	Ollas, Short (<2) and Medium (2.1-3.9)	Same as 360, with lug
370	Ollas, Short (<2) and Medium (2.1-3.9)	Medium necked inclined olla
377	Ollas, Short (<2) and Medium (2.1-3.9)	Medium necked olla, no angle, vertical handle at rim
378	Ollas, Short (<2) and Medium (2.1-3.9)	medium necked olla, no angle, vertical handle just below rim
379	Ollas, Short (<2) and Medium (2.1-3.9)	Medium necked olla, no angle
380	Ollas, Short (<2) and Medium (2.1-3.9)	Collared olla, no angle
381	Ollas, Short (<2) and Medium (2.1-3.9)	Collared olla, very inclined body, straight neck
382	Ollas, Short (<2) and Medium (2.1-3.9)	Collared olla, very inclined body, slightly flared neck
383	Ollas, Short (<2) and Medium (2.1-3.9)	collared olla, slightly inclined body, straight neck
384	Ollas, Short (<2) and Medium (2.1-3.9)	collared olla, slightly inclined body, slightly flared neck
385	Ollas, Short (<2) and Medium (2.1-3.9)	collared olla, inclined body, straight neck
386	Ollas, Short (<2) and Medium (2.1-3.9)	collared olla, inclined body, slightly flared neck
387	Ollas, Short (<2) and Medium (2.1-3.9)	collared olla, slightly inclined body, straight neck, with lug

TAP ceramic form codes: *Ollas*

Code/General Category/Specific Form		
400	Bowl	bowl, no angle
401	Bowl	bowl, with horizontal handle on rim, titled slightly up
402	Bowl	bowl, with loop on rim
403	Bowl	bowl, no angle, horizontal handle at rim
409	Bowl	possible bowl
410	Bowl	vertical sided bowl
411	Bowl	vertical sided bowl, shallow
412	Bowl	vertical sided bowl, medium
413	Bowl	vertical sided bowl, deep
414	Bowl	vertical sided bowl, lug just under rim
419	Bowl	possible vertical sided-bowl
420	Bowl	slightly flared bowl
421	Bowl	slightly flared bowl, shallow
422	Bowl	slightly flared bowl, medium
423	Bowl	slightly flared bowl, deep
424	Bowl	slightly flared bowl with decorative nubbin
425	Bowl	slightly flared bowl with horizontal handle (Tia)
426	Bowl	slightly flared bowl with rounded base
429	Bowl	possible slightly flared bowl
430	Bowl	flared bowl
431	Bowl	flared bowl, with rim scallops
432	Bowl	flared bowl, with horizontal handle just below rim

TAP ceramic form codes: Bowls

Code/General Category/Specific Form		
439	Bowl	Possible flared bowl
440	Bowl	Slightly convex bowl, no angle
441	Bowl	Slightly convex bowl, slightly flared sides
442	Bowl	slightly convex bowl, flared sides
443	Bowl	slightly convex bowl, vertical sides
444	Bowl	slightly convex bowl, slightly flared with lug
445	Bowl	slightly convex bowl, vertical sides with lug
446	Bowl	slightly convex bowl, no angle, horizontal handle just below rim
447	Bowl	slightly convex bowl, vertical sides, horizontal handle on rim
448	Bowl	slightly convex bowl, vertical sides, horizontal handle just below rim
449	Bowl	slightly convex bowl, inclined
450	Bowl	Convex Bowl, no angle
451	Bowl	slightly convex bowl, inclined, horizontal handle on rim
452	Bowl	sl convex bowl, no angle, with lug
453	Bowl	slightly convex bowl, slightly flared sides, horizontal handle on rim
454	Bowl	slightly convex bowl, flared sides, horizontal handle on rim
455	Bowl	Convex Bowl, with short neck, similar to short necked olla (Chiripa)
456	Bowl	Slightly convex bowl, no angle, loop on rim
457	Bowl	Short Necked slightly flared bowl, red banded. Tia 1
458	Bowl	Short Necked slightly flared bowl, red banded. Tia 1, with horizontal handle below neck
459	Bowl	Short necked slightly flared bowl, red banded, with vertical handle below neck
460	Bowl	Incurving Bowl

TAP ceramic form codes: Bowls

Code/General Category/Specific Form		
462	Bowl	Convex bowl with short neck (455) with lug
465	Bowl	Carinated bowl, with slightly flared sides
466	Bowl	Carinated bowl, with vertical sides
467	Bowl	Carinated Bowl, no angle
468	Bowl	Carinated Bowl, slightly flared, medium depth
470	Bowl	Tazon
480	Bowl	Zahumador
490	Bowl	Zoomorphic head incensario
491	Bowl	Scalloped incensario (may or may not have zoomorphic head)
492	Bowl	Shelf rim bowl, vertical sides
493	Bowl	Shelf rim bowl, slightly flared sides
494	Bowl	Shelf rim bowl, no wall left
497	Bowl	Incensario, no scallops on the piece preserved

TAP ceramic form codes: Bowls

Code/General Category/Specific Form					
500	Bottles	Bottle	817	Ear Plug	Ear Plug
509	Bottles	Possible Bottle	818	Lip Plug	Lip Plug
600	Keros	Kero (rim only)	819	Loop	Rim loop no rim
601	Keros	Banded kero	820	Lug	Horizontal Lug
609	Keros	Possible kero	821	Lug	Vertical Lug
710	Miscellaneous Tiwanaku Shapes	Spouted Jar	822	Lug	Semi-Circular Lug
720	Miscellaneous Tiwanaku Shapes	Challador	823	Lug	EC type squared horizontal lug
800	Spindle Whorl	Spindle Whorl	824	Lug	wavy lug
801	Blank Spindle Whorl	Blank Spindle Whorl	825	Lug	ring lug
805	Polishing Tool	Polishing Tool	826	Nubbin	Nubbin
806	Possible Polishing Tool	Possible Polishing Tool	827	Scallop	Scallop
810	Trumpet	Trumpet	828	Pierced Rim Scallop	Pierced Rim Scallop
811	Trumpet	Trumpet with handle	829	Appliquet Fillet	Appliquet Fillet
815	Figurine	Figurine	830	Box-Shaped vessel	Box-shaped vessel
816	Hemispherical Object	Hemispherical Object			

TAP ceramic form codes: Various other forms

Code/General Category/Specific Form		
900	Unknown	Unknown
901	Unknown	Unknown, closed vessel
902	Unknown	unknown, body sherd, probable bowl
903	Unknown	unknown, small diameter, probable neck
904	Unknown	same, open vessel, slightly flared
905	Body Sherd	Body sherd, probable tia Cantaro
906	Unknown	Unknown, open vessel, flared
907	Unknown	Unknown, straight angle
908	Body Sherd	body sherd from olla or jar, globular
909	Body Sherd	body sherd from somewhere near neck
910	Unknown	Unknown, necked vessel (short or medium necked olla), no angle
911	Body Sherd	body sherd, maybe kero
912	Unknown	unknown, open vessel, no angle
913	Unknown	unknown, necked vessel (olla or jar), slightly flared
914	Body Sherd	Decorated body sherd, don't know shape
915	Body Sherd	Plain body sherd scraped for sherd char
916	Body Sherd	Body Sherd Wall Near Base
917	Body Sherd	Body Sherd Flat Part of Base
918	Body Sherd	Body Sherd with Repair Hole
919	Body Sherd	Decorated Body sherd with repair hole
920	Tierra Quemada	Tierra Quemada
921	Tile	Tile
922	Unknown	Unknown with horizontal handle
923	Unknown	Unknown with vertical handle
924	Body Sherd	Body Sherd with broken off handle

TAP ceramic form codes: Various unknown categories

Code/General Category/Specific Form					
B10	Base	Flat Base, Flared Wall (35-55)	B70	Base	Rounded Base
B19	Base	Flat Base, no wall or less than 1 cm	B79	Base	Possible Rounded Base
B20	Base	Flat Base, Slightly Flared Wall (56-80)	B80	Base	Ring Base, no height
B21	Base	Same, With nubbin on wall	B81	Base	Ring Base, < 2 cm
B30	Base	Flat Base, Straight Wall, (80-90)	B82	Base	Ring Base, 2.1-4 cm
B33	Base	Same, Probable Kero	B83	Base	Ring Base, 4.1-6 cm
B40	Base	Thickened edge base, less than 1 cm of wall	B89	Base	Possible Ring Base
B41	Base	Thickened edge base, very flared wall	B90	Base	Carinated Base
B42	Base	Thickened edge base, flared wall	B93	Base	Possible Carinated Base
B43	Base	Thickened edge base, slightly flared wall	B94	Base	Foot of Tripod or tetrapod vessel
B44	Base	Thickened edge base, straight wall	B95	Base	Basal Flange
B50	Base	Up then outcurving wall	H10	Handle	Strap Handle
B60	Base	Flat Base, Convex Wall	H20	Handle	Strap Ridge
B61	Base		H30	Handle	Squared Oval
B65	Base	Indented Base, flared convex wall	H40	Handle	Round
B66	Base	Indented Base, slightly flared convex wall	H50	Handle	Oval
B67	Base	Indented Base, No angle	H99	Handle	Broken, can't get handle shape

TAP ceramic form codes: Bases and handles

Code	Carbonization
1	light powder
2	medium powder
3	heavy powder
4	light encrustation
5	medium encrustation
6	heavy encrustation
7	light encrustation with yellow or white edges
8	medium encrustation with yellow or white edges
9	heavy encrustation with yellow or white edges
10	scorched gray
11	scorched white
12	fire blackened
13	black all over/post breakage charring

TAP carbonization codes

Appendix 3
Paleoethnobotany Sort Forms

Phytolith Sort Form
02/2017

Sample #:______________________ Project: PARIAVI
Slide: ______________________ Scanner: S. Reilly
Date:______________________ Microscope:
Start:___________ Stop: __________ Rows: ______________________

Cucurbitacaea
Cucurbita spp.
Faceted sphere:______________________

Euphorbiaceae
Manihot esculenta
Heart-shaped:______________________

Fabaceae
Phaseolus sp.
Unicelular hair, hooked end, intercellular space:______________________

Marantaceae
Maranta arundinacea
Cylindrical body:______________________

Poaceae
Zea mays
Narrow elongate rondel:______________________

Ruffle-top rondel:______________________

Half-decorated rondel:______________________

Cross:______________________

Panicoid grasses:
Simple:______________________
Conical: ______________________
Rondel:______________________
Square/rectabgle:______________________
Lobbed:______________________
Saddle:______________________
Other:______________________

Unidentified
Other:

Phytolith sort form

Starch Grain Sort Form
09/2016

Sample #:______________________________ Project: TAP
Slide: ______________________________ Scanner: S. Reilly
Date:______________________________ Microscope:
Start:______________ Stop: ____________ Rows: ____________

Basellaceae
Ullucus tuberosus
Ovate:____

Convolvulaceae
Ipomoea batatas
Domed:____
Quadrangular:____
Spherical:____
Polygonal:____

Dioscoreaceae
Dioscorea spp.
Ovoid to ovate:____
Cuneiform depression (*d. trifida*):_______________________
Damaged (include description):____________________________
____

Euphorbiaceae
Manihot esculenta
Bell-shaped (star fissure):_______________________________
Bell-shaped (linear fissure):______________________________

Fabaceae
Phaseolus sp.
Ovular w. large, ragged fissure:___________________________
Damaged (include description):____________________________
____

Marantaceae
Maranta arundinacea
Ovular and dented:_____________________________________

Oxalidaceae
Oxalis tuberosa
Clam shell:____

Poaceae
Zea mays
Blocky and faceted:_____________________________________
Smooth circular:_______________________________________
Vase-shaped:____

Starch grain sort form

Damaged (include description):____

Solanaceae
Capsicum spp.
Blood cell shaped:____

Solanum tuberosum
Spherical or ovate:____
Damaged (include description):____

Unidentified

Ovate (unidentifiable tuber):____

Other:

Starch grain sort form