PUTTING POTTERY IN PLACE: A SOCIAL LANDSCAPE PERSPECTIVE ON THE LATE FORMATIVE UPPER DESAGUADERO VALLEY, BOLIVIA

PUTTING POTTERY IN PLACE: A SOCIAL LANDSCAPE PERSPECTIVE ON THE LATE FORMATIVE UPPER DESAGUADERO VALLEY, BOLIVIA

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ABSTRACT

Recent archaeological investigations demonstrate that landscapes of the past are not just passive backdrops to peoples' practices, but rather play a key role in social, cultural, political, and economic processes. Archaeologists have typically studied landscapes by analysing settlement patterns and architecture, yet newer approaches include the study of production practices such as pottery or stone-tool production. One such approach focuses on the 'taskscape', which includes skilled agents, and daily tasks occurring on the landscape. Scholars using this framework consider the rhythms and the embodied experience of people in specific places, and explore both the social relationships and ecological affordances of landscapes. Archaeologists, in particular, have considered the embedded nature of daily tasks performed on the landscape, and the material remains of these tasks. In this project I focus on the taskscapes of the Late Formative Period (200 B.C.- A.D. 500), in the Upper Desaguadero Valley, just south of Lake Titicaca in Bolivia. Little is known of Late Formative landscapes, a period prior to the rise of the Tiwanaku state. I study Upper Desaguadero landscapes to contribute to scholarship exploring the social, political and economic changes of the Late Formative Period, prior to the emergence of the Tiwanaku state.

I study ceramics from two recently excavated sites, Khonkho Wankane and Iruhito. My research explores the difference between Khonkho Wankane and Iruhito taskscapes and whether this is evident through ceramics. Potters' choices during production are based on their taskscapes, which can affect the materials selected for the paste (the mixture of clay and inclusions), to how the vessels were decorated. Pottery was not only made but also used during daily tasks and thus pottery usage can be used to examine taskscapes. I conduct attribute analysis, with particular attention to paste. For a more detailed analysis of paste I employ a Dino-Lite digital USB microscope. The digital USB microscope is portable, affordable and time efficient, allowing for analysis to be conducted in the field. This method is promising for ceramic analysis, as it encourages standardization and inter-site comparisons. Ultimately, this tool provides quick yet detailed insights into past social landscapes.

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IRU= Iruhito
KW= Khonkho Wankane
LF= Late Formative Period
MF= Middle Formative Period
PAJAMA= Jach'a Machaca Project
TAP= Taraco Archaeological Project
TIW= Tiwanaku Period

Chapter 1: Introduction

1.1 General Introduction

Many archaeologists study landscapes to understand societies of the recent and deep past. Initially, archaeologists viewed landscapes as relatively passive and static backdrops, a mere location where material remains were recovered and the scene for past processes (Knapp and Ashmore 1999:1). Others, interested in economic and political systems, viewed landscapes as resources that were drawn from, and constraints to people's possible actions in the past. More recently, archaeologists have considered the social and symbolic aspects of landscapes. They recognize that landscapes are not static, but rather are dynamic, meaning-laden and complex (Knapp and Ashmore 1999:1). Today archaeologists studying social landscapes explore interactions between communities, relationships to local ecologies and natural rhythms, and how past people would have perceived and experienced these landscapes through the body (Arden and Lowry 2011; Bradley 2000; Gosselain 1999; Gosselain and Livingstone Smith 2005; Michelaki, Braun and Hancock 2014; Roddick 2013). A focus such as this is essential for archaeologists working to understand past processes (i.e. the emergence of complex polities) because they also aim to understand how lifeways changed. As Barrett (1999:30) reminds us "landscape archaeology is…central to the archaeological programme as a whole because the history of human life is about ways of inhabiting the world."

Archaeologists have typically studied landscapes by analysing settlement patterns (i.e. mapping sites across space) or defining architectural spaces (i.e. measuring buildings, monuments, and site layout) (Ashmore 2002:1173–1174). More recent approaches include the study of production practices such as pottery or stone-tool production (Bradley 2000; Jones 2002, 2004; Logan and Cruz 2014; McBryde 1997; Michelaki et al. 2014; Roddick 2013). One such approach focuses on the *taskscape* (Ingold 1993), where skilled agents perform interlocking daily *tasks* (i.e. practical operations) in a shared rhythm, producing what we recognized visually as landscapes Scholars using this framework consider the rhythms and the embodied experience of people dwelling in specific places, and explore both the social relationships and ecological affordances of landscapes. Archaeologists, in particular, have considered the embedded nature of daily tasks performed on the landscape, and the material remains of these tasks.

Several archaeologists working in the Southern Lake Titicaca Basin of highland Bolivia have been developing such approaches. These scholars recognize that these high-altitude landscapes were neither static, nor separated from social practices. For instance, Smith and Janusek (2014:694-696) have examined Southern Titicaca landscapes vis-à-vis the socio-political dynamics of the expanding Tiwanaku state (A.D. 500-1100), paying particular attention to the movements of people via llama caravans in trade circuits (Smith and Janusek 2014:694-696). Only recently have projects begun to investigate the earlier Late Formative period (200 B.C.- A.D. 500) landscapes (Roddick 2013; Smith 2009, 2016; Smith and Pérez-Arias 2015). This research is exploring both large-scale social, political, and economic processes, but also smaller scale processes. While certainly the economic and ecological factors play a role here, this approach asks more integrated questions, such as what it was like to *dwell* in these Southern Titicaca landscapes. What was it like to live in the Upper Desaguadero Valley throughout seven centuries of the Late Formative period? How diverse were these social landscapes before the appearance of the first city (Tiwanaku) in the 5th century A.D.?

In this project, I examine Late Formative period taskscapes (Ingold 1993; Roddick 2013) through an investigation of ceramics from the Upper Desaguadero Valley, located in the Bolivian altiplano. This region is located just south of the Lake Titicaca and the Quimsachata-Chilla Mountain range, giving it a distinct landscape compared to the more intensively analysed Tiwanaku Valley (Figure 1.1) (Janusek 2013:7). The Upper Desaguadero Valley has recently been the focus of intensive archaeological works in the region (Janusek 2008, 2013; Marsh 2012a; Pérez Arias 2013; Smith 2009, 2016; Zovar 2012). I explore the difference between the taskscapes of those inhabiting two different Late Formative sites, Khonkho Wankane and Iruhito, through recently excavated ceramics (Janusek 2008, 2013; Marsh 2012a; Pérez Arias 2013; Smith 2009, 2016; Smith and Janusek 2014; Smith and Pérez Arias 2015). These two sites are believed to have had distinct functions (ceremonial center vs. fishing community), ecologies (inland site vs. riverine site), and subsistence economies (fishing and pastoralism). Although up until now the taskscapes of these sites have not been examined, these differences suggest that inhabitants moved through distinct taskscapes.

The Late Formative potters living in these landscapes made choices during their production routines, choice that are visible today in a number of ceramic attributes, from which materials were being selected for the paste (the mixture of clay matrix, inclusions, and voids) (Quinn 2013:39), to how the vessels were decorated. Those using these pots also left traces of their choices and attributes that can also be analyzed to reveal past taskscapes. I ask three specific questions concerning Late Formative Desaguadero Valley taskscapes in regards to pottery production and use: (1) were potters drawing on distinct resources while inhabiting their taskscapes? (2) Were potters producing distinct forms while inhabiting distinct taskscapes? (3) Were people using pots in different ways while inhabiting distinct taskscapes?

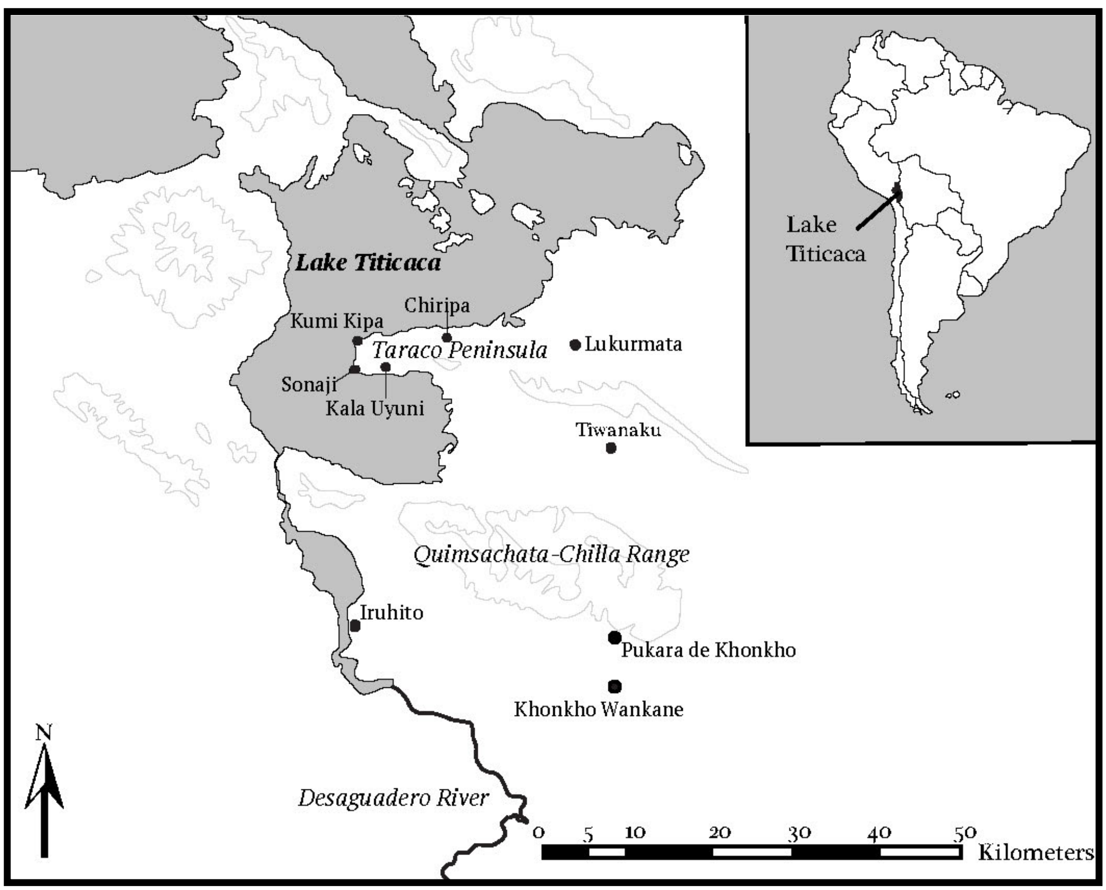

Figure 1.1 Map of the Lake Titicaca Basin (modified from Smith and Janusek 2014:683).

I conducted attribute analysis, with particular attention to paste, to answer questions about the Late Formative taskscapes in the Desaguadero Valley. For a more detailed analysis of paste, I employed a Dino-Lite digital USB microscope. A USB microscope can measure the size, shape and abundance of particular inclusions more accurately than a hand lens. The digital USB microscope is portable, affordable, and time efficient, allowing for analysis to be conducted in the field. This method is promising for future ceramic analysis, as it encourages standardization and inter-site comparisons, which was not possible before due to varying paste systems between projects and vague written descriptions. Ultimately, this tool provides quick yet detailed insights into past pottery production and taskscapes.

1.2 Archaeology in the Southern Lake Titicaca Basin

Archaeological sites in the Southern Titicaca Basin, most notably Tiwanaku and Chiripa, have attracted explorers and archaeologists for centuries (Janusek 2008:3–4). Most of the archaeological projects conducted in the Southern Titicaca Basin have focused and on the Middle Formative Period (Bandy 1999; Beck, Jr. 2007; Hastorf 2003; Chavez Mohr 1988) and the formation and organization of the urban-ceremonial center of Tiwanaku (Janusek 2004a, 2006; Marsh 2012b) (Table 1.1). In the following sections I will provide a brief background on the Early-Middle Formative and Tiwanaku periods.

Table 1.1Period names and dates used in the Titicaca Basin (Janusek 2008). *I follow Janusek (2008:22) and use Tiwanaku 1 and 2 rather than Tiwanaku IV and V.

Period	Date
Early Formative	1500-800 B.C.
Middle Formative	800-200 B.C.
Late Formative 1	200 B.C.- A.D. 250
Late Formative 2	A.D. 250- 500
Tiwanaku 1*	A.D. 500-800
Tiwanaku 2*	A.D. 800-1100

Early and Middle Formative Periods

During the Early Formative period, around 1500 B.C., autonomous agricultural villages were first established in the Lake Titicaca Basin. These early villages appear to have no complex social structure or formal ritual activity, and would fission frequently due to internal conflict (Bandy 2004:322–323, 2006:233). Pottery technologies were introduced throughout the region in this period but the earliest evidence of fired clay objects were recovered from the site Quelcatani dating to 1660 B.C. (Stanish 2003:102). At the start of the Middle Formative period, fissioning ceased and around 250 B.C. the early village period ended and multi-community polities formed on the Taraco Peninsula (Bandy 2006:233).

During the Middle Formative period (800-200 B.C.) two cultural complexes developed, Qaluyu in the Northern Basin and Chiripa in the Southern Basin (Janusek 2008:19). This period also saw communities engaging in long-distance trade through llama-caravans with southern regions, specifically with Wankarani cultures found in a drier region in the south of Bolivia (Janusek 2008:20; Smith and Janusek 2014). More is known about Chiripa, an interregional cultural complex located on the Taraco Peninsula and occupied from 1300-100 B.C. (Hastorf 1999, 2003; Janusek 2004a:138). By the later half of the Middle Formative the site of Chiripa had impressive architecture including platforms, a sunken court and sandstone stelae (Janusek 2004a:127). Chiripa style ceramics were made with fiber-tempered pastes, red-brown slip and bowl forms with flat bases (Janusek 2004a:127; Steadman 1999). According to Chavez Mohr (Chavez Mohr 1988), Chiripa played an important role in integrating Lake Titicaca communities and influencing later cultures such as Pukara and Tiwanaku.

Tiwanaku Periods

The site of Tiwanaku[1] was founded sometime between A.D. 40 and 120 (Marsh 2012b:214; Smith and Janusek 2014). Tiwanaku is located in the Tiwanaku Valley, west of the Lake Titicaca, and bordered by the Taraco chain of hills in the north and the Quimsachata-Chilla mountain range in the south (Albarracin-Jordan 1996:187). Tiwanaku emerged as a state and principal urban/ceremonial center in the Late Tiwanaku 1 period (A.D. 500-800) (Janusek 2008:1). Tiwanaku potters produced a wide variety of ceramics, with standardized forms (e.g. keros, tinajas, and incense burners), finishes (highly burnished with red and black slip) and iconography that characterized the Tiwanaku style (Figure 3.6) (Janusek 2003:57). Albarracin-Jordan (1996:205) hypothesizes that Tiwanaku was initially a "segmentary state", lacking centralized control

[1] The name Tiwanaku is used for the site/urban center, state name and time period.

over local communities but having a nested hierarchy of semiautonomous socio-political groups (Janusek 2004a:162). During the Tiwanaku 2 period (A.D. 800-1100) the state's control shifted from incorporative to transformative (Albarracin-Jordan 1996:206; Janusek 2004a:162). Tiwanaku's control became a more "tightly centralized political economy" (Janusek 2004a:164) with elite groups trying to control key resources and local socio-economic networks. This intensified control, state exploitation, social instability, and environmental stresses due to low lake levels, caused the Tiwanaku state to disintegrate and collapse in A.D. 1100 (Erickson 1999; Janusek 2004a:165–166, 2008:24).

Archaeologists working in the Southern Titicaca Basin were initially attracted to the region due to impressive sites with monumental architecture (Janusek 2008:3–4, 2013:8; Stanish 2003:78). Later, projects focused on questions of state formation, but now archaeologists recognize that we must explore the transition between the Middle Formative and Tiwanaku periods and turn to the Late Formative period to understand this process and the larger culture history of the region (Janusek 2004a, 2013; Marsh 2012a; Pérez Arias 2013; Roddick 2009; Smith 2009, 2016).

1.3 Turning to the Late Formative Period

Until fairly recently, little was known of the Late Formative period (200 B.C. - A.D. 500), which has been described as the "missing link" in the cultural history of the Titicaca Basin (Janusek 2004a, 2008:87). I focus on this time period in this thesis, specifically to contribute to a richer understanding of the Late Formative period and the social-political processes that eventually lead to the rise of the Tiwanaku state. During the Late Formative 1 period, the site of Pukara emerged and replaced the Qaluyu culture (Janusek 2008:88; Klarich and Román Bustinza 2012:105). Pukara was the first regional center in the Northern Basin, influencing the South-Central Andes (Klarich and Román Bustinza 2012:105).

The cultural development in the Southern Basin was very different compared to the Northern Basin; there was no regional center comparable to Pukara until A.D. 200 (Janusek 2008:90). In the Southern Basin many ritual-political centers (i.e. Tiwanaku, Khonkho Wankane, Lukurmata and Kala Uyuni) developed after the Chiripa culture (Janusek 2008:21). These Late Formative centers shared similar architecture including raised platforms, trapezoidal sunken courts used for ceremonies, and stone monoliths with mythical iconography (Janusek 2008:90). Ceramic technology and decorative styles drastically changed during this period (e.g. a shift from fiber to mineral temper, serving vessels were smaller, and more red band decoration) and access to elaborate ceremonial wares became more exclusive (Janusek 2003:53, 2008:91; Marsh 2012a:490; Roddick 2009:27–30). Trade networks continued and expanded during this period, as well there was an intensification of herding and farming practice (Janusek 2008:21). Khonkho Wankane and Tiwanaku were considered as having equal control over the region, but Tiwanaku became the primary regional center in the Southern Titicaca Basin, beating out Khonkho Wankane in this "ideological showdown" (Janusek 2004a:150, 2013:31).

1.4 The Upper Desaguadero Valley

Just as archaeologists have recognized the importance of the Late Formative period, some have also recognized the importance of researching the Upper Desaguadero Valley (Janusek 2004a, 2013; Marsh 2012a; Pérez-Arias 2013; Smith 2009, 2016; Zovar 2012). The Desaguadero River is the primary drainage for Lake Titicaca and runs north-south linking Lake Titicaca to Lake Poopó, 260 km to the southeast (Figure 1.1) (Janusek 2013:7). The Tiwanaku Valley and the Upper Desaguadero Valley are separated by the Quimsachata-Chilla mountain range which created a physical barrier between the resource-rich north, and the drier pastoralist-based landscape in the south (Janusek 2013:7; Smith and Janusek 2014:683; Zovar 2013:76).

The Upper Desaguadero Valley has a very distinct ecology, and the Proyecto Jach'a Machaca (PAJAMA) divided the region into "inland" and "river" zones (Janusek 2013:7). Inland Upper Desaguadero sites such as Khonkho Wankane and Pukara de Khonkho share similar features, both are located closer to the Quimsachata-Chilla mountain range with access to sandstone quarries, and have drier climates ideal for herding practices. While Iruhito, a "river zone" site, has a wetter landscape, is located on the edge of the Desaguadero River and was suited for fishing activity (Pérez Arias 2013; Janusek 2013:7). Although more attention has been given to the Tiwanaku Valley when it comes to archaeological investigations, the Upper Desaguadero Valley is an important region because of its distinct landscape, large ceremonial centers (Khonkho Wankane) and long enduring sites (Iruhito). It was also a trading hub between the Tiwanaku Valley in the north and the Wankarani region in the south (Smith and Janusek 2014:693; Pérez-Arias 2013:71). In order for us to construct a richer culture history of the Southern Titicaca Basin, we need to include the Upper Desaguadero Valley.

1.5 Research Problems and Contributions

Archaeologists typically rely on architecture, site layout, and settlement patterns when trying to understand past human-landscape relationships (Ashmore 2002; Jones 2004). We can certainly learn much on how past people interacted with their landscapes through their built environment, but there are limitations with this approach (e.g. archaeologists may focus on monumental architecture) and not all sites have architecture remains. Ingold's (1993:193–194) concept of the taskscape helps archaeologists focus on other datasets to address these questions of human-landscape interactions. Logan and Cruz (2014), Michelaki et al. (2014), and Roddick (2013) have analysed ceramic remains to examine taskscapes because ceramic production and consumption were taking place on the landscape during daily activity. Potters collect raw material from their surrounding landscapes while performing other daily tasks thus ceramic paste can inform us which materials were used in ceramic production and the association between clay/temper procurement with other daily activity (e.g. fishing, herding and farming) (Druc 2013; Gosselain and Livingstone Smith 2005; Roddick 2013). Ceramic form can indicate the intended use of a vessel; certain daily activities (e.g. cooking and rituals) may have required specific forms thus form could reveal past taskscapes (Orton et al. 2013; Rice 1987; Roddick 2009). Based on ceramic deposits in the landscape and soot/carbonization residue on sherds, we can explore where certain daily tasks (i.e. cooking, storage and serving) were taking place. In short, ceramics can offer us a new avenue to explore questions regarding social landscapes and this thesis plans to build on this approach of using ceramics to examine past taskscapes.

Archaeologists in the Titicaca Basin have primarily relied on ceramics as cultural and temporal markers (chronologies) (Roddick 2009:185) and put a heavy emphasis on typologies. The problem with relying on typologies is that only the finished product is analysed, and not the production and technological sequence (Roddick 2009:182–183; Shepard 1980; Steadman 1995:48–50, 2007:60–61). It also limits which vessels can be used focusing on complete vessels and resulting in a significantly smaller sample size.

Domestic pottery is typically under-analysed and under-theorized in Andean archaeological projects in favour of ceremonial ceramics (Roddick 2009:17-19). I argue that archaeologists should not only study exotic, rare, ceremonial pottery but should also include local, common, domestic pottery when trying to understand past daily practices, production choices, and taskscapes (Chilton 1998; Druc 2013; Logan and Cruz 2014; Michelaki et al. 2014; Sillar 2000).

Currently scholars analyse paste, or the mixture of clay and inclusions, in a very subjective and descriptive way, making reproduction very difficult. In my thesis, I work to standardize ceramic paste analysis. By taking detailed photographs of different pastes using a Dino-Lite USB microscope, I can add a visual aid to these written descriptions. These images can also be shared across the region creating the opportunity for inter-site and inter-regional comparisons. The Dino-Lite microscope has been used to analyse archaeological material (e.g. faunal remains, paintings, stone tools and ceramics) (Druc 2015; McConaughy et al. 2014; Rots et al. 2015; Van de Voorde et al. 2014). This tool is particularly useful when petrographic samples cannot be analysed due to cost, difficulties of exportation, or the time and skill-set required at the petrographic microscope. The Dino-Lite microscope allows ceramists to analyse a large quantity of sherds and to confirm paste groups. The photographs taken with the Dino-Lite microscope can help researchers select sherds for further chemical and petrographic analysis. Inclusions in a paste can be measured and quantified using image analysis software (e.g. JMicroVision).

1.6 Thesis Outline

In Chapter 2, I review theoretical approaches to ceramic and landscapes analysis and detail Ingold's (1993) concept of taskscapes. I also demonstrate that a careful study of domestic pottery can reveal past taskscapes. In Chapter 3, I provide a brief background (ecology, geology and culture history) of the Upper Desaguadero Valley to contextualize my project. Here I also outline my research questions and my sampling protocol. I discuss the methodologies I employed in this study in Chapter 4. This chapter includes a discussion of attribute and paste analysis as well as my protocol using the Dino-Lite microscope and the JMicroVision software. I present my results in Chapter 5, and discuss whether there is evidence to suggest that Iruhito and Khonkho Wankane potters had different production practices, and whether inhabitants used pottery differently. In

Chapter 6, I contextualize my findings within a broader regional context and discuss the contributions of my research to ceramic analysis, landscape studies (taskscape) and archaeology in the Southern Titicaca Basin.

Chapter 2: Landscape and Pottery

2.1 Overview

Archaeologists can address a number of questions (economic, social-political, and embodiment) about past societies through the careful study of landscapes. In this chapter I explore theoretical approaches to ceramic and landscape analysis. I begin by briefly outlining a few examples of approaches archaeologists have used to study past landscapes. This work demonstrates that landscape studies are essential for archaeologists working to understand larger processes because these processes are occurring in the landscape and the relationship between people and landscapes maintain them. I argue that the detailed analysis of pottery can reveal past taskscapes. I then review how landscape studies and ceramic analysis have changed in recent years, and how archaeologists have used ceramics to investigate ancient landscapes. I also discuss how archaeologists have developed relational approaches in landscape studies (e.g. phenomenology and place-making). I then present Ingold's (1993)taskscapes, and discuss how others have applied taskscapes to ceramic analysis. I conclude by outlining the benefits of analysing landscapes through pottery (specifically domestic pottery).

2.2 Landscape and Larger Processes

Archaeologists interested in past subsistence economies and trade systems can examine the geology and ecology of a landscape to determine which resources would have been available, the limits of a landscape, and the movement of materials (Knapp and Ashmore 1999:1). Some projects have employed geographic information systems (GIS), efficiency models, and optimal foraging behaviour to examine how people were organized around key resources and the relationship between sites, hydrology, soils, vegetation and arable land (Brandt et al. 1992; Duncan Beckman 2000; Hunt 1992; Kohler et al. 2000; Mehrer and Wescott 2006; Wescott and Brandon 2000 as cited in Kosiba and Bauer 2013:63).

Others have applied geochemical and mineralogical techniques (e.g. petrography) to determine the provenience of resources used by in craft goods and to track the movement of these resources and objects (Day et al. 1999; Roddick 2015). Arden and Lowry (2011) also consider landscapes when examining trade systems and political interactions in the Classic Maya culture. Maya merchants would travel from the inland urban sites to the sea and move exotic and quotidian goods (Arden and Lowry 2011:429). Arden and Lowry (2011:433-434) examined the geological terrain to understand the factors that would have influenced which route a merchant would take (i.e. climate, fauna, fresh water, topography, way-station locations and interpersonal relationships).

Archaeologists analyse settlement patterns, site layout and architecture on the landscape to address questions regarding social-political organization. Kosiba and Bauer (2013:67) explain that political powers create spatial and social boundaries (i.e. urban/rural, public/private, and ceremonial/domestic), and when archaeologists analyse the built environment they are also mapping out the political landscape. Kosiba and Bauer (2013:67) examined how spatial boundaries and organization at the site of Cuzco would have restricted people's movement and maintained an Inka model of social order (Kosiba and Bauer 2013:67). Monroe (2010:368) also considered the build environment to examine how the Kingdom of Dahomey, in West Africa used royal architecture to maintain political order.

Archaeologists have also considered landscapes when examining past ritual activities. Williams and Nash (2006:466) examine how mountains (i.e. *apu*- which are viewed as sacred powers) played an important role in Andean societies and formed part of the cognitive landscape. Williams and Nash (2006:466) demonstrate that architecture found in Wari sites in Peru, were aligned towards these sacred peaks, and that during the Wari state's expansion the elite used *apu* rituals to establish a hegemony over local communities and legitimize authority. These projects demonstrate that landscapes could influence and were influenced by economic, political, social, and ritual systems. Landscapes are an integral part of societies and because of this archaeological investigations should consider past human-landscape relationships.

Early landscape studies in archaeology were Cartesian and binary in their worldview, with nature (the external, objective world) divided from culture (the internal subjective mind) (Knappett 2005; Jones 2002; Thomas 2001). Scholars viewed landscapes as inanimate and only given meaning by animate thinking subjects (i.e. humans) (Jones 2002). Some archaeologists believed that landscapes were only transformed from abstract spaces to meaningful places, after people had altered them (Thomas 2001). Thus this relationship was thought to be one-directional with people only affecting landscapes (Thomas 2001). Objects were also considered inanimate and only given meaning by people (Hodder 2011). These views of objects and landscapes as inanimate influenced early analysis of ceramics. As these views changed in the last few decades, so too have archaeological approaches to ceramics on past landscapes.

2.3 Landscapes and Ceramics in Archaeology

There have been three major phases[2] in ceramic analysis: the art-historical, the typological, and the contextual phase (Orton et al. 2013). During the art-historical phase (A.D.1500 onwards) the emphasis was placed on fine-wares and whole vessels, which were considered to be cultural objects (Orton et al. 2013:6; Shepard 1980:3). Pottery (specifically decorated pottery) was used to determine cultural affiliations and boundaries as well as social status (Chilton 1998; Orton et al. 2013; Velde and Druc 1999). Archaeologists interpreted the distribution of pottery in order to understand past landscapes at a very broad level (i.e. the movement of people and the boundaries between cultural groups).

During the typological phase (A.D. 1880 onwards) ceramic typologies were in development and pottery (including potsherds) was linked to stratigraphy and used for dating (Orton et al. 2013:8). Pottery was now used as a temporal and cultural marker. Early forms of paste analysis were also developed in this phase (Orton et al. 2013:11–12). Later, Shepard's (1956) work led to considerable changes in ceramic analysis and marked the contextual phase (1960s to present) (Orton et al. 2013:12). Shepard (1980) analysed pottery to investigate trade and technological practices. This phase moved beyond simple descriptions of pottery and towards the analysis of smaller units (e.g. ceramic attributes and paste inclusions[3]) using scientific methods (Orton et al. 2013:12–13), including ceramic petrography. Petrographic analysis of ceramic thin sections was first applied in the mid-19th century, but it was not until the 1970s and 1980s that the approach became

[2] Orton and Hughes (2013:4) explain these phases overlap, thus they do not create rigid date ranges. New approaches were developed and used alongside older methods, which were rarely rejected and part of a wider approach.
[3] For more information refer to Chapter 4

common in the discipline (Quinn 2013:12). Petrographic analysis can reveal the techniques used in pottery production, but also where potters accessed their raw materials, and how it moved across the ancient landscape.

Matson's (1965) and later Arnold's (1985) work in "ceramic ecology" was critical in archaeological approaches to ceramic analysis. Ceramic ecology is a contextual approach that relates the properties of resources to pottery production techniques and considers ecological and sociocultural factors (Rice 1987:314). This approach explicitly links ceramics to the landscape by analysing ceramic raw materials. Ceramic ecologists evaluate which raw materials were used to reveal the limits set by the environment (Shepard 1980:xii). Matson and Arnold's ceramic ecology moved beyond analysing the pot and explicitly focused on the relationship between pottery, people and the environment.

Although ceramic ecology focused on the potter's relationship with the environment, this concept did have some significant problems. This approach is rather environmentally deterministic, as ceramics are viewed as objects created as an adaptive response (Arnold 1985:5). Ceramic ecologists often do not consider other factors that may influence pottery production besides the environment, western models of efficiency and the economy. Arnold's "ceramic resource threshold model"[4] (1985:50-52) assumes that distances travelled to raw material sources are universal and based on energy costs models[5] with little cultural influence (Arnold 2006:3,7; Druc 2013:490). Relying on these energy costs models can be problematic because past potters likely did not calculate distance and energy the same way as modern researchers (Bradley 2000). Recent projects have demonstrated that a focus on technological, economical, and adaptive factors offers a limited view of pottery production. They argue that cultural traditions, kinship and political affiliations should also be considered (Druc 2013; Gosselain 1999; Gosselain and Livingstone Smith 2005; Sillar 2000).

[4] The "ceramic resource threshold model" is the distance travelled by potters to access raw materials. The common distance traveled is approximately 7 km (1985:50-52).

[5] Zipf (1949) "Principle of Least Effort" is an example of an energy cost model. According to this principle people will select material based on less amount of labour for most profit, and artisans will select material based on proximity, because this will require less energy.

2.4 New Approaches in Landscape Theory

A shift occurred in how archaeologists conceived of and studied landscapes in the 1990s. Landscape was no longer conceived as a static backdrop, but rather as meaning-laden, and shaped by and influencing peoples' actions (Ashmore 2002; Thomas 2001). Scholars challenged the Cartesian worldview and recognized that the human mind, culture, and social actions cannot be divided from the "external" landscape because people and their minds are always dwelling in the landscape (Ingold 1993). Humans and landscapes are now viewed as in a constant mutual and iterative relationship, rather than being hierarchical, causal or one-directional. This change of perspective impacted both archaeological theory and ceramic analysis.

Archaeologists began to develop relational and sensual approaches when studying landscapes (Bruck 2005; Gosden 1994; Tilley 1994; Thomas 1993). Tilley was the first to incorporate the concept of phenomenology to archaeology. Phenomenology aims to understand the embodied experience, specifically how people interact, perceive and understand the material world (i.e. built environment) and the landscape (Brück 2005:46). Tilley (1994) encouraged archaeologists to engage with more qualitative characteristics of the landscapes and the cultural meanings of places. He explains that the understanding of the landscape occurs through the body and thus we need to consider the sensory aspects of human experience (Brück 2005:46). Tilley (1994) argued that modern archaeologists are engaging with the same places via the human body, therefore these modern interactions would be like those of the past (Brück 2005:54).

Although phenomenology has been one of the most provocative theoretical developments in archaeology it does have some problems (Brück 2005:45). This theory assumes that the human body is universal. Yet sex, age and physical capabilities will affect how an individual will experience a landscape and cultural context will influence how landscapes are perceived (Brück 2005:55). Phenomenology encourages archaeologists to consider the individual, but only modern embodied experiences (specifically of the archaeologist) of archaeological sites are described and it is unclear what these modern descriptions add to past understandings of landscapes (Brück 2005:54). Julian Thomas (1993, 1996, 2004) recognized the importance of temporality and the fact that objects cannot be de-historicized, as Tilley appears to imply. Embodied experiences are shaped by culture and social principles thus the same place and material will vary within and between societies (Brück 2005:55). Archaeologists applying phenomenological approaches tend to focus on ceremonial monuments and ritual activity while mundane (daily) activities are over looked (Brück 2005:62).

The Importance of Place

The social meaning of a landscape also affects people's actions and the craft production (Jones 2002). Keith Basso (1996)studied meaningful places and place-making to demonstrate that the Western Apache not only had meaning attached to places but also memories of ancestors, wisdom and myths. If an individual was thought to be behaving inappropriately they were sent to these places where they "sense the place" and reflect on themselves (Basso 1996:54). This place then influenced the individual to behave in a socially acceptable manner and during the process the individual animated the meaning of the place (Basso 1996). Basso (1996) demonstrated that the relationship between the landscape and people is a complex one.

Some places in the landscape may also have ritual or cosmological significance. For people from the Pueblo culture in Rio Grande, features on the landscape (e.g. bodies of water, mountains, and piles of stone) are viewed as shrines and places of ritual worship (Fowles 2009). These types of understandings and perceptions of landscape would also influence the procurement of raw materials used in craft production (Jones 2004). McBryde (1997)explains that groundstone quarries used by Australian Aboriginals appear to be places of social and ceremonial significance. The perceptions of these quarries influenced people to acquire material from these particular locations. Gosselain and Livingstone Smith (2005)agree, and show how the choices that potters make in selecting clay in Zarma Nigeria include 'non-economic' factors (e.g. religion, land tenure, and individual preferences) (Livingstone Smith 2000).

Bradley et al. (1992) also warn archaeologists not to rely on the 'modern economic' factors and Zipf's (1949) "Principle of Least Effort" to explain procurement practices. Bradley (2000) demonstrates that Neolithic period stone procurement in England was affected by how people perceived the quarries and material. These quarries were visually unusual, which people would have recognized as meaningful places. By making stone axes with material from these special places the objects would not only carry their own life histories but would also be “pieces of places” (2000:88) because artifacts can carry the meaning of their places of origin (2000:85). Jones (2002:87) shares this idea and says places become bounded with the history and identity of people, when using raw material from these places the object then carries the particular cultural significant beyond that zone. Bradley (2000) encourages archaeologists to reject simple hypothesis of procurement processes (based on ecological and efficient factors) and explore cultural perceptions of specific source because this would have been important factor to past people.

These authors recognized the importance of places and how places affect people and production practices. Archaeologists and anthropologists now recognize that raw materials are not selected randomly but are influenced by a number of factors (Gosselain and Livingstone Smith 2005; Livingstone Smith 2000; Roddick 2015). The procurement of raw materials was not solely based on economic or ecological factors (as suggested by ceramic ecology) but also cultural perceptions of the landscape and daily practices of potters.

Daily Practices and Domestic Pottery

When it comes to artifact analysis archaeologists tend to focus on objects that are exotic, rare, and ceremonial over local, common, and domestic (Druc 2013; Michelaki et al. 2014). The assumption appears to be that these ‘special’ types of objects can reveal more about past social, economic, political and ideological practices than domestic/mundane objects (Michelaki et al. 2014:3). According to Helms (1988) in many cultures, objects and raw materials from distant places are imbued with “foreign exoticism” and “cosmic mysteries” (1988:9). This idea has certainly remained prominent in archaeology. Archaeologists also tend to favour objects that are rare, the assumption appears to be that the less common an object is, the more valuable it is and the more it can reveal about past societies (Gero 1989:93). Joan Gero explains that all prehistoric artifacts have the potential to “transmit social information” (1989:92) but some (i.e. rare objects) may be more effective than others.

Walter Benjamin (1936) discusses how rare objects are more valuable than common objects, specifically replicas. According to Benjamin (1936:3) authentic objects have an *aura* that contains the specific social context of when the object was produced and makes the object unique. While mass-produced replicas do not contain an aura and can even decay the aura of the authentic object (Benjamin 1936:3). Thus according to Benjamin the replica objects will not reveal much about past societies. When archaeologists find larger numbers of similar objects they are treated as modern commodities; these objects are typically overlooked, under-analysed and under-theorized (Roddick 2009:17-19; Roddick 2015). This notion of the exotic and rare also affects how archaeologists conduct pottery analysis. John Janusek (2003:40) explains that: "In the domain of ceramic vessels serving and ceremonial wares are often sensitive markers of cultural affiliations, social status and identity because they are most visible … they embed dense stylistic properties." Archaeologists focus their analysis on highly decorated and ceremonial pottery (made with exotic and rare materials) because we believe they were more valued and have better evidence of past social structures.

Nevertheless, the relationship between people and objects is now understood as complex. Objects do not simply depend on people, but people also depend on objects (Hodder 2011). This relationship is a mutually constituted one that is entangled with objects, people, landscapes and social structures (Hodder 2011; Jones 2004; Michelaki et al. 2014; Joyce and Gillespie 2015). Some scholars (Chilton 1998; Druc 2013; Michelaki et al. 2014; Sillar 2000) have used domestic pottery to explore past daily practices, production practices, where these practices were occurring on the landscape. For instance, from the mid-1980s to the early 1990s, Bill Sillar (2000) conducted ethnographic work on potting communities in the Andes. His goal was to demonstrate how domestic pottery production occurring on the landscape, is connected to the construction of social structures. Sillar (2000:19) explains that in Andean communities, *pacha* (the earth) is both space (including fields, mountains and houses) and time, where time is not abstract but part to the landscape and experienced through activities. Material remains from these activities are considered products of the past, thus pottery, landscapes and households can be used as evidence of past histories (Sillar 2000:19). By analysing remains of domestic activities (e.g. cooking, storage, food processing, pottery and craft production) archaeologists can examine change in access to land and goods, and interpret the development of households and social structures (Sillar 2000:50).

Sillar (2000:71) explains that children become adults when they begin to contribute to the household economy. At a young age boys begin to assist in pottery production by accompanying older males to collect raw materials, preparing clay, and make small vessels for the household (Sillar 2000:71). Over time they become more confident in their skills and by ages 14-16 boys sell their first pots, and are considered men who contribution to the household (Sillar 2000:71). In this example pottery production is not only a rite of passage for boys to become men and members of the community, but the community's social structure is maintained through pottery production. Sillar demonstrates that pottery production is a daily task occurring on the landscape, in which children learn to be part of the community and by their participation in this practice they maintain Andean social structures.

The act of pot making is social, individuals become potters through the performance of this act; this task takes place in specific contexts, landscapes and social structures, thus traditions and social relations are maintained during pottery production (Michelaki et al. 2014; Sillar 2000). Oliver Gosselain (1999) demonstrates that every step of technical process such as pottery production (clay selection, firing and finishing) can also be a moment of symbolic discourse. Social structures are maintained and transformed through daily tasks, and pottery (including domestic pottery) are made and used during these daily tasks on the landscape, thus these objects are endowed with meaning and can provide use with some insight to past social structures and landscapes.

When Place Meets Practice: Taskscapes

Tim Ingold (1993) recognizes the importance of phenomenology, meaningful places, daily activities and complex relationships between landscapes, objects and people. He challenges the Cartesian worldview and explains that people's thoughts and ideas are not imported on to the world but already exist in the world (Ingold 1993:186). According to Ingold (1993:193) the landscape is not land, nature, or space but is "the world as it is known to those who dwell therein, who inhabit its places and journey along the paths connecting them". *Tasks* are daily activities done by skilled agents in landscape and the ensemble of these interlocking tasks make up the *taskscape* (Ingold 1993:195). These tasks are not isolated but take their meaning from other tasks they are associated with and are usually performed by many people (Ingold 1993:195). Ingold (1993) challenged the notion of separating technical and social practices, and reminded archaeologists that human practices are embedded in their culture and social processes (Ingold 1993:195). A key element of the taskscape involves temporality, the "social time" of tasks within people's environments and society (Ingold 1993:196). Thus the landscape is not nature and taskscape is not culture, and the two are not opposed by the Cartesian worldview (Ingold 1993:197). This concept also considers daily rhythms (e.g. temporal, solar, seasonal, social, agricultural and ecological), which likely influenced skilled agents and the tasks they performed (Roddick 2013:290-291). Although those investigating taskscapes are concerned with subsistence activities and the production of crafts, this concept is not simply new jargon for investigating economies. Taskscape studies explore daily tasks including subsistence activities, but also consider the political and social contexts, and more importantly the embodied lives of people dwelling on the landscape.

While a powerful concept, some have critiqued Ingold's taskscape as romanticizing and somewhat apolitical (Conneller 2009:184). Ingold does not acknowledge how taskscapes are political, unequal and how daily tasks can reinforce the social status of skilled agents- not all people are permitted to do certain tasks (Conneller 2009:188). Another problem is that an emphasis on generic/mundane tasks may overlook subtle changes in past communities (political and social) (Conneller 2009:189). For example focusing on generic tasks (e.g. flintknapping, hunting and food processing), in a specific region and time period (e.g. British Mesolithic) overlooks the politics, social and ideological aspects of a community and results in a homogenized, unaltered view of past communities throughout a time-period (Conneller 2009:188–189). Conneller (2009:189)explains that these problems result in an archaeology that is both too general (focused on quotidian tasks) and too specific (focused on particular sites).

In sum, this approach does help archaeologists to overcome the Cartesian worldview, avoid environmental determinism, examine the role of daily tasks in producing landscapes, and consider political influences (Conneller 2009:188). Ingold agrees that the relationship between people and landscapes is a complex and mutual one, he writes: "through living in it the landscape becomes part of us, just as we are a part of it" (1993:191).

2.5 Ceramic Analysis and Taskscapes

Some archaeologists have drawn on the concept of taskscapes to understand the complex relationship between potters and their social landscapes (Logan and Cruz 2014; Michelaki et al. 2014; Roddick 2013, 2015). These researchers consider the social aspects of each task associated with pottery, from the production, distribution, use and re-use of materials (i.e. pottery), and how together they contribute to the landscape. They consider other tasks associated with pottery production while challenging the Cartesian worldview and efficiency models. Michelaki et al. (2014) remind archaeologists that raw materials sources are not isolated locations and can "reveal histories of interactions among people, materials, and entire landscape" (Michelaki et al. 2014:784). Tasks gain their significance by the spatial and temporal relations they have with other tasks, while places gain their significance from all the tasks occurring there (Michelaki et al. 2014). When potters are selecting clays they could also be performing other tasks in conjunction with this pot making (Roddick 2013:298-299). Thus archaeologists should consider other resources that are near raw materials.

Michelaki et al. (2014:40) write: "We operationalized the concept of taskscape archaeologically by treating raw material sources as histories of movements and interactions and ceramics themselves as congealed taskscapes". They study two small Neolithic sites (Umbro Neolithic and Penitenzeria sites) in Calabria Italy, to demonstrate how interactions with the local landscape was meaningful and that certain areas were perceived as appropriate for pottery production (Michelaki et al. 2014:784). While this landscape is highly dynamic, with several erosional processes in the past (including powerful earthquakes, volcanoes, and storms), it appears that main geological units have remained consistent since the Neolithic period (Michelaki et al 2014:789-790). Michelaki et al. (2014) aim to demonstrate that they can explore how people engaged with their landscapes in this highly dynamic and archaeologically rich environment. Their study reveals that Neolithic potters were exclusively selecting local clay units where other raw materials available to potters (e.g. rocks for groundstone tools, ochre, water and flat land for animal herding and gardening) (Michelaki et al. 2014:822-823). It appears that coastal areas and their clays were not a part of the Neolithic potters' daily tasks. Michelaki et al. (2014) study demonstrates that clay units were selected in the inland area near settlements and other resources. Although the choice of local clays appears to follow the Principle of Least Effort, it may not have been the logic driving the collecting. Clay procurement was part of a larger taskscape and not divorced from social or cultural matters.

Roddick (2013:287) considers the affordance of landscapes and draws on the concept of taskscape to analyse the temporality of daily practices and long-term processes in the Southern Titicaca Basin from the Middle Formative to the Tiwanaku period. The benefit of using the taskscape perspective is that long-term rhythms and habitual temporalities are considered, and technical practices are re-embedded into the landscape (Roddick 2013:289). Roddick (2013:287) explains that the Lake Titicaca is not a static backdrop but its rhythms would create new affordance, influence daily practices and taskscapes. Archaeologists working in the Titicaca Basin focus on the shifts in ceramic production and do not consider changes in lake rhythms and fishing techniques (Roddick 2013:297). Using ceramic chronologies, archaeologists recognize the effects of social and historical rhythms but overlook daily and landscape rhythms, which skilled agents are always attuned to (Roddick 2013:290-291). Roddick (2009) and the Taraco Archaeological Project (TAP) (Steadman 2007) project conducted detailed ceramic analysis (attribute analysis, raw material survey, geochemistry and mineralogy) and focused on embodied practices and changes through time. Roddick (2013:297) was able to recognized subtle changes in pottery technology (e.g. form and finishing techniques) indicating changes in embodied rhythms and connected to larger taskscapes.

Roddick (2013: 297), like Michelaki et al. (2014), believes Late Formative farmers would find raw materials for pottery production while performing other daily tasks. He considers how pottery production would have been linked with agro-pastoral and construction practices (Roddick 2013:298). Microanalysis and geochemical analysis reveals that Late Formative period architecture has floors made with similar ceramic clays indicating the use of common technical practices in a common taskscape (Roddick 2013:298-299). Some tools used for farming (e.g. stones hoes perhaps used to dig clay, camelid bone scrapers and spindle whorls, perhaps used for preparing slips) could have also been used for pottery production thus these tasks were not isolated (Roddick 2013:298). Roddick (2013:303) demonstrated that the past Titicaca Basin landscape is made up of entanglements of different temporalities and during the Formative periods habitual times and daily tasks (collecting wood, farming, herding, and pottery production) would have impacted the taskscape.

Logan and Cruz's (2014) research on Banda communities in Ganda, combines ideas of gender and technology with taskscapes to study the relationship between farming, food, and craft production over the last three centuries. To explore how taskscapes shifted in Banda, Logan and Cruz (2014) analysed ethnographic data and archaeological remains of food and craft practices. Logan and Cruz (2014:203) argue that craft production and use "cannot be fully understood without reference to food production, preparation and consumption" and these practices are interrelated revealing the rhythms of daily life. Like the scholars discussed above, they explore how clay/temper procurement and ceramic production are interconnected with other key tasks such as food production.

Logan and Cruz (2014) also examine pottery usage and food processing in terms of the taskscape. Pottery and food consumption have an obvious relationship- pots are made to process, store, and consume/serve food (Logan and Cruz 2014:218). Researchers use vessel form to determine the intended use of a vessel (Orton et al. 2013; Rice 1987), however in contemporary Banda vessel form does not dictate how the consumer will use the pot and pots acquire their purpose through use (Logan and Cruz 2014:218-219). Despite this complex relationship pottery form can change due to shifts in food practices (i.e. new cooking techniques or new dishes) (Logan and Cruz 2014:220). For example new bowl forms made in the 1990s had incisions on the interior surface, which made it easier to grind vegetables (Logan and Cruz 2014:220). Archaeologists working in this region have found 19th century bowls show use-wear evidence likely caused by grinding food (Logan and Cruz 2014:220). This new bowl form was created to make this food processing practice easier and more efficient (Logan and Cruz 2014:220).

2.6 Theoretical Background Summary

In this chapter I have outlined how landscape studies and ceramic analysis have changed in archaeology and I discussed Ingold's (1993) taskscape, which is the theoretical concept I specifically draw from. I demonstrated that an analysis of pottery (both special-use or "ceremonial" pottery and domestic pottery) can provide us with an insight towards understanding past taskscapes in the Southern Titicaca Basin. The two sites (Khonkho Wankane and Iruhito) I am exploring in this thesis have distinct ecologies (inland vs. riverine) and have been interpreted as having distinct functions (ceremonial site vs. fishing community). Taking a more nuanced approach to these spaces, I investigate whether they differed in terms of their taskscapes. This emphasis on taskscapes in the Lake Titicaca Basin is beneficial in four distinct ways.

1. Domestic body sherds

Daily tasks and domestic pottery can be analysed in detail and related to broader landscapes. Archaeologists tend to overlook domestic vessels, undecorated body sherds and smaller sites with less ceremonial material. Archaeologists working in this region in the past have focused on analysing decorated ceremonial vessels because they were thought to reveal more on past social structures and cultural boundaries. These archaeologists did not have methodologies to conduct detailed ceramic and paste analysis on undecorated body sherds, but new methods are being developed (refer to Chapter 4). A taskscape approach highlights the value of domestic pottery datasets. This is especially beneficial because more domestic pottery and body sherds are recovered compared to ceremonial pottery in the Titicaca Basin. Although my emphasis is on domestic contexts and pottery I also recognize that ceremonial contexts and practices are part of the taskscape and pottery production and use of ceremonial pottery was also a daily practice, thus I analyse both domestic and ceremonial pottery.

2. Beyond architecture

Although archaeologists working in the Titicaca Basin (Roddick 2009; 2013) have recognized the connection between landscape and ceramics, there still seems to be an emphasis on architecture when studying past human-landscape relationships. The taskscape approach highlights people's daily tasks performed on the landscape and material remains from these tasks could reveal much of this relationship. Pottery offers us a new avenue to explore these questions regarding past human-landscape-object relationships. This is particularly important in the Titicaca Basin because not all sites have evidence of architecture.

3. Considering Daily Rhythms

As Roddick (2013:290-291) demonstrates, archaeologists working in the Titicaca Basin focus on chronological and archaeological phases over habitual daily rhythms. Yet these daily rhythms can reveal subtle change or continuity of practices and traditions. Thus the concept of taskscapes has archaeologists consider these daily rhythms and how they were impacted by the surrounding landscape. Changes in the Lake Titicaca water levels also affect the Desaguadero River, and these important features would have influenced the daily lives of people in the Southern Titicaca Basin (Baucom and Rigsby 1999:598; as cited in Smith 2016:41). The influence of river rhythm changes can be seen today when contemporary inhabitants Iruhito explain that they "follow the water/river" during dry periods (Smith 2016 personal communication).

4. Beyond ceramic ecology

An important contribution Ingold made was to challenge the Cartesian worldview of dividing nature (external world) from culture (internal subjective humans). Unlike ceramic ecology, which heavily emphasises environmental factors and cost efficiency in pottery production, the taskscape considers the social factors that also impacted daily practices. Thus the taskscape includes ecological and social influences and the division between nature and culture could be resolved.

Pottery production and usage are not just meaningless tasks divorced from social practices; but rather they maintain and transform social structures, and by analysing pottery I can work towards understanding past taskscapes in the Upper Desaguadero Valley. In the next chapter I provide a regional background of the Upper Desaguadero Valley (including the ecology, geology and social history) and describe the Iruhito and Khonkho Wankane contexts I sampled from.

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Chapter 3 The Upper Desaguadero Valley

3.1 Overview

In this chapter I provide a brief background of this region to contextualize my project. I begin by discussing the ecology and geology of the Upper Desaguadero Valley. This is followed by an overview of previous archaeological projects conducted in this region. I then outline changes in the social landscape and ceramic technology in the Upper Desaguadero Valley from the Middle Formative to the Tiwanaku period. I conclude this chapter by outlining my research questions and describing the contexts I sampled from Iruhito and Khonkho Wankane.

3.2 The Ecology and Geology of the Upper Desaguadero Valley

Figure 3.1 Photo of Lake Titicaca from the Taraco Peninsula (Photo taken by author in 2014).

On the border of Peru and Bolivia, located in the northern Altiplano, lies Lake Titicaca, the highest navigable lake in the world (3800 meters above sea level) (Smith 2016:39) (Figures 3.1 and 1.1). This massive lake (approximately 8500 km^2) has been home for several communities and cultures both past and present. Here I focus on the Southern Lake Titicaca Basin- a geological basin located in the Bolivian Altiplano between the Andean ranges Cordillera Oriental and Cordillera Occidental (Smith 2016:39).

The Lake Titicaca Basin is classified as an intertropical climatic zone (Smith 2016:41). This region has a wet season from November to March, where the mean temperature range from -5° C to 23° C (Bandy 2001:26). The dry season is from June-August with a mean temperature range from -14° C to 22° C (Bandy 2001:26). The average precipitation for this region is 500-700mm per year (Smith 2016:41). Lake levels are very dynamic and fluctuate. During periods of low water levels, large amounts of wetlands are exposed and this rich soil is suitable for farming practices (Erickson 1999:637; Smith 2016:42). The most important crop in this region's wetland zone is totora reeds (*Schoenoplectus tatora*), this aquatic crop is used to build homes, boats and as food (Erickson 1999:640; Pérez-Arias 2013:9; Smith 2016:42). Faunal resources in the region include two native genera of fish *Trichomycterus* and *Orestias,* and several species of aquatic birds (Pérez Arias 2013:8; Smith 2016:42).

Figure 3.2 Photo of the Desaguadero River from the site of Iruhito facing west. (Photo taken by Daniel Ionico in 2015).

The Desaguadero River is the primary drainage for Lake Titicaca, running north to south linking Lake Titicaca to Lake Poopó, approximately 398 km southeast (Figures 3.2 and 1.1) (Pérez -Arias 2013:6). The Desaguadero River is divided into an upper and lower portion (beginning South of Calacoto), which experiences distinct fluvial processes (Baucom and Rigsby 1999:605; as cited in Smith 2016:41). The river would cycle between periods of drought and floods (Erickson 1999:641). The upper portion of the Desaguadero River is primarily fed by Lake Titicaca and has a low gradient, creating a marshy area during high-water periods (Baucom and Rigsby 1999:598; as cited in Smith 2016:41). While the lower portion of the river is unaffected by the fluctuating lake levels because it is fed by the Mauri River, which deposits a large quantity of water and sediments (Smith 2016:41). During periods of high water levels, lake resources such as fish, aquatic birds, and fresh water would have been abundant (Pérez Arias 2013:6). However, higher water levels would have made contact with the north (Tiwanaku and Southern Titicaca Basin) difficult (Pérez Arias 2013:70). Today, low vegetation in the Titicaca Basin highlands [6]makes this zone best suited for camelid grazing, domestic camelid species include llamas (*Lama glama*) and alpacas (*Lama pacos*) while wild camelid species include vicuñas (*Vicugna vicugna)* and guanacos (*Lama guanicoe*) (Smith 2016:44).

Figure 3.3 Map of the Upper Desaguadero Valley (Map modified from Google Earth 2016).

The Desaguadero River runs into the Upper Desaguadero Valley, which is separated from the Tiwanaku Valley by the Quimsachata-Chilla mountain range (Figures 3.3 and 3.4) (Janusek 2013). The Upper Desaguadero Valley extends approximately 4900 km^2 and is bordered by the Quimsachata-Chilla mountain range in the north and east, the

[6] The highlands in the Titicaca Basin are known as the *puna* and begin at 4200 masl (Erickson 1999; Smith 2016:44).

Cordillera Occidental in the west, and the convergence of the Mauri and Desaguadero rivers in the south (Smith 2016). Resources available for pottery production in the Upper Desaguadero Valley and the Tiwanaku Valley likely differed due to their underlying ecology and geology.

Figure 3.4 Photo of the Quimsachata-Chilla mountain range from the site of Khonkho Wankane, facing north. (Photo taken by the author in 2015).

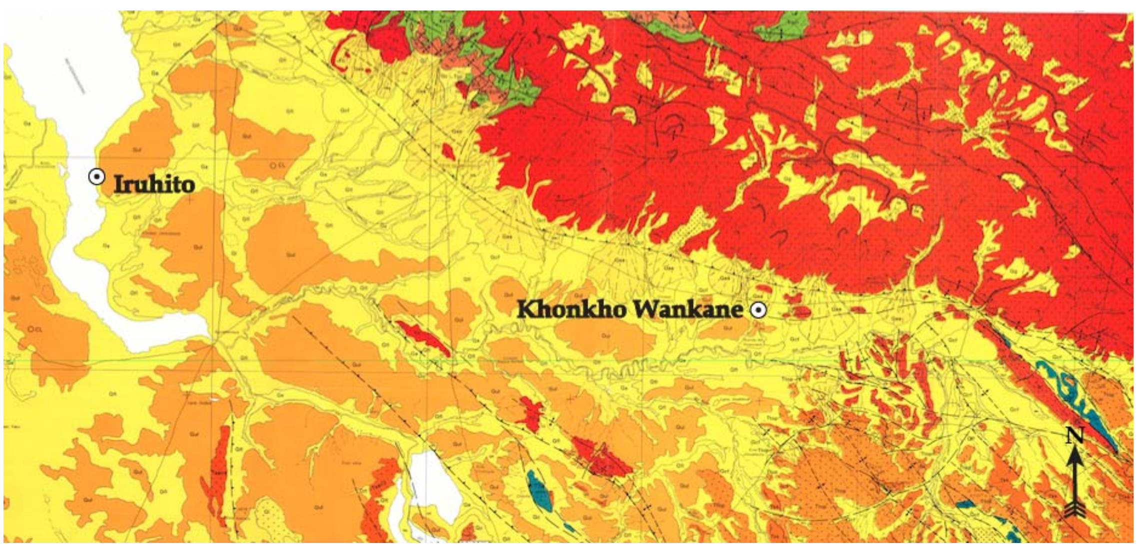

Figure 3.5 Geological map of the Upper Desaguadero Valley. Qa=alluvial deposits in yellow, Qfl= fluvial deposits in yellow, Qul= orange, TTI=Tiwanaku formation in red, Kem= Molino formation in green, PE-Ech= Chilla formation in pink (Map modified from García D. and García M. 1995).

Both alluvial and fluvial lacustrine deposits contribute to the geology of the Upper Desaguadero Valley, resulting in rich sands and small quantities of calcareous deposits located near the Desaguadero shoreline (García and García 1995). Alluvial deposits near the site of Iruhito include pebbles, gravel, sand, mud and clay (Qa in Figure 3.5) and fluvial lacustrine deposits include gravel, sand, mud, clay (Qfl), silt, sand gravel and calcareous crusts (Qul) (García D. and García M. 1995). The Quimsachata-Chilla range is a very important source for ceramic production in the Southern Titicaca Basin because it provides raw materials that could be used as paste temper (Roddick 2014:26). In Figure 3.5 the Quimsachata-Chilla range is divided into the Tiwanaku formation (TTI), the Molino (Kem) and the Chilla complex (PE-Ech). The geology of the Tiwanaku formation includes red-purple sandstone, shale, loam and conglomerates, while the Molino formation includes beds of grey, white, green and red casts and clays (García D. and García M. 1995). The geology of the Chilla formation includes grey-green quartzite, slate, marron arkose, sandstone, maroon-yellow shale, basaltic lava, and intrusive gabbro (García D. and García M. 1995). Roddick (2014:26-27; 31) explains that the metamorphic rocks eroded in the Chilla formation are important because they are unique to this region and thus can signal local production.

The PAJAMA project has divided the region into "inland" and "river" zones (Janusek 2013:7). Inland Upper Desaguadero sites such as Khonkho Wankane and Pukara de Khonkho are located closer to the Quimsachata-Chilla mountain range, sandstone quarries, and have drier climates ideal for pastoralism. The river site Iruhito, in contrast, has a wetter landscape, and is closer to the Desaguadero River making it ideal for fishing practices during the Formative periods[7].

3.3 Previous Work

The site of Khonkho Wankane is located outside of the contemporary community Qhunqhu Liqiliqi, approximately 30 km south of Tiwanaku and 20 km northeast of the Desaguadero River, in the Upper Desaguadero Valley. The site is in between the Quimsachata-Chilla mountain range (2.5 km south from the foothills of the range) and the Rio Grande [8] (0.5 km away), a tributary of the Desaguadero River (Janusek 2013; Smith 2013, 2016:55). From 1938-1941, Portugal Zamora conducted excavations at

[7] Recent dredging projects in this region have result in the destruction of fisheries (Smith and Roddick 2016 personal communication).

[8] The Rio Grande is also known as Jach'a Jawira River.

Khonkho Wankane, and dated monoliths from the site to the Pajano period[9] (Portugal Zamora 1941, 1955 as cited in Smith 2016:43). Archaeologists Stig Rydén (1947) and Carlos Ponce Saginés (1981:83)also investigated Khonkho Wankane but dated the site to the Tiwanaku period (Janusek 2005:18, 2013:19; Smith 2016:55–56). These scholars argued that Khonkho Wankane was a second city, or "wunderkind" of the Tiwanaku state in the Upper Desaguadero Valley (Janusek 2013:15). In 1987 Proyecto Wila Jawira, led by Alan Kolata (1993), excavated Khonkho Wankane and interpreted the site as a Tiwanaku satellite site. They explained Khonkho Wankane as the center of a multi-community polity and all the sites affiliated with Khonkho Wankane would also be considered Tiwanaku sites (Janusek 2013:15). From 2001-2007 the PAJAMA team directed by John Janusek, conducted excavations at Khonkho Wankane and revealed that Khonkho Wankane was not a "second city" to Tiwanaku but was a Late Formative political and ceremonial center (Janusek 2013:21).

The archaeological site of Iruhito is located on the edge of the Rio Desaguadero and on the outskirts of the contemporary town of Iruhito, an Uru community (Pérez-Arias 2013). Iruhito was first described by Max Uhle in 1895 and later in the 1990s surveys were conducted by Oswaldo Rivera Sundt (Smith 2014:3). In 2002, members of Proyecto Jach'a Machaca (directed by Adolfo Pérez-Arias) conducted the first systematic archaeological excavations at Iruhito. Earlier archaeologists assumed that the earliest inhabitants here were fisher/hunter/gatherers, and gradually became intensive farmers (Smith 2014). Due to continual practice of fishing in Iruhito, early scholars considered the site "fragile" and its inhabitants "backwards" who barely collected enough resources to survive (Smith 2014:2). However, evidence shows that the fisher people of Iruhito were resilient and the site was continuously occupied (Smith 2014:2).

3.4 The Social Landscape of the Upper Desaguadero Valley

In this section I trace the changes in the social landscape of the Upper Desaguadero Valley from the Middle Formative through the Tiwanaku period (Hastorf 1999, 2003; Janusek 2004a; Stanish 2003). I focus on political influences and interaction with other regions (i.e. trade evident through material culture including ceramics), and how the ecology and climate impacted social interactions and subsistence practices (i.e. herding

[9] The Pajano period is now referred to the Late Formative 2 period.

and fishing). These particular themes are important for understanding changes in past taskscapes and pottery production).

Middle Formative

Iruhito has been continuously occupied for 2,700 years. The earliest ceramics at this site date to the Middle Formative Period (Pérez-Arias 2013:3; Smith 2014) and are similar to pottery from the well-known ritual center of Chiripa (Hastorf 1999; 2003; Pérez-Arias 2013:49). Chiripa-style ceramics are characterized by their paste (fiber-tempered), surface finish (red-brown slip) and form (flat-based bowls) (Janusek 2004a:127). The first occupation in Iruhito occurred during a drought period, when Lake Titicaca water levels were low (Pérez Arias 2013:34). Low water levels allowed for more interaction between areas such as the Taraco Peninsula (where Chiripa is located) and Iruhito, and for more trade with Wankarani areas (found near Oruro in the south) and sites in Peru (Janusek 2008; Pérez-Arias 2013; Smith 2014).

In the Early-Middle Formative period inhabitants of the region fished, foraged, and hunted (Janusek 2008:177). Faunal remains indicate that in Chiripa, 97% of their diet consisted of fish (Janusek 2008:177). Iruhito has the highest density of fish remains of excavated Upper Desaguadero sites[10] (Pérez-Arias 2005:146-147), but it appears the villagers shared a similar economy as Chiripa (Janusek 2008:177). Pérez-Arias (2013:67) explains that although Chiripa and Iruhito did interact and shared pottery production practices, potters from Iruhito did not adopt the Yaya-Mama Religious Tradition[11] (Pérez Arias 2007:243). Ceramic analysis conducted by Pérez -Arias (2007:245) reveals that Iruhito style shares some similarities with ceramics from Chuquña, La Barca, and Pusno, all of which are associated with the Wankarani culture in the south. During the Middle Formative period there appears to be no interaction between inhabitants from Khonkho Wankane and Chiripa or Iruhito, likely because Khonkho Wankane was not occupied until the Late Formative period (Pérez-Arias 2013:243-244).

[10] Five sites from the Upper Desaguadero Valley have been extensively excavated and published on but 76 sites have been identified from the Middle Formative- Tiwanaku periods (refer to Lemuz Aguirre 2011; Smith and Janusek 2014).

[11] Approximately 800 B.C. the Yaya-Mama Religious Tradition became a widespread standardized religion, unifying diverse groups and characterized by sunken courts, stone sculptures with specific iconography, ceramic trumpets, and burners (Janusek 2004a:136).

Late Formative

Many ritual-political centers appeared during the Late Formative in the Southern Titicaca Basin (Table 3.1, Janusek 2008:21). Archaeologists think these centers may have been served as the heads of multi-community polities (Bermann 1994; Janusek 2004a:142–146, 2008:90; Marsh 2012a:62–63; Roddick 2009; Stanish 2003:140–155)[12]. Late Formative centers shared similar and continuous constructions including raised platforms, trapezoidal sunken courts used for ceremonies, stone monoliths rich in iconography, and larger populations of permanent residents (Janusek 2008:90; Marsh 2012a:63). Khonkho Wankane was a ceremonial center and based on material culture and architecture, inhabitants appear to have interacted and competed for influence with Tiwanaku during the Late Formative period (Janusek 2004a).

Table 3.1 Late Formative regional centers and regions in the Southern Titicaca Basin (Janusek 2008:93)

Region	Regional Center
Tiwanaku Valley	Tiwanaku
Katari Valley	Lukurmata
Taraco Peninsula	Kala Uyuni
Upper Desaguadero Valley	Khonkho Wankane

Ceramic technology and styles drastically changed during the Late Formative period. Potters gradually shifted towards using less fiber and more sandy/mineral tempers, they produced smaller serving vessels, and included red bands of paint on the rims of their vessels. Potters produced two decorative styles during this period, the Kalasasaya (e.g. bowls and vasijas with red rims) and Qeya styles (e.g. small-medium jars, bowls, keros, and sahumadores painted or incised) (Janusek 2003:53–54). Access to such vessels became more exclusive (Janusek 2003:53, 2008:91, Marsh 2012a:490; Roddick 2009: 27-30).

During the Late Formative period, inhabitants of the Desaguadero region no longer heavily relied on lake resources, and more people moved to drier areas inland to adopt herding and farming practices (Janusek 2008:177). The high quantity of camelid remains (75%) found in Khonkho Wankane suggests to some that pastoralism was the principle resource for the productive economy of this site (Janusek 2004b:271; Smith

[12] See Roddick et al. (2014) who question this theory.

2009:417). Only a small portion of faunal remains in Khonkho Wankane were fish and bird (Marsh 2013:48). Khonkho Wankane is further from lake resources and its dry grasslands would have been ideal for pastoralism (Janusek 2004b:271). Camelid would not only provide meat and wool, but llama caravans were also used for transportation and trade (Janusek 2008:193). Llama iconography found on materials from Khonkho Wankane may indicate the significance of pastoralism (Ohnstad 2013:58). Although archaeologists have also found camelid remains in Late Formative Iruhito contexts, the high quantity of fish remains indicate that fish continued to be a staple at this site likely due to the proximity of the Desaguadero River.

Inhabitants of Khonkho Wankane also interacted with those living in further south, near Oruro[13] (Marsh 2013:51). The circular structures and some ceramics found in Khonkho Wankane resemble the Wankarani style, suggesting some sort of interaction between the two regions (Marsh 2013:51). Iruhito appears to have been in contact with many sites during the Late Formative period. The shared ceramic styles, architecture, and proximity, may indicate that Iruhito had more contact with Khonkho Wankane compared to other sites (i.e. Tiwanaku and Wankarani) (Pérez Arias 2013:69-70). Overall, Khonkho Wankane was an important ritual-political and trade center during the Late Formative period that interacted with both the north and south but declined in power during the Tiwanaku periods.

Tiwanaku

Around A.D. 500 Tiwanaku emerged as the principle urban and ceremonial center in the Southern Titicaca Basin (Janusek 2004a:150). During the Tiwanaku 1 phase (A.D. 500-800)[14], Tiwanaku was defined by a nested hierarchy of semiautonomous socio-political groups and did not have a centralized control over local communities (Albarracin-Jordan 1996:205; Janusek 2004a:162).During Tiwanaku 2 (A.D. 800-1000) the state shifted from incorporative to transformative control and became a more tightly centralized political economy (Albarracin-Jordan 1996:206, Janusek 2004a:162). The Khonkho Wankane site was abandoned sometime after Tiwanaku became a state (Janusek 2013). Few sites in this region had evidence of Tiwanaku-style material, but

[13] Wankarani region is characterized by its drier landscape, undecorated ceramics, stone effigy llama heads, and circular structures (Janusek 2004a:127).

[14] I follow Janusek (2008) and use Tiwanaku 1 and 2 rather than Tiwanaku IV and V.

Iruhito is an exception with an elaborate political-religious complex (Smith and Janusek 2015:689-691). The PAJAMA team has found Tiwanaku-styled ceramics, four *chachapumas*[15] and a pedestal (similar to ones found in la K'araña and Akapana in Tiwanaku), demonstrating Tiwanaku's political influence in Iruhito (Pérez-Arias 2013:74). Scholars believe that leaders in Tiwanaku developed relationships with riverine sites, such as Iruhito, to gain access to trade routes along the Desaguadero River (Smith and Janusek 2015:693).

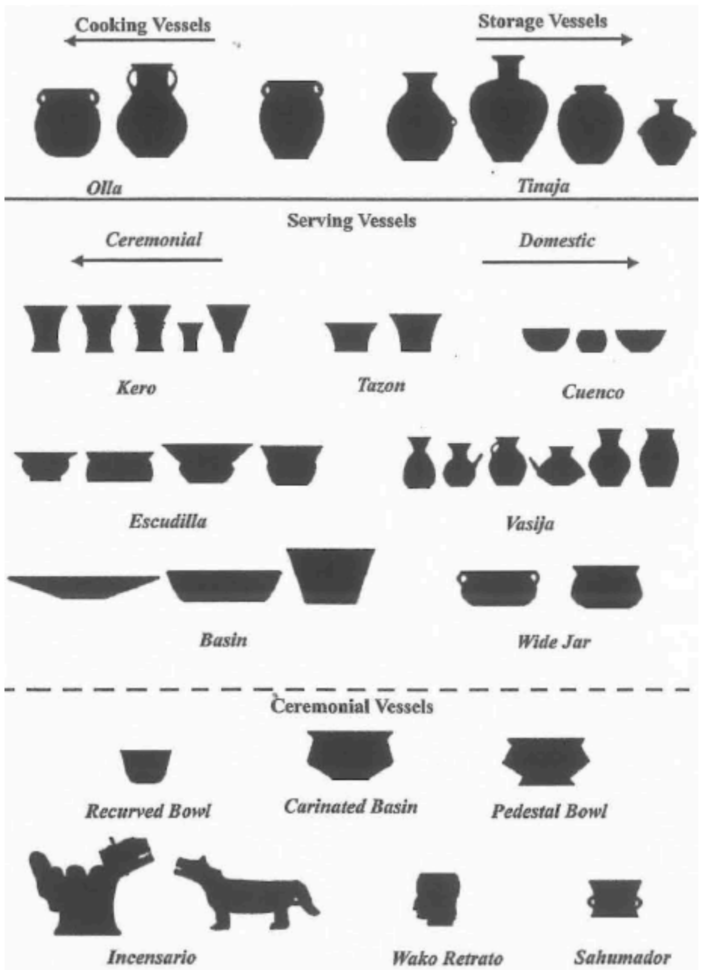

Figure 3.6 Tiwanaku-style vessel forms. (Image from Janusek 2003:57, figure 3.27).

We can identify Tiwanaku phases because potters produced a wide variety of ceramics, with standardized forms, finishes and iconographic styles (Figure 3.6). Cooking vessels during this period include ollas, which remained consistent from the Late Formative period (Janusek 2003:58-60). Serving vessels include tinajas, which have long

[15] Chachapumas are stone carved were-feline warrior figurines often placed in the front of Tiwanaku period public architecture.

cylindrical necks used for fermenting and storing liquids, while jars were used for storage (Janusek 2003: 58-60). The increase in olla size and number of tinajas (along with other data) indicates the importance feasting during the Tiwanaku period (Janusek 2003:81). Around A.D. 500 potters were producing elaborate serving vessels, including keros, tazones, escudillas, vasijas, and bowls, while ceremonial forms, including portrait drinking vessels[16], sahumadores and incensarios (both adapted from ceremonial Qeya burners) (Janusek 2003: 60-79). Tiwanaku serving and ceremonial vessels were red and black slipped, highly burnished or polished, and decorated with geometric iconography (Janusek 2003:56).

3.5 Research Questions and Sampling

My research explores how different Khonkho Wankane and Iruhito taskscapes are and if this is evident through ceramics. I investigate Late Formative ceramic taskscapes through a fine-grained analysis of ceramics from domestic contexts dating to similar time periods at both sites (see Tables 3.2 and 3.3). As will be seen below, the Upper Desaguadero Valley is suitable for the questions I am interested in. These two sites are from the same region but differ in terms of ecologies, subsistence economies and interpreted as having distinct functions. Based on these differences it is suggestive that Iruhito and Khonkho Wankane had different taskscapes. My project is the first to examine these taskscapes and compare the role of pottery production and use in these taskscapes. Specifically, I ask:

1. Were potters drawing on distinct resources while inhabiting their taskscapes?

As discussed in Chapter 2, pottery production is a daily task, and was likely one of the multiple interlocking practices that made up taskscapes of the past. Thus analysing pottery can contribute to our understanding of the pre-Columbian taskscapes of the Lake Titicaca Basin. Ceramic pastes are made from raw materials (clays and temper inclusions) associated with geological deposits (Quinn 2013:39). By analysing paste we can explore which materials were selected and how potters interacted with their landscape. When other tasks and the social context of the potter are considered we can begin to explore the taskscape. Michelaki et al. (2014) and Roddick (2013) demonstrate that pottery production and raw materials were not separated from other daily tasks, but

[16] Portrait vessels depict human faces.

rather were part and parcel of fishing, herding, farming, and ritual practices. A potter's choice in raw materials is influenced by a complex relationship between both the ecology and the contextual understanding of the social landscape (Gosselain and Livingstone Smith 2005; Livingstone Smith 2000).

Iruhito and Khonkho Wankane are thought to have different economies and daily activity likely resulting in distinct taskscapes. High density of fish bones found in Iruhito indicates that fishing was a primary resource (Janusek 2008:177). Iruhito has been interpreted as a fishing community and fishing practices were likely closely tied to pottery production. Potters in Iruhito had more riverine resources available, most notably the *totora* reeds used for building homes and boats and perhaps used as paste temper. When water levels were low, rich soil and clay sources were exposed (Erickson 1999:637; Smith 2016:42). Resources near the site include sands, calcareous deposits, pebbles, mud, silt and clay (Roddick 2014). By analysing the paste and considering river resources and other tasks, we can better understand this site's taskscape.

While the high quantity of camelid remains found in Khonkho Wankane indicates that pastoralism was the principle resource for this site (Janusek 2004b: 271; Smith 2009:417). Khonkho Wankane was further from the Desaguadero River and suited for pastoralism (Janusek 2004b: 271), thus likely had a different taskscape compared to Iruhito. Potters likely used resources from the Quimsachata-Chilla range, which include sandstone, clasts, quartzite, basaltic lava, and clays (Roddick 2014:26). The PAJAMA team interpreted Khonkho Wankane as a ceremonial center (Janusek 2013:21; Marsh 2012a:6; Smith 2009:13) and daily tasks likely included controlled ritual practices resulting in a distinct taskscape.

I expect there to be a difference between the pastes of Iruhito and Khonkho Wankane due to the available resources near the site and their distinct taskscapes. Iruhito potters likely used riverine resources for their pastes because the river was part of their daily movement across the local landscapes. In contrast, Khonkho Wankane potters likely used resources from the Quimsachata-Chilla mountain range in their pastes. Differences in paste may also reflect the inhabitants' different daily tasks (fishing vs. ceremonial activity), which likely affected access to resources and pottery production. If pastes from these sites are similar then perhaps potters from Khonkho Wankane and Iruhito shared practices and viewed the same resources as appropriate for pottery production.

2. Were potters producing distinct forms while inhabiting distinct taskscapes?

Pottery was not only made during daily tasks but also once manufactured, used in daily tasks. The form of a ceramic vessel can indicate the intended use of a vessel (Orton et al. 2013; Rice 1987; Roddick 2009). Certain tasks (e.g. fishing, herding, rituals and farming) may have required specific forms, or resulted in particular traces on vessels. Thus different ceramic forms or uses may have played important roles in different daily tasks and taskscapes. To address my second question regarding pottery production and vessel forms I analysis vessel shape, firing cores, and finishing techniques.

Khonkho Wankane and Iruhito had different economies and those living there had distinct daily tasks (e.g. fishing, herding and ritual activities). Pottery production is not isolated and other activities such as cooking and storage would impact how potters chose to make their vessels, and conversely choices in production might impact cooking and storage choices. I expect there to be some difference in the shape, size, and quantity of certain vessels. I suggest that variation in vessel form between these two sites support distinct taskscapes, whereas similarity suggests more shared ways of doing. Archaeologists of this region suggest that Iruhito and Khonkho Wankane likely interacted, which could have included ritual ceremonies, exchange (i.e. stops on llama caravan circuits), and intermarriage, all moment when ideas surrounding pottery production could have been shared (Pérez-Arias 2013; Smith and Janusek 2014). If ceramic forms are similar between the two sites, then this may be result of shared views on what are appropriate ceramic forms. If vessels from Iruhito and Khonkho Wankane had similar forms but made with different pastes, this may indicate that different resources were available to potters but regional uses of pots remained consistent. If both the paste and form were different, then a difference in resources and tasks influenced the production of pottery.

3. Were people using pots in different ways while inhabiting distinct taskscapes?

Inhabitants of Khonkho Wankane and Iruhito likely had different taskscapes, which could have affected how domestic pottery was used within their settlements. Spatial distribution of vessel forms across a site, could give us insight into the inhabitants' taskscapes. By analysing attributes such as carbonization I will examine which particular forms (and which paste recipes) were used for cooking practices. Fishing in Iruhito was wrapped up in other tasks such as food storage and cooking practices, which certainly influenced pottery usage. The clear distinctions between ceremonial and domestic areas in Khonkho Wankane would have also influenced where and how domestic pottery was used at this site. There was no such clear distinction between Formative Period domestic and ceremonial spaces at Iruhito, thus the spatial distribution of domestic pottery at this site was difficult to analyse. I ask whether potters made and used different types of pots at these two sites due to their distinct taskscapes. If the paste, form, finish, carbonization, and deposition of these ceramics vary between these sites, then perhaps pottery was used very differently at these sites, if not they could have been used in similar ways

Late Formative Domestic Contexts

Because I am interested in comparing two taskscapes I assume that domestic pottery would be more sensitive to local (i.e. site) differences and likely produced from raw materials near the site[17] (Arnold 1985: 50-52; 2005:18; Druc 2013: 505) Ceremonial decorated pottery, in contrast, might have been moving longer distances around the landscape. Little is known of domestic contexts in the Late Formative period, and only a few sites have a clear distinction between domestic and ceremonial spaces (Bermann 1990:243; Escalante Moscoso 1994:272; Janusek 1994:106; as cited in Marsh 2012a:117).

Sampling the Late Formative

Excavations suggest that Khonkho Wankane reached its apex during the Late Formative period (Janusek 2004a; Marsh 2013; Smith 2009) while Iruhito had a longer occupation, from the Middle Formative period through to the Pacajes period (Pérez-Arias 2013; Smith and Janusek 2014:691). To select Late Formative contexts, I referred to peer reviewed publications and site reports, paying attention to C^{14} radiocarbon dates (see Table 3.2) and stratigraphic profiles. I also drew upon personal conversations with the excavators. More radiocarbon dates are available for the Khonkho Wankane excavations. There are fewer Late Formative contexts at Iruhito, and in general they are more difficult to identify due to disturbance and little radiocarbon dating (Smith personal conversation 2015). As such, I included Middle Formative and Tiwanaku contexts from

[17] According to Dean Arnold's (1985:35, 55) "exploitable threshold model" potters will travel a maximum of 7 km radius on foot to obtain clay and temper sources; although this distance can vary archaeologists agree that raw materials used in pottery production must be located near the potters occupational and/or work site (Druc 2013; Gosselain and Livingstone Smith 2005; Michelaki et al 2014).

Iruhito (Table 3.2-3.3), and tracked changes in ceramic production through time. However, I used Late Formative samples from Iruhito when comparing these two sites as almost all of my samples from Khonkho Wankane date to Late Formative period (Table 3.2-3.4).

The contexts selected from these two sites were identified as domestic spaces by the PAJAMA team. These spaces (Sector 7, 9, 12, 3 at Khonkho, and Sector del Montículo and Ribera at Iruhito–Figures 3.7 and 3.10) based on material culture identified as 'domestic' (e.g. spindle whorls, ground stones, and lithics etc.), specifically ceramic, middens, and domestic architecture (Marsh 2012a:278). According to Marsh (2012a: 116-128) ceremonial spaces tend to have ceremonial architecture (e.g. sunken courts, platforms) cleaner surfaces, exotic and elaborate material (e.g. ceremonial ceramics, burners, monoliths etc.), thus if an area had evidence of domestic activities (e.g. cooking, food processing etc.), hearths, dwelling refuse and dense quantities of ceramics then it is considered a domestic area. Although I primarily selected domestic pottery, I also analysed some ceremonial vessels to define the domestic: ceremonial distinction between sectors (Tables 3.2 and 3.3).

Table 3.2 Radiocarbon measurements of sectors analysed from Iruhito and Khonkho Wankane. All dates were recalibrated by the PAJAMA project using OxCal version 4.1 and 4.2 (Bronk Ramsey 2001,2009,2013) and IntCal 04 and IntCal 13 calibration curve (Reimer et al. 2001, 2013).

Site	Lab Code	Context	^{14}C age (BP)	1 sigma 63% (cal BC/AD)	2 sigma 95% (cal BC/AD)	Mean	Period	Source
IRU	AA75516	5-1	1278±33	AD 682-767	AD 659-855	AD 727	TIW I	Smith & Janusek (2014:688)
IRU	AA75520	4-2	2493±35	N/A	760-540 BC	N/A	MF	Pérez-Arias (2013)
KW	KW13	7.46 L4	1655±37	AD 339-430	AD 259-533	AD 392	LF2	Smith (2009)
KW	KW17	9.20 L4	1676 ±37	AD 266-417	AD 251-504	AD 362	LF2	Smith (2009)
KW	KW8	12.65 L3	1799±38	AD 137-255	AD 126-337	AD 219	LF1	Smith (2009)

Horizontal vs. Vertical Excavations

These two sites were excavated very differently. Khonkho Wankane had a shorter occupation compared to Iruhito and thus had shallower units which is why the PAJAMA team excavated the site horizontally and could reveal a larger area (Marsh 2012a:189-

190). Archaeologists predominantly excavated 2x2m units, identifying new levels/strata based on natural changes or identifying arbitrary levels every 10cm (Marsh 2012a:189). Horizontal excavations provide a clearer picture of the site's layout and organization, as well as a clear distinction between domestic and ceremonial spaces (Janusek 1994:80-81). We have a better understanding of the spatial changes in Khonkho Wankane but not as much information on the temporal changes, because the site was primarily occupied during one period (the Late Formative).

Iruhito was excavated vertically, resulting in deeper units and more stratigraphic information (Pérez -Arias 2007; 2013). The PAJAMA project only excavated two units in great detail (4-2 and 5-1), resulting in less information on the spatial variation of this site. Due to the different excavation methods I found it challenging to select contemporary domestic contexts to sample. Although most of my samples are from Late Formative period domestic contexts, I did collect samples from Khonkho Wankane ceremonial contexts. This proved useful, as it permitted me to better identify the distinction between these kinds of vessels. I also was able to briefly explore the transitions between the Middle and Late Formative, and the Late Formative and Middle Horizon. In sum, this is a primarily synchronic study with a brief discussion of diachronic change at Iruhito and spatial variability at Khonkho Wankane.

3.6 Iruhito

From 2002, 2008-2013 Proyecto Jach'a Machaca and director Adolfo Enrique Pérez-Arias conducted the systematic archaeological excavations at the site Iruhito. The project divided the site into five sectors (Ribera, Montículo, Central, Sur, and Este) based on different topography and physical features and material culture. Little work has been conducted at Sectors Central, Sur, and Este (Pérez Arias 2013). Since my samples from Khonkho Wankane were chosen from domestic Late Formative contexts, I analysed samples the Ribera and Montículo sectors (Figure 3.7), which have some Late Formative domestic contexts. The distinction between domestic and ceremonial spaces is not as clearly defined at this site as at Khonkho Wankane. Many of the spaces could have been implicated in a range of practices at different times. I focused my sampling protocol on Late Formative period contexts.

Figure 3.7 Map of Iruhito (Modified from Google Earth 2016)

Ribera Sector

Sector Ribera is adjacent to the Rio Desaguadero, measures 500 meters from north to south and is highly disturbed due to contemporary activity (Figure 3.7) (Pérez Arias 2013). This sector has a 6m mound with high quantities of human bones, artifacts, and fragments of stone (andesite, quartzite, and limestone) (Pérez Arias 2013:9). Evidence for the earliest occupation in Iruhito was found in Ribera and dates to the Middle Formative period (Pérez Arias 2013:3; Smith 2014). Sector Ribera continued to be occupied until the Late Formative Period.

The ceramic sequence for Ribera sector was not completely defined due to a disruption of this area (Pérez-Arias 2013:53). Levels XII and X in unit 4-2 contained a large quantity of Middle Formative (Late Chiripa) ceramics (Figure 3.8) (Pérez -Arias 2013:50). Late Chiripa style ceramics have a discrete sequence; this style appears in level XII and continues until level X (Pérez -Arias 2013:53). Although the Ribera sector was primarily occupied in earlier periods (Middle Formative), there is evidence of Late

Formative domestic practices and pottery within this unit (Figure 3.8). Pérez Arias (2013:16) has identified Late Formative period ceramics in Ribera, including ollas, jars, and bowls, which were domestic in function (Pérez Arias 2013:16). There is no clear distinction between Late Formative 1 and 2 contexts. After the appearance of Late Chiripa ceramics, there appears a mix of both Late Formative 1 and 2 ceramics, and thus no distinction between these types can be made, and no distinct fine vessel forms (Kalasasaya or Qeya) have been found in this unit (Pérez -Arias 2013:54).

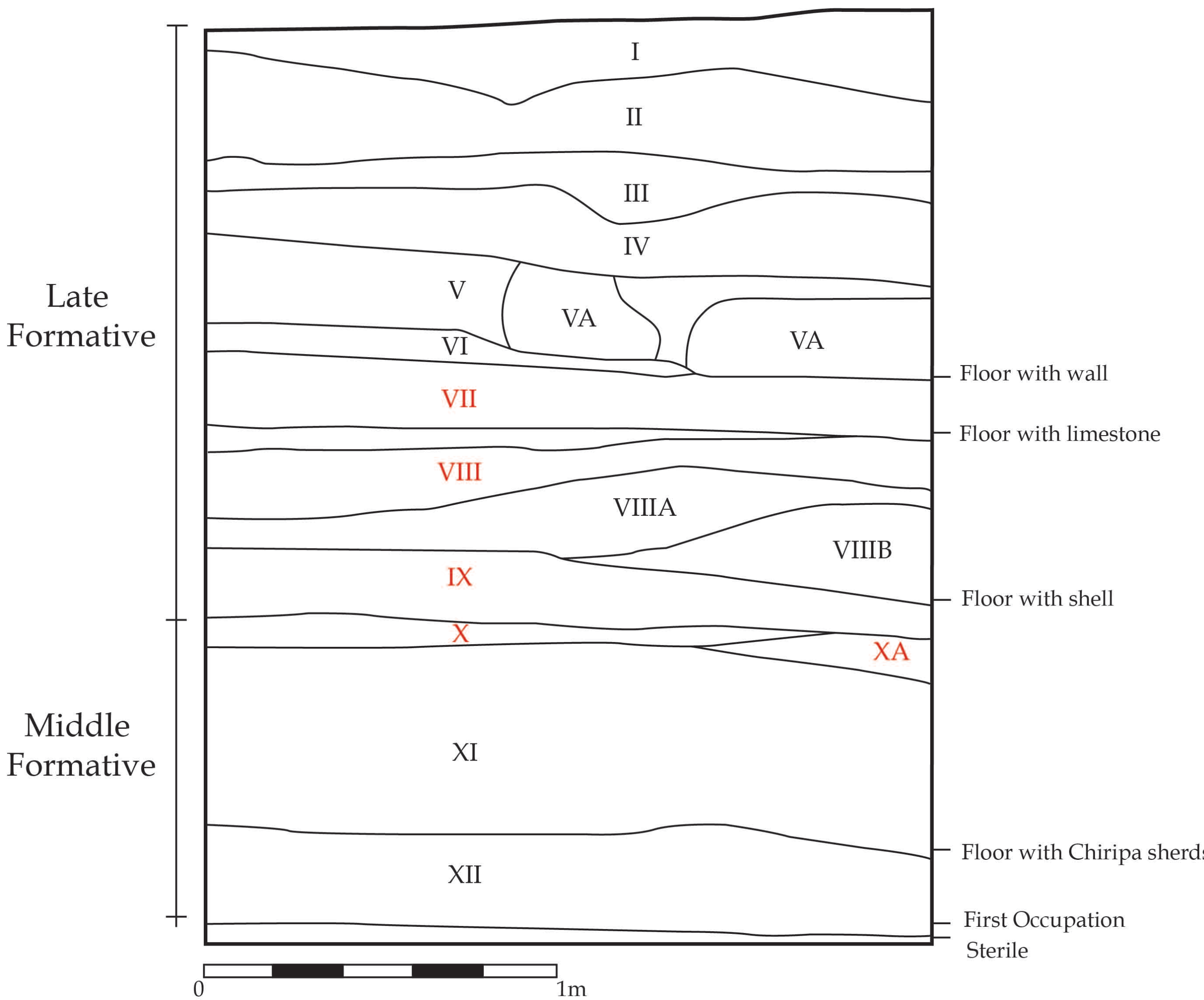

Figure 3.8 Stratigraphic profile of Unit 4-2, in Ribera Sector. Red= levels selected for ceramic analysis. (Modified from Pérez -Arias 2007:219).

I sampled from seven levels VII, VIII, IX, IXA, X, XA, and XIII- refer to Figure 3.8 and Table 3.3. Levels VII-IX are Late Formative contexts while levels X to XIII are

Middle Formative contexts. My analysis of Ribera ceramics will build on the previous ceramic analysis conducted by Pérez -Arias (2007, 2013). In total 1354 sherds were found in Iruhito and Pérez -Arias (2007, 2013) analysed ceramic finish, firing, cores, and made some observations on ceramic pastes. I discuss Pérez -Arias and my results further in Chapter 6. I also explore ceramic production at this site from a diachronic perspective, from the Middle Formative through Tiwanaku phases.

Montículo Sector

Sector del Montículo is 300-meters east of the river and approximately 1.2 hectares in size (Figure 3.7) (Pérez Arias 2013:10). This sector has a large mound 60-meters east-west, 130-meters north-south, and 4-meters high (Pérez Arias 2013:10). Sector del Montículo was continuously occupied from the Late Formative period (levels IX-XI) to the Tiwanaku period (levels I-VIII) (Figure 3.9) (Pérez Arias 2007:241; 2013; Smith 2014). During the Tiwanaku period Sector del Montículo was primarily in use while Ribera was used for burials (Pérez Arias 2013:650). The Tiwanaku period andesite pedestal found in the Montículo sector is what originally sparked interest and excavations in this area (Pérez-Arias 2013:28). The highest density of archaeological material culture at this site was found in this sector (Pérez -Arias 2013:10). Although evidence of ceremonial activity was found in this sector during later phases, Pérez Arias (2013:20) believes domestic practices define the earlier Late Formative periods.

Ceramics found in unit 5-1 Sector del Montículo were mostly decorated ceramics related to Tiwanaku period, which is why this sector was initially characterized as an exclusively ceremonial area (Pérez -Arias 2013:20). Pérez Arias (2013:20) argues that this sector was used for both domestic activities and ritual activities. There were several different stages of construction and three floors found within this unit (Pérez -Arias 2013:22-25). In total 1009 ceramic sherds were found at Sector del Montículo. These ceramics have been analysed by Pérez-Arias and his findings will be discussed in Chapter 6. For this project I analysed ceramic samples from five levels VI-VIII, IX, X (Figure 3.9 and Table 3.3). Levels VI-VIII date to the Tiwanaku period and are thought to be ceremonial contexts, but levels IX and X date to the Late Formative 2 period and could be domestic contexts. My project provides more detail on the ceramic pastes, and compared production routines and use with ceramics from Khonkho Wankane.

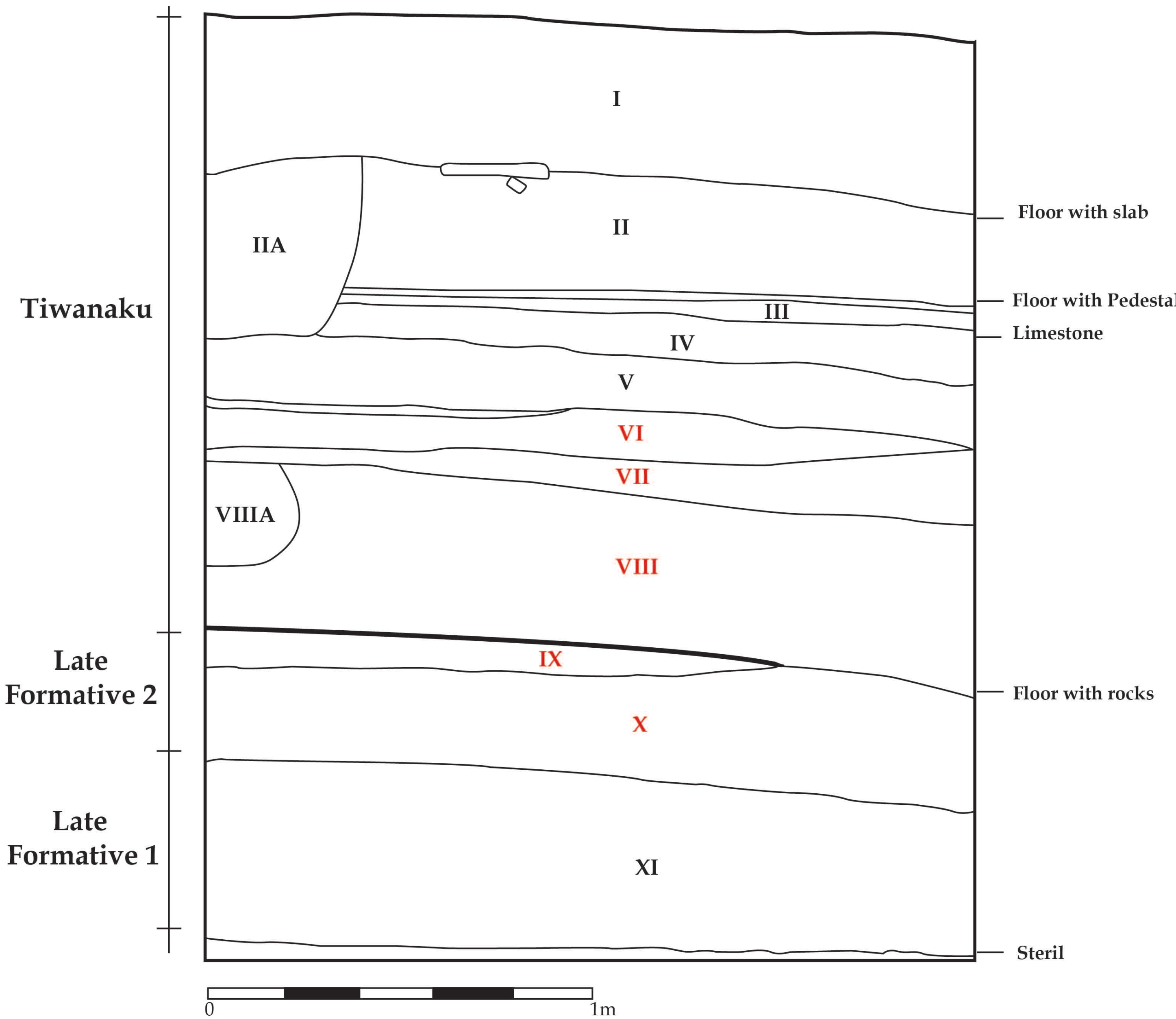

Figure 3.9 Stratigraphic profile of Unit 5-1, in Montículo Sector. Red= levels selected for ceramic analysis. (Modified from Pérez -Arias 2007:220).

Table 3.3 Contexts and number of ceramics analysed from Iruhito.

***Based on how the PAJAMA team classified the time period of these unit and levels.**

****Based on the PAJAMA teams interpretations. Contexts identified as domestic or ceremonial.**

*****Sherd fragments less than 2cm² were classified as too small and not analysed.**

Sector	Level	Period*	Context**	Diagnostic	Body	Small ***	Total	Weight (g)
Ribera (4-2)	VII	LF	Domestic	-	52	-	52	399.8
	VIII	LF	Domestic	4	46	-	50	264.7
	IX	LF	Domestic	4	36	3	43	214.3
	IXA	LF	Domestic	2	69	-	71	407.9
	X	MF	Domestic	5	68	3	76	567.9
	XA	MF	Domestic	7	107	7	121	823.5
	XIII	MF	Domestic	-	50	4	54	454.4
Montículo (5-1)	VI	Tiwanaku	Ceremonial	8	55	13	76	459.9
	VII	Tiwanaku	Ceremonial	3	18	-	21	115.5
	VIII	Tiwanaku	Ceremonial	1	19	16	36	188.6
	IX	LF2	Domestic	29	127	32	188	1080.3
	X	LF2	Domestic	23	53	10	86	891.5

Table 3.4 Contexts and number of ceramics analysed from Khonkho Wankane

Sector	Unit/Level	Period*	Context**	Diagnostic	Body	Small ***	Total	Weight (g)
3	3.11_5 2421	LF2	Domestic	5	16	3	24	100.9
	3.11_5 2428	LF	Domestic	2	32	16	50	181.6
	3.12_5	LF2	Domestic	7	24	10	41	169.2
	3.12_6	LF1	Domestic	4	41	21	66	299
7	7.50_3(NE)	LF2	Domestic	16	78	27	75	959.8
	7.50_3 (S)	LF2	Domestic	6	32	27	65	220.5
	7.52_2	LF2	Domestic	6	29	9	44	554.7
	7.52_3 SW	LF2	Domestic	1	12	1	14	156.2
9	9.19_3 5759	LF2	Domestic	7	24	7	38	142.3
	9.19_3 5760	LF2	Domestic	-	10	-	10	42.3
	9.19_4	LF2	Domestic	10	22	7	39	307.9
	9.22_3	LF2	Domestic	1	10	-	11	56.1
	9.22_4	LF2	Domestic	19	86	76	181	496.5
12	12.12_3	LF	Domestic	13	18	7	38	291.6
	12.13_5	LF	Domestic	2	17	3	22	223.3
	12.14_4	LF	Domestic	15	106	48	169	383.6
	12.16_5 R2	LF	Domestic	14	68	47	129	588
	12.59_2 R2	LF1	Ceremonial	15	30	12	57	664.9
	12.67_1 R1	LF1	Ceremonial	15	77	22	114	707.6

3.7 Khonkho Wankane

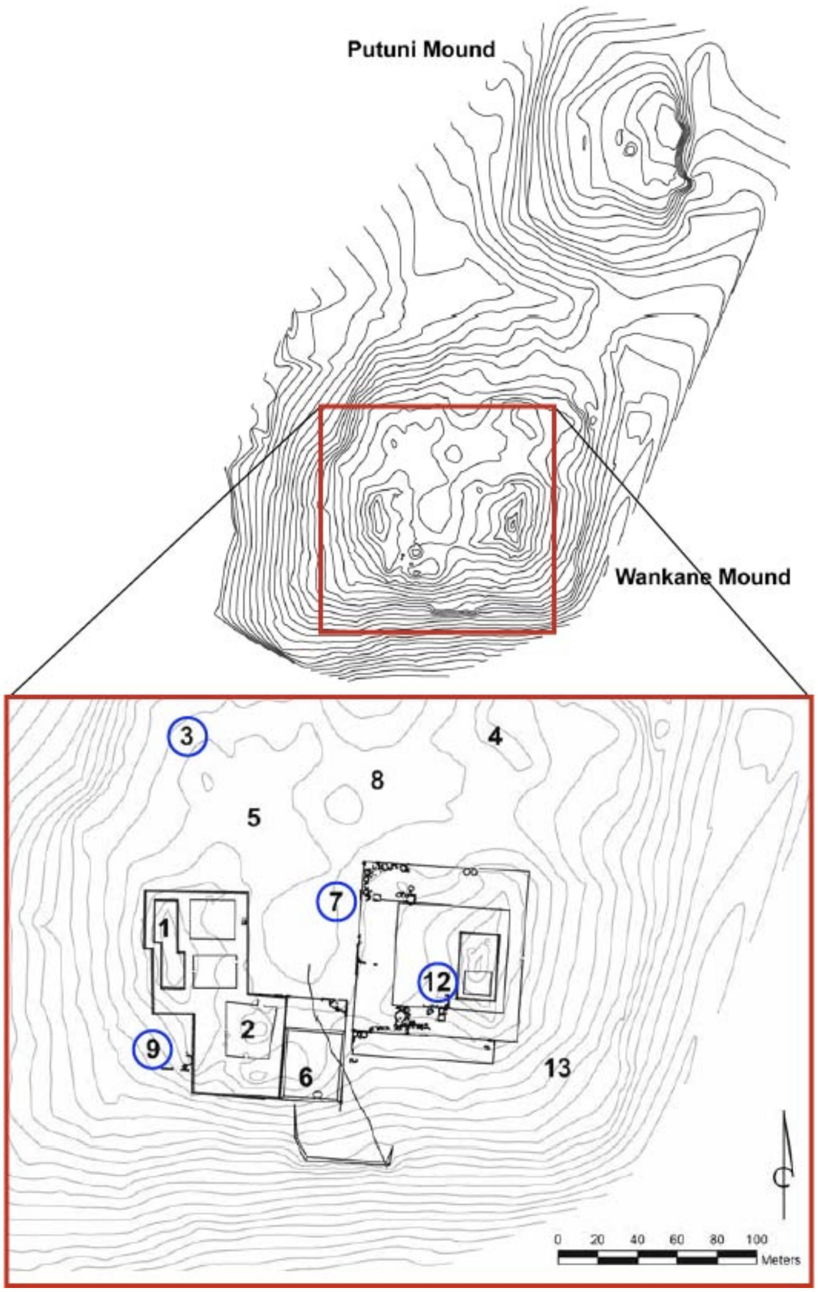

Figure 3.10 Map of Khonkho Wankane Mounds and Sectors. Blue= sectors samples for ceramic analysis. (Modified from Smith 2016).

The site of Khonkho Wankane has two mounds, the Wankane mound[18] is the site's principle artificially made mound, while Putuni is a smaller natural mound (Figure 3.10) (Janusek 2011, 2013; Smith 2013). The Wankane mound is 7 ha in size and located in the southern portion of the site; a residential complex and three courtyards (the Sunken

[18] Also known as the Principle Mound

Court, and the Dual Court Complex) are located on top of the mound (Janusek 2013, 2003; Smith 2013). The Wankane mound has a trapezoidal Sunken Court, with its principle entrance facing south, resembling the sunken courts associated with the Yaya-mama Religious Tradition(Janusek 2004b:473, 2008).

Khonkho Wankane is divided into 15 Sectors; my four sampled areas came from Sector 3, Sector 7, Sector 9, and Sector 12 (Figure 3.10 and Table 3.4). Each of these sectors, are defined by walled off areas with similar stone foundations, domestic architecture and refuse (Marsh 2012a: 191-193). There is no clear evidence of social distinctions, or social hierarchy, between these areas (Marsh 2012a; Smith 2009). Marsh (2012a: 191-193) has found that the domestic practices are similar in these sectors. Ceremonial/ritual spaces are relatively clean, and have decorated Kalasasaya and Qeya serving vessels (Marsh 2013:50).

Sector 3

Sector 3 was located on the base of the Wankane Mound in the north-eastern corner of the site (Cable and Beebe 2006; Janusek 2005:141). Two Bolivian archaeologists (Alejandro Coleman and Gregorio Cordero Miranda) excavated this sector, but their findings were not published (2005:25). The PAJAMA team excavated this sector in 2001. Located on the periphery of the Wankane Mound, it was thought to be both a residential area and the location of mortuary activity (Janusek 2005:25). In total, 14 units were excavated: units 3.1-3.4 were excavated in 2001, units 3.9- 3.12 were excavated in 2002, and units 3.13-3.14 were excavated in 2005 (Cable and Beeb 2006; Janusek 2005:144).

The excavations revealed a history of occupation from the Late Formative period and mortuary activity in the Tiwanaku period (Janusek 2005:153). During the Late Formative period this sector was a permanent and semi-permanent residential area (Janusek 2005:144; Ohnstad 2007:141). Some evidence of residential activity includes a remnant floor (Str. 3.F1), abode bricks and fieldstone used for a rectangular foundation wall (Smith 2013:27). Several of the areas on the periphery of the Wankane Mound appear to have been intensively occupied habitations during the Formative period, which lead to much construction and the accumulation of middens (Sectors 3,8,13 and 14) (Onhstad 2007). Excavations in 2005 revealed burials dating to the Tiwanaku period

(Units 3.13 and 3.14- Cable and Beebe 2006; Smith 2013:27). In total six burials were found in sector 3, and all date to the Tiwanaku period (Janusek 2005:147).

I selected two units to analyse from sector 3, units 3.11 and 3.12 excavated by Ruden Plaza Martínez (Figure 3.11 and Table 3.4). These units were found in the eastern portion of this sector where high quantities of Late Formative materials were recovered (Janusek 2005:142). I specifically selected level 5 from 3.11 and level 5 and 6 from 3.12, as they were the thickest strata (Janusek 2005:153) with C14 dates (250- 450 AD) associated with the Late Formative 2 period (Janusek and Onhstad 2006). Diagnostic ceramics from unit 3.12 date to Late Formative 1 and 2 (Janusek 2005), but I am the first scholar to conduct detailed ceramic analysis on Sector 3 materials.

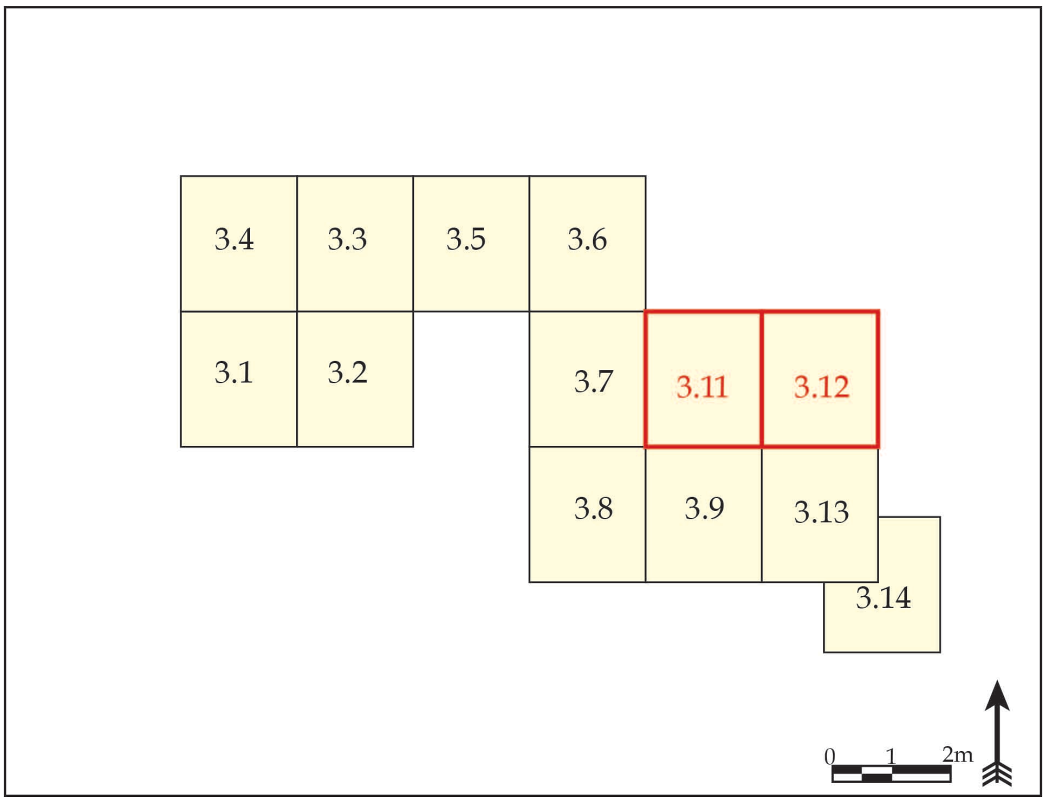

Figure 3.11 Map of Sector 3 and units excavated. Red= units selected for ceramic analysis (Modified from Smith 2007:74)

Sector 7

Sector 7 bordered the northern part of Sector 6 and included the Central Plaza (7.B1), Compound K3, as well as the patio group- a residential area on the Wankane Mound (Figure 3.10 and 3.12) (Smith 2013:29). In 2004 Sonia Chacaltana, John Janusek and Scott Smith excavated this sector (units 7.7-7.15). Here they found a wide wall part of Compound K3 and two circular structures (Marsh 2013:45). From 2005-2007 Erik Marsh excavated 63 units, and revealed 13 structures and walls forming a patio group (Figure 3.12).

The patio group located in Sector 7 was the best-preserved Late Formative domestic context in the region (Marsh 2013:45). The patio group was made up of 12 circular structures (7.C1-7.C12) following the perimeter of the compound wall (St.7W1) and facing a central patio (Figure 3.12) (Smith 2013:29). The patio measured 18.3m (N-S) by 22.8m (E-W) (Smith 2013:31). The circular structures all had a diameter of 2.4m, each had a large stone entrance block, and between many of the structures were storage areas and midden deposits (Marsh 2013: 48; Smith 2013:31). The northern and western border of the patio group made the northwest corner of the Eastern Compound (K3), and severely restricted the access to other compounds (the Main Plaza and three temples) (Marsh 2013:45; Smith 2013:31). Two radiocarbon samples from two circular structures (units 7.29 and 7.46) were dated to AD 340-429, suggesting that the patio group was established during the Late Formative Period when a number of constructions began at Khonkho Wankane (Marsh 2012a: 247, 259; 2013:45; Smith 2009).

I sampled from units 7.50 and 7.52 (Figure 3.12 and Table 3.4). These units are associated with circular structure 7.C9 (Figure 3.13), excavated by Marsh in 2005 (Marsh 2013). I selected these units because they have evidence of domestic activities and architecture. Cooking vessels, faunal remains, ash layers and river stones, all suggest this area was used for cooking practices (Marsh 2013:49). The radiocarbon dates found in this sector, as well as the highly micaceous sherds from utilitarian vessels, all date to the Late Formative period (Marsh 2013:50) which is the focus of this project. Marsh identifies structure 7.C9 as the "East Kitchen" and suggests it was used for food preparation, cooking, and serving (Marsh 2012a: 343). It was the largest structure ($6.7m^2$) in the Patio Group and had the most diversity in vessels forms found in the Patio Group (Marsh 2012a:344). According to Marsh (2012a:344) the interior of 7.C9 was used for smaller meetings, while "cooks probably served to visitors outside of the structure, where there is evidence for food preparation". Although Marsh (2012a) analysed samples from structure 7.C9, my project provides a more detailed analysis of ceramic attributes, particularly paste.

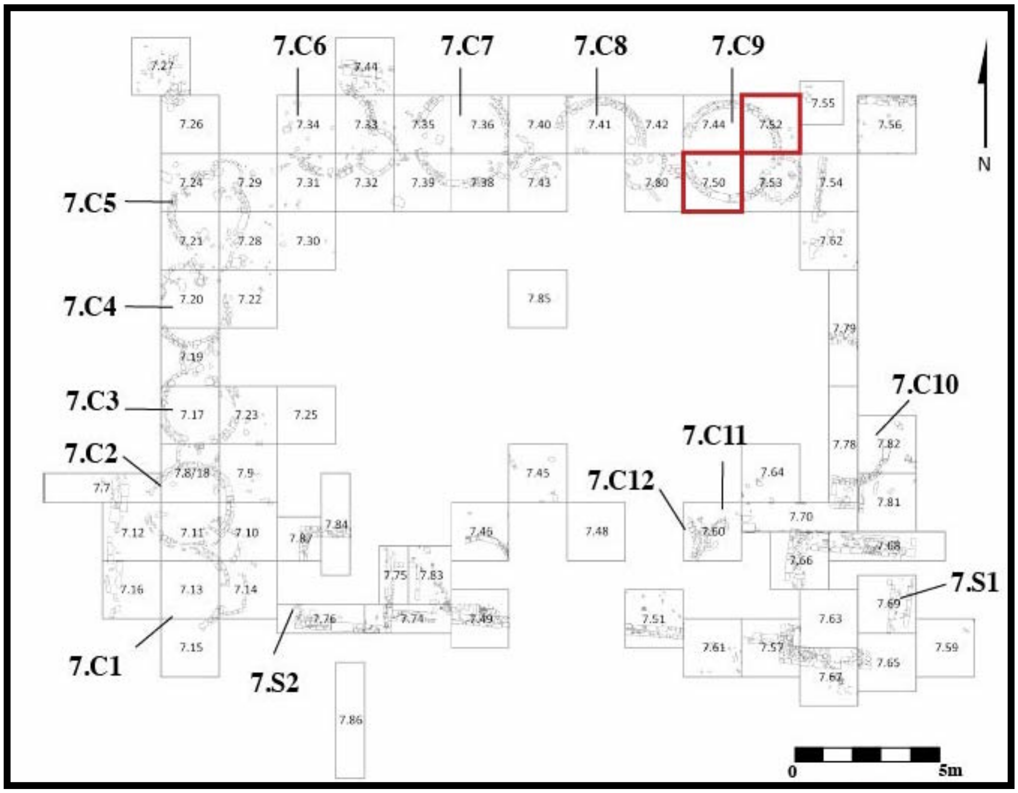

Figure 3.12 Map of Sector 7 and units excavated. Red= units selected for ceramic analysis. (Map modified from Smith 2016).

Figure 3.13 Photo of circular structure 7.C9 taken facing west by Wolfgang Schuller. From Marsh (2012a: 343).

Sector 9

Sector 9 was located on the southwest corner of the Wankane Mound (Figure 3.10) (Smith 2013:31). This sector was first identified in 2002 during geophysical survey and excavated (9.1-9.3) by Arik Ohnstad (Marsh 2012a:192). In 2004, Jennifer Zovar, Ruden Plaza Martínez and Joel Zovar excavated two units (9.4- 9.23) (Marsh 2012a:193). In 2005, Jennifer Zovar, Joel Zovar, Erica Beebe, and Charlotte Cable excavated 12 new units (9.24-9.35)(Marsh 2012a:193; Zovar 2006:127) (Figure 3.14). This sector also had a large residential area, which may have been used for cooking and food preparation (Marsh 2011:108, Fig 6, 2012a:193; Smith 2011:83, Fig 9 and 10; Zovar 2009:373, Fig7).

Compound K2 was initially interpreted as a communal food preparation area used for feasts that would have taken place in the Sunken Temple (Zovar 2006:127). The most prominent architecture in Sector 9 was circular structure 9.C1, which was adjacent to a compound wall, and had a diameter of 4.4 meters (Figure 3.14) (Smith 2013:31). Attached to the structure wall of 9.C1 was a hearth used during this structure's occupation (Smith 2013:32). Structures 9.C1 was associated with large quantities of camelid bones, ground stones, midden and ash deposits (Zovar 2006:127, 130). There were also a number of intrusive burials, suggesting the area may have been used as a cemetery in later periods (Zovar 2006:127). A radiocarbon sample dates the structure to 324 AD, or the Late Formative 2 period (Zovar 2006:131). Marsh (2012a:258) hypothesizes that Sector 9 was a residential area for those who used Compound K2. In fact Structure 9.C1 was built around AD 373 (334-405), or Khonkho Wankane Phase 6, the same period that Compound K2 was built (Marsh 2012a:259). Excavators found ollas, jars, serving vessels, and bowls used for incense burning in 9.C1 (Marsh 2012a:265). Additionally they recovered three *batánes*[19], suggesting food preparation occurred in this structure (Marsh 2012a:265).

I specifically selected five samples from units 9.19 and 9.22 because they were found within structure 9.C1 (Figure 3.14 and Table 3.4). It is currently unclear how structure 9.C1 was used. Marsh (2012a:266) has argued that this structure was used for a variety of domestic activities including residence, food preparation, cooking and serving during the Late Formative period. While other archaeologists (Smith 2009:286-298; Zovar 2009:379-381) have proposed that structure 9.C1 was used for ritual activities and food preparation for feasting (Marsh 2012a:267). Marsh (2012a) has also analysed

[19] A batán is a millstone/grinding stone.

ceramics from these units. My analysis builds on Marsh's work and contributes to the debate on what structure 9.C1 was used for (domestic practices vs. ritual activities).

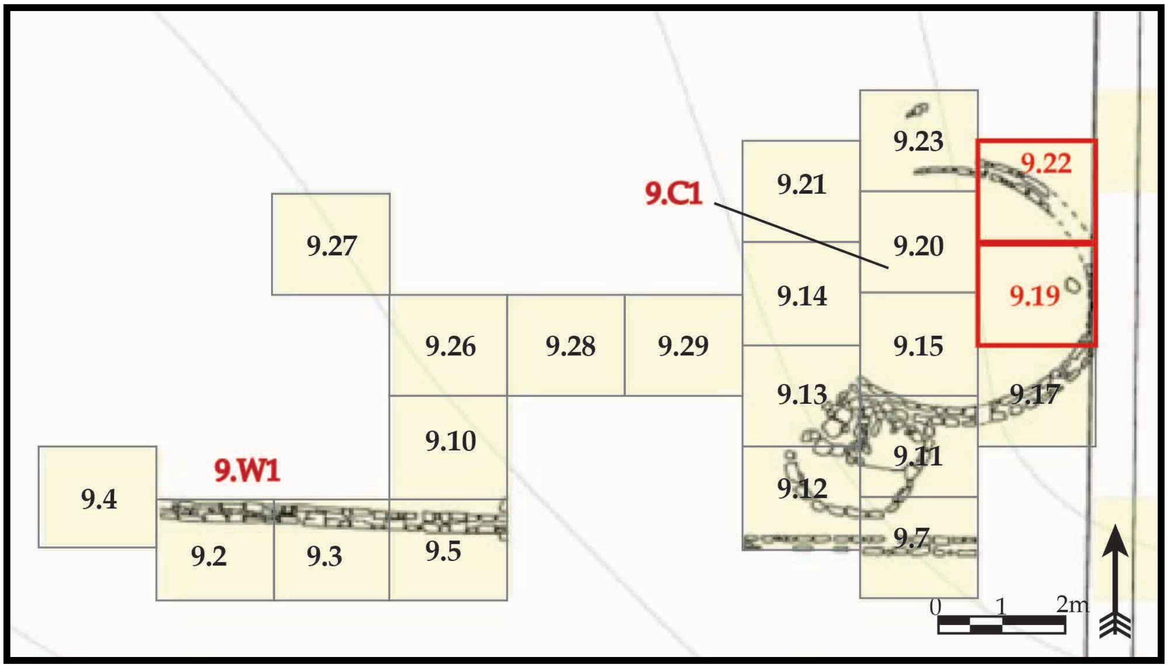

Figure 3.14 Map of Sector 9 and units excavated. Red= units selected for ceramic analysis. (Map modified from Smith 2016).

Sector 12

Sector 12 was located on the eastern portion of the Wankane Mound and was enclosed by 7.W1 wall (Figure 3.10)(Smith 2009:116). Sector 12 was excavated from 2004-2007 with 48 units excavated in 2006 (Gladwell 2007; Pérez Arias 2008; Smith and Pérez Arias 2007:118). During the 2005 field season, the PAJAMA team discovered a series of circular structures, likely Formative period domestic residences, in the northeast border of the sector (Units 12.11, 12.12, 12.13 and 12.14-refer to Figures 3.15-3.17) (Gladwell 2007:113). In the northern part of this sector, west of the northern entrance of Compound K3 and east of the Sector 7's patio group, were two circular structures 12.C1 and 12.C2 (Figures 3.15 and 3.16) (Smith 2009:116). Both of these structures were found in units 12.13 and 12.14 and had a diameter of 2.4 meters and were adjacent to each other, south of 7.W1 wall (Smith 2009:116). Structure 12.C2 was constructed from two courses of sandstone bricks. The entrance for this structure faces southeast and has a storage annex attached (Gladwell 2007:119; Smith 2009:116). The fill of the annex was rich in ash, organic material and six large rocks, perhaps used to support large ollas while cooking over a fire (Gladwell 2007:120-121). Within units 12.14 and 12.15 was a semi-circular structure, outside of the structure excavators uncovered a patio area coved with small river stones (approximately 3-5 cm), ceramics, faunal remains (fish bones), lithics, carbon, burned soil and limestone (Gladwell 2007:123).

Figure 3.15 Photo of unit 12.14 and circular structure 12.C2. (Taken from Gladwell 2007:120).

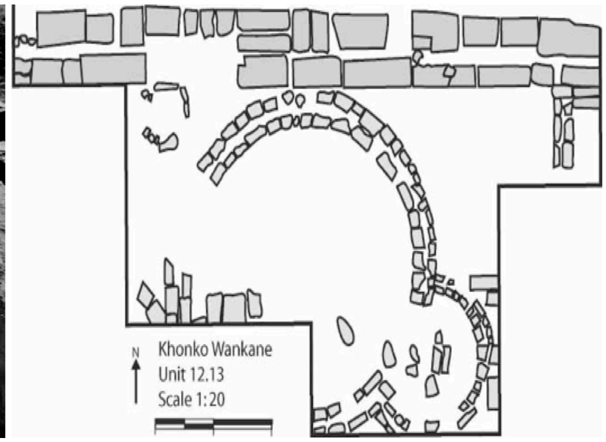

Figure 3.16 Drawing of unit 12.13 and structure 12.C1 (Taken from Gladwell 2007:120).

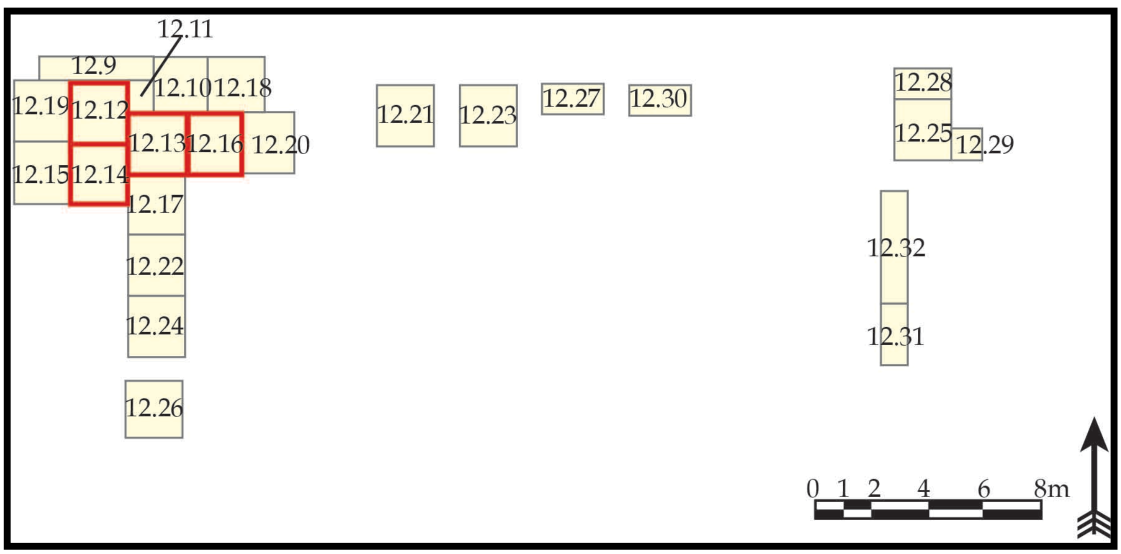

Figure 3.17 Map of Sector 12 (North) and units excavated. Red=units selected for ceramic analysis. (Map modified from Janusek et al. 2007).

Structure 12.C9 was the largest circular structure in Khonkho Wankane measuring 4.9 meters in diameter (Figure 3.18)(Smith and Pérez-Arias 2015:109). This structure had a unique assemblage of 972 human bones, representing a minimum of 25 individuals. Most of the bones were coated with a thin, white plaster and some specimens had evidence of red pigment (Smith and Pérez-Arias 2015: 109). Blocks of the same white chalky material used to coat the human remains, were also found associated with structure 12.C9 (Smith and Pérez -Arias 2015:110). West of structure 12.C9 is a large hearth with a large quantity of chalky white clay (Smith and Pérez-Arias 2015:113). This hearth was not only used for cooking food but perhaps also as a limekiln (Smith and Pérez -Arias 2015:113). Smith and Pérez –Arias hypothesize that structure 12.C9 was used by ritual specialists to process human bones brought by pastoralists traveling with camelid caravans from other regions and thus this structure would have been considered a specialized space (Smith and Pérez-Arias 2015:113,118).

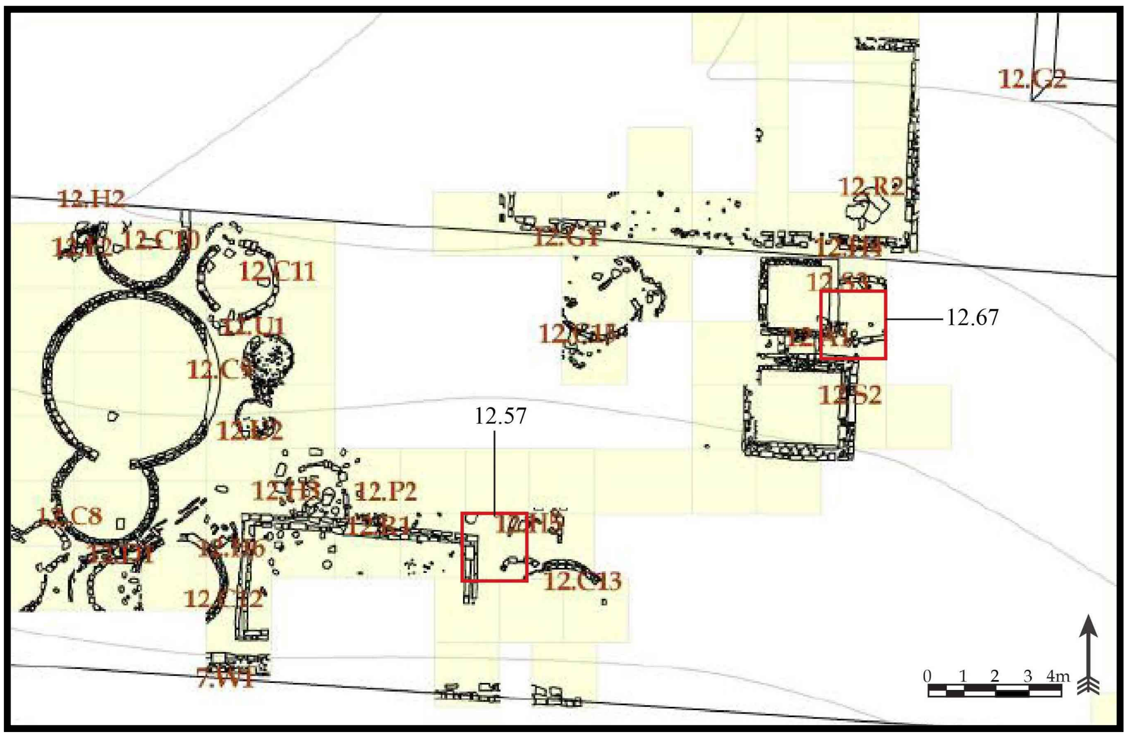

Figure 3.18 Map of Sector 12 (South) and units excavated. Red= units selected for ceramic analysis. (Map modified from Janusek et al. 2007).

I selected samples from units 12.12, 12.13, 12.14, and 12.16 (located in the northern portion of Sector 12) because they have been identified as potentially residential (domestic) areas and ceramics from these units have not been analysed in detail (Figure 3.17 and Table 3.4). This area (especially the circular residences) appears to have been used for domestic activity and is similar to the structures in Sector 7 (Gladwell 2006:119). Randi Gladwell (2006:113-126) excavated these units but did not analyse ceramics from them. Erik Marsh believes that the northern part of Sector 12 may have been used for similar domestic practices as those of the Sector 7 Patio Group (Marsh personal communication 2015). I also analysed samples from units 12.59 and 12.67 (the southern part of Sector 12- refer to Figure 3.18 and Table 3.4), which are more ceremonial contexts. These units are located to the east of structure 12.C9 and in the southern area of Sector 12. I analysed ceramics from these types of contexts to better understand the differences between domestic and ceremonial ceramics and contexts.

3.8 Upper Desaguadero Chapter Summary

In this chapter provided a brief background on the Upper Desaguadero Valley in order to contextualize this project. I summarized the geology, archaeological history, changes in ecological and social landscapes, as well as changes in ceramic technology from the Middle Formative to the Tiwanaku period in this region. I focused on two very different sites in this region. Khonkho Wankane reached its peak during the Late Formative Period. Iruhito was occupied continuously from the Middle Formative. These sites had different economies and functions, but share some similarities. Both are located in the Upper Desaguadero Valley and functioned as important hubs in trade networks. I presented my research questions and sampling procedure, before providing information on the contexts I sampled. In the next chapter I outline my methods of analysis for exploring the ceramic taskscapes of the Late Formative Desaguadero Valley.

Chapter 4: Methods

4.1 Overview

In this chapter I outline the methods of analysis I used to investigate the ceramics from Iruhito and Khonkho Wankane and to explore the past taskscapes of the Upper Desaguadero Valley. I begin by providing a brief background on paste analysis conducted in the Lake Titicaca Basin and how I identified and created different paste types for Khonkho Wankane and Iruhito. I then provide a background on ceramic attribute analysis and present the system I used, which is a modified version of Steadman's Taraco Archaeological Project (TAP) system. This system allowed me to analyse a range of other ceramic attributes to interpret ceramic vessel forms and usage. I then outline the procedure I developed for using the Dino-Lite microscope in my ceramic paste analysis. I conclude this chapter by outlining my protocol for using the open access software JMicroVision (Roduit 2002-2008) to analyse images of ceramic paste and conduct semi-quantitative analysis.

4.2 Paste Analysis

I focus on ceramic pastes in this thesis because analysing paste can reveal which materials potters selected and how these choices were part of the larger taskscape[20] (Logan and Cruz 2014; Michelaki et al. 2014; Roddick 2013).

Andean archaeologists rely on ceramic attributes as cultural and chronological markers (Roddick 2009:185), and ceramic pastes are particularly important. Ceramic pastes in the Lake Titicaca Basin can reflect shifting pottery production practices across time and space (Roddick 2009: 185; Steadman 1995). Archaeologists use the variation of pastes for phasing purposes while paste recipes are used to define "local" production, as well as political and ethnic boundaries (Roddick 2009:185). For instance, the presence of mica-rich pastes separates the Late Formative 1 and Late Formative 2 periods (Janusek 2003:51; Marsh 2012a:226; Roddick 2009:157). However, Janusek (1994:93),(Lémuz Aguirre 2001:169) and Roddick (2009), caution Andean archaeologists on using paste as types. As Roddick explains, "they can be the results of local geology, particular choices, or wider taskscapes..." (2009:169). Another issue concerns the usage of the descriptive paste terminology employed in the Late Titicaca Basin, which is vague and subjective.

[20] Refer to Chapter 2 and Chapter 3 for a further discussion on ceramic paste and taskscapes.

Steadman (1995; 2007) and Roddick (2009) address this by creating paste reference collections for sites on the Taraco Peninsula. A paste reference collection (or paste box), allows future ceramists to rely on more than vague written descriptions.

I created two paste reference collections for the Upper Desaguadero Valley, one for Khonkho Wankane and one for Iruhito, to encourage future intra- and inter- site comparison. I began by creating a fresh break with pliers and using a 10x hand-lens to identify the temper type, inclusion types, size, shape, grain abundance, texture and compactness (Table 4.1). A fresh break is needed to provide a 'clean' surface - without depositional residues and that isn't heavily eroded or taphonomically modified - for observation. I ignore paste colour in creating my paste types, as colour is a product of firing environments, including their position and exposure to oxygen (Roddick 2009:223; Shepard 1980:103).

Table 4.1 Paste attributes identified and described during paste analysis. *Based on Druc's (2015) Grain Abundance Chart.

Paste Attributes	Classification
Temper Types	Fiber or Mineral
Inclusion Types	Fiber Voids, Quartz, Mica, Rocks, Feldspar
Size	Small to Large
Shape	Rounded (R), Sub-Rounded (SR), Sub-Angular (SA), Angular (A)
Grain Abundance	Given in %*
Texture	Fine to Coarse
Compactness	Compact to Subcompact

I first used a 10x hand-lens to carefully and efficiently analyse approximately 100 sherds. I identified the shape, type and colour of inclusions.[21] I first distinguished between what I call paste groups here, specifically mineral or fiber-tempered groups. I then divided the sherds by their most dominant feature and create paste subgroups namely micaceous, large fiber voids, white-speckled, coarse, dense, white-transparent, and buff pastes. Within these paste subgroups I identified what I call individuals paste types and assigned each type with a specific number and provided a detailed description.[22] Figures 4.2-4.5 are flowcharts I created to determine the paste type of a specific sherd; these flowcharts show the breakdown of different paste groups (fiber vs. mineral temper), subgroups (e.g. mica, buff and large fiber voids), and types (i.e. individual pastes such as

[21] All sherds were analysed during the day from 8am- 5pm when there was enough natural light available.
[22] Refer to Appendix A for a list of all paste type descriptions and photographs.

micaceous Iruhito paste 21) (See Roddick 2009: figure 7.9 for a similar example from the Taraco Peninsula).

Once I was confident that I had identified a paste type, I took a few representative sherds (only non-diagnostics) and placed them inside of a plastic tackle box with sub-dividers and labeled the section with the assigned paste type number using a permanent marker (Figure 4.1). This paste box and sherds were photographed and a record of their excavated context was kept. Future ceramicists can use the flowchart, the paste images, and the actual reference collection to easily classify Upper Desaguadero pastes and to compare their findings to my work

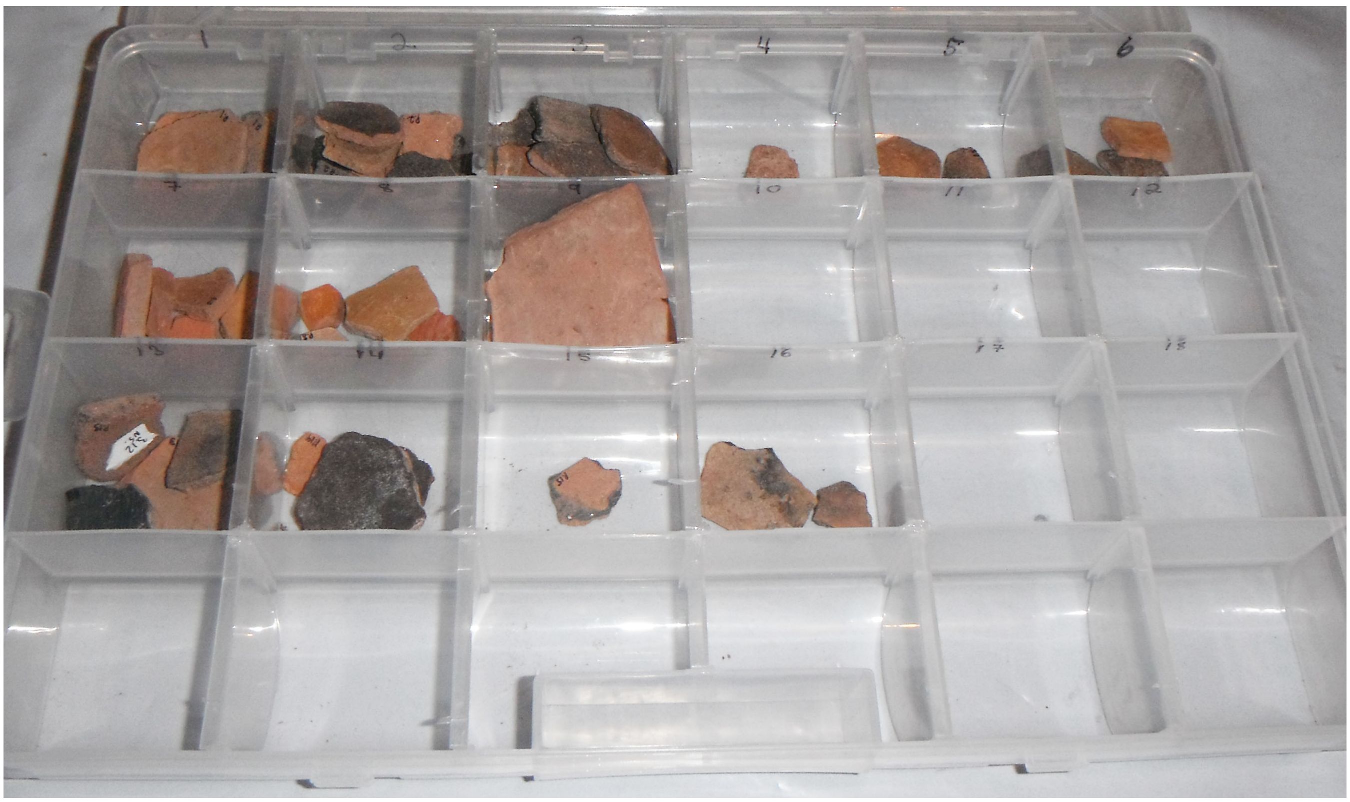

Figure 4.1 Photo of the Khonkho Wankane paste box.

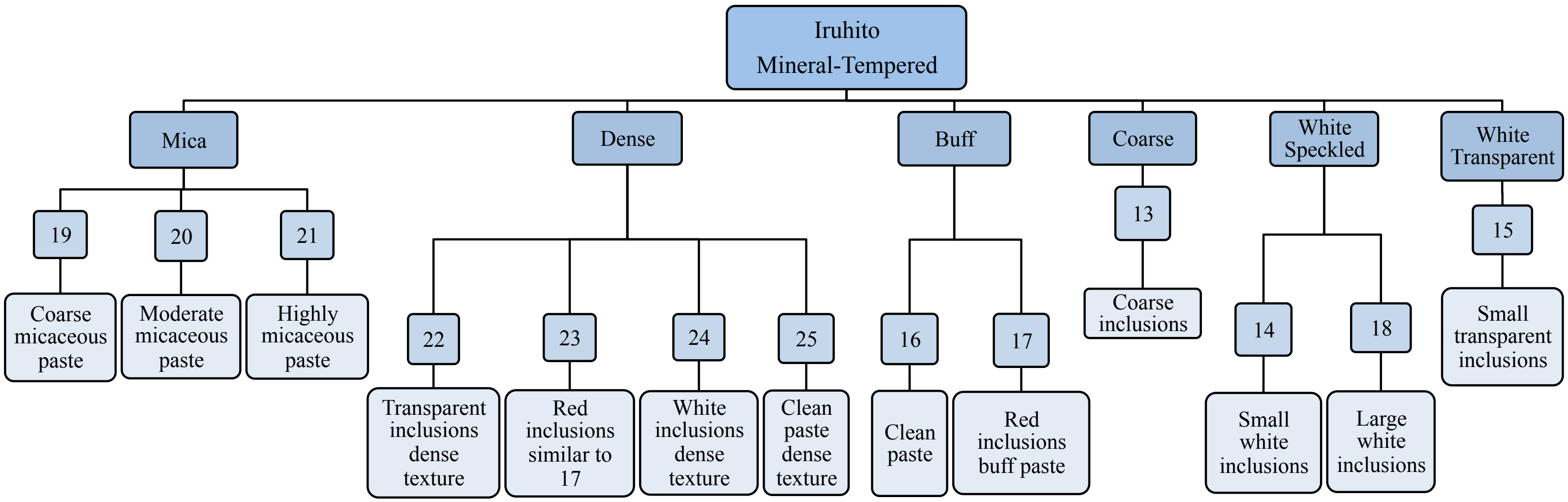

Figure 4.2 Iruhito mineral-tempered group, subgroups, paste type numbers and descriptions. *

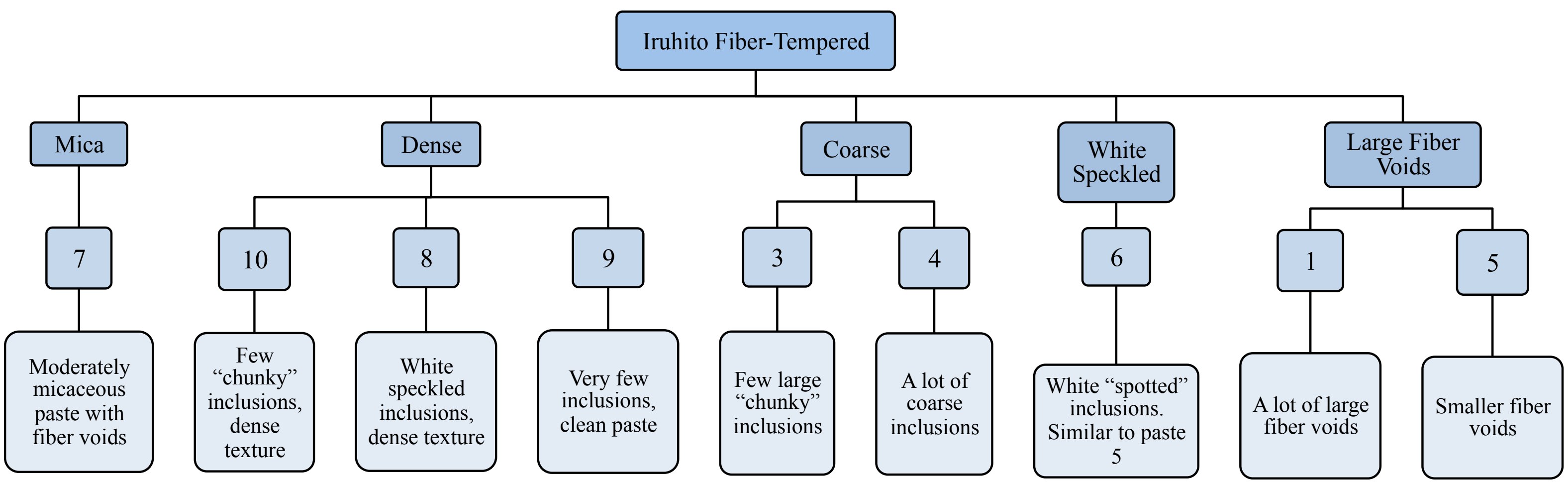

Figure 4.3 Iruhito fiber-tempered group, subgroups, paste type numbers and descriptions. * To use the flowcharts, the analyst must first determine whether the sherd was mineral or fiber tempered. Then identify the most prominent feature of the paste (e.g. mica inclusions) and select one of the paste subgroups that match with this feature (e.g. the mica subgroup). Then using the paste type description one can determine this sherd's specific paste type (e.g. either paste 19, 20, 21).

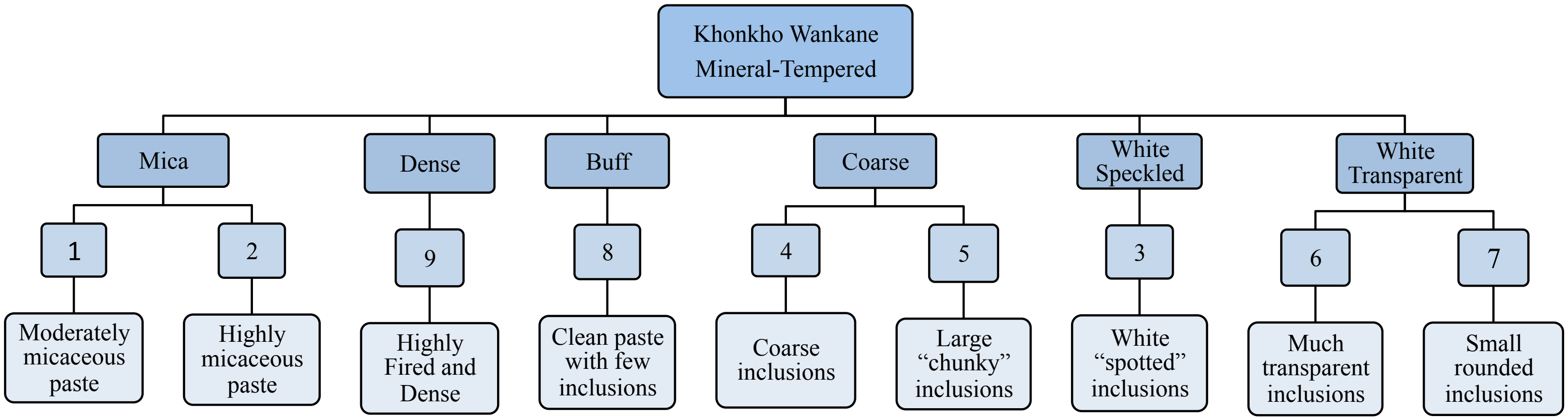

Figure 4.4 Khonkho Wankane mineral-tempered paste group, subgroups, type numbers and descriptions. *

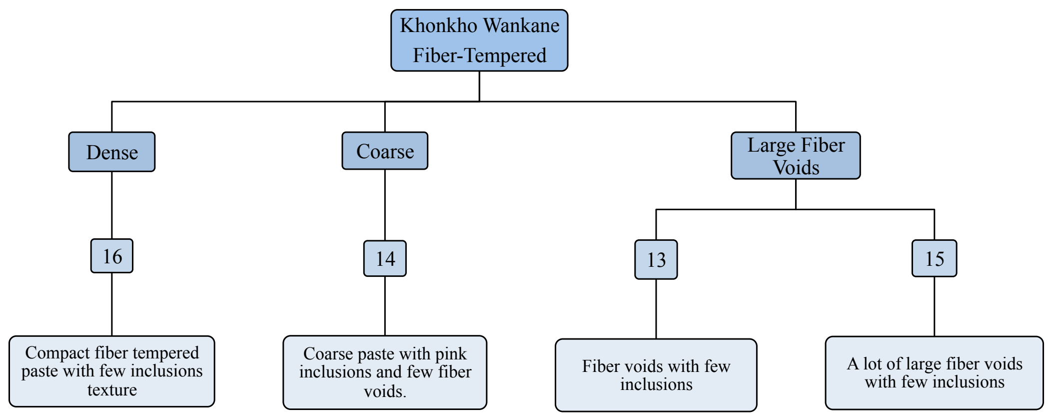

Figure 4.5 Khonkho Wankane fiber-tempered paste group, subgroups, type numbers and descriptions. * To use the flowcharts, the analyst must first determine whether the sherd was mineral or fiber tempered. Then identify the most prominent feature of the paste (e.g. mica inclusions) and select one of the paste subgroups that match with this feature (e.g. the mica subgroup). Then using the paste type description one can determine this sherd's specific paste type (e.g. either paste 1 or 2)

4.3 Attribute Analysis

Since I wanted to recognize subtle changes in pottery production I decided to analyse ceramics using attribute analysis. Anna Shepard first developed the ceramic attribute analysis method in 1956. By using this approach, analysts study a number of individual attributes rather than a cluster of attributes and the overall ceramic type (i.e. typological approach) (Rowe 1959:320; Shepard 1980:307–319; Steadman 1995:48–50). Attributes are the smallest observable characteristic of an artifact (Rowe 1959:320) and an attribute is "the result of a single action or a micro-sequence of actions" (Roddick 2009:182). These attributes are independent meaning that a specific attribute (e.g. paste) is not always linked to other attribute (e.g. form). For example, not all ollas (cooking pots) are made with fiber-tempered paste, thus no attribute is privileged. Roddick (2009:182) explains that attributes should be clear, easily identifiable, and similarly recorded by other analysts.

There are several benefits of using attribute analysis in ceramic analysis compared to typological analyses. This detailed methodology is sensitive to change through time and across space, revealing more local variability and the embodied movements and actions of past potters rather than just analysing the type of vessel (Plog 1983:131–132; Plog and Hantman 1990; Steadman 1995:48–50, 1999). Rather than highlighting the similarities between ceramics like typological approach does, attribute analysis highlights the differences (Hammond 1972; Steponaitis 1983:48; as cited in Steadman 1995:48). Although attribute analysis is more time consuming, it allows analysts to identify small changes within assemblages (Roddick 2009:182). Another benefit of using attribute analysis is that no set of attributes is privileged (e.g. finish, form and decor) and all attributes are recorded equally (Roddick 2009:182). This is important because future researchers could approach these datasets and ask questions different than the original analyst. These datasets thus become more accessible for further research. Attribute analysis moves beyond identifying ethnicity and cultural affiliation (a common focus of typological analyses), and offers a deeper understanding of: "the technological and social contexts of ceramic manufacture and use" (Chilton 1998:132).

Various scholars working in the Lake Titicaca Basin have applied ceramic attribute analysis (Chavez 1992; Lémuz Aguirre 2001; Roddick 2009; Steadman 1995). Roddick (2009:182) explains that attribute analysis is an appropriate method for Late

Formative ceramic assemblages. This time period is defined by social, political, and economic changes; shifts were also occurring in ceramic production (Bandy 2001:173; Janusek 2003:52-54; Lemuz Aguirre 2001:159; Roddick 2009; Steadman 1995). Attribute analysis can track subtle chronological and spatial changes (Roddick 2009:182; Steadman 1995:48). Typologies may homogenize assemblages and work best with long-term production traditions. In contrast, attribute analysis can track quick and subtle changes occurring within long standing ceramic traditions (Roddick 2009:182-83; Steadman 1995:48). Attribute analysis also allows for inter-site comparisons of specific attributes and technological practices (Roddick 2009:183; Steadman 1995:49). Since individual attributes are being analysed and recorded one could focus on a specific trait (e.g. paste) and compare the production practices between two sites. Since I analysed ceramic attributes at Iruhito and Khonkho Wankane in the same way, I can ask both local questions of production practices but also ask regional questions about production routines.

I applied a modified version of Steadman's (1995) TAP ceramic analysis system. Although there are three level of analysis in the TAP system: C-analysis, Z-analysis and A-analysis. I drew on A-analysis, the most detailed of the three levels (Roddick 2009:204). This approach is only applied on samples that come from single and unmixed contexts. I began by counting and weighing all body sherds, diagnostics and small fragments (sherds measuring less than 1 cm^2) from each bag and recorded the information on the TAP's Ceramic Catalog Form[23] along with the contextual information and date. I placed the smaller fragments into a separate bag, labelled it "small fragments under 1cm^2" and placed this back into the original bag. These sherds were not analysed further because of their small size.

I then analysed each body sherd and recorded a code for paste, firing, maximum thickness, sherd ID, weight and interior and exterior finish, colour and carbonization (Roddick 2009:204). Diagnostic sherds were recorded with more detail. If there was enough of a diagnostic sherd to accurately draw (i.e. percent of diameter) or if there was a special feature (e.g. decoration) the sherd was recorded using the drawn or non-drawn diagnostic form (Roddick 2009:204). Diagnostic forms add to the body sherds form and

[23] Refer to Appendix A for TAP's Ceramic Catalog Form

record additional information such as general ID (sherd ID), form, interior and exterior luster, contour, mica, and direction of finish, as well as diameter, percent of diameter, rim type, base finish, and decoration[24]. I slightly changed Steadman's A-analysis. I did not record wares because they are specific to the TAP assemblage and thus would not apply to the Iruhito and Khonkho Wankane samples. Motifs were also not recorded because my sample primarily came from domestic contexts with very few decorated sherds and no identifiable motifs.

I first recorded paste using the TAP A-Analysis form. To accurately identify paste as well as core colour (much like my process for creating the paste box), I first used pliers to create a fresh break. I then divided the sherds into two groups based on paste temper: mineral-tempered and fiber-tempered. I then further divided these groups into the 22 Iruhito paste types or the 13 Khonkho Wankane types (see Figures 4.2-4.5).

I then recorded the interior and exterior colour and carbonization for each sherd, unless the sherd was heavily eroded. The surface colour was identified using the Munsell Soil Colour Chart. Both the Munsell number (e.g. 2.5 YR 4/4) and a TAP code were recorded. The TAP system groups a variety of Munsell colours and creates a substitute list that classifies several Munsell colours as a single shade/colour (e.g. Red brown, red/red orange, brown, light brown, black, and gray). The TAP colour codes also distinguish between a slipped or unslipped surface. If a sherd had any evidence of interior and exterior carbonization it would be recorded and identified as one of 13 types (light-heavy powder, light- heavy encrustation, scorched, fire blackened, post breakage charring). A sherd's core colour was also recorded in order to provide information on firing environments. Steadman's system identifies 34 firing codes that include a variety of different variations of red brown, black, brown, light brown, and purple. Within my samples I found three more firing cores and added them to Steadman's system[25].

The next set of attributes I recorded were the surface treatments of each body sherd, which includes: finish, colour, and carbonization. For each body sherd both the interior and exterior finish techniques were analysed and given one code[26]. A sherd's

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24 Refer to the Appendix A for examples of body sherd and diagnostic sherd (drawn and not drawn) forms.
25 Refer to the Appendix A for further information on carbonization and firing cores.
26 Refer to the Appendix A for a full list of finishing codes and section 5.4 in Chapter 5 for a further description of the most common finish techniques used at these sites.

finish might be completely burnished (CB), incompletely burnished (IB), wiped (W), smoothed (S), rubbed (R), or eroded (E) (see Figure 4.6). I also identified four more finishing combinations and included them in Steadman's system. Roddick (2009:204) explains that it is very difficult to identify these attributes without a "surface finish collection" and an expert to apprentice with. I was fortunate enough to be trained by Roddick, who in turn was trained by Steadman. I was also given access to Steadman's surface finish collection, which contained examples of each of these finishing types.

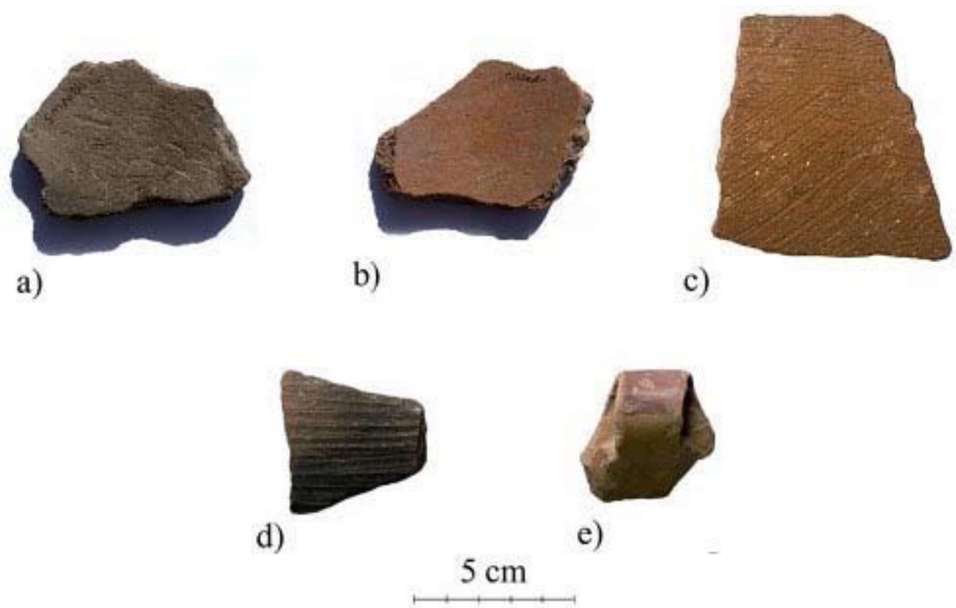

Figure 4.6 Example of surface finish a) smoothed, b) rubbed, c) wiped, d) incomplete burnish, e) complete burnish. Image modified from Roddick 2009:193.

All sherds were individually weighed, counted and measured for maximum thickness. Each sherd was weighed in grams (g) using an electronic scale. Each sherd was measured in millimeters using calipers at the thickest most point on the sherd. Since every single sherd over $1cm^2$ was analysed the count was usually 1, however there were times where multiple sherds could be mended together, or a sherd broke into pieces during analysis, or it was clear sherds came from the same vessel. In these cases, the number of sherds was counted but analysed only once and recorded as a single entry. Each sherd was given a sherd ID code identifying whether it was a body sherd, rim, handle, base, neck, polishing tool, spindle whorl etc.

Along with surface colour, carbonization and finishing, a diagnostic sherd's contour, luster, mica and direction of finish were recorded if the surface was not completely eroded. Contour refers to the evenness of a sherd's surface. This was determined based on touch and could be identified as either very even (VE), even (E), slightly irregular (SI), and irregular (I). A sherd's luster was also identified and recorded as having high (H), medium (M), and low (L) luster or matte (MA). If mica was visible on the surface of a diagnostic sherd then the size of the mica inclusions were recorded as either large (L), medium (M), small (S), and very small (S). These three attributes were fairly subjective and only determined by visually analysing the sherds at a macro level at times using a hand lens. If the diagnostic sherd was decorated then depending on the number and colour of the paint, the sherd would be given a specific decoration attribute code. The last surface attribute measured specifically for diagnostic sherds was direction of finish. If the orientation of the sherd could reliably be identified then the direction of finish could be identified as either vertical (V), horizontal (H), diagonal (D) or a combination of the three.

Using a diameter chart, the diameter and diameter percentage were also recorded for rim and base sherds. If the diameter percentage of a sherd was higher than 5% then the diagnostic sherd would be drawn. Rim shape types were also analysed and based on Steadman's rim chart they were given a code and recorded. Diagnostic sherds were not only given a general sherd ID code but a detailed form code. Diagnostic sherds could be identified as a necked vessel, base, handle, tool, or more specific forms, such as a short-necked flared olla. A neck type was determined by the angle of the point where the neck meets the body. If the angle was less than 35 degrees then the neck is considered very flared. An angle of 35-55 is considered flared, 56-77 is a slightly flared neck, and 78-94 is a straight-necked vessel. If there was enough of a neck on the sherd to reliably identify the neck angle, then the diagnostic sherd would also be drawn.

Finally, I used the comments section to note any features that were not quantifiable or part of the TAP system. I also used this section to record the sherds selected for further paste analysis and sherds that would be photographed.

4.4 Dino-Lite Microscope

In this section I provide a brief background on the Dino-Lite microscope and how I incorporated it into ceramic analysis. I also outline my procedure on how to take photos of sherds using the Dino-Lite microscope. I analysed all sherds using the system of attribute analysis discussed above, but certain sherds were selected as representatives of particular paste groups (Table 4.2). These representative sherds were photographed and analysed using a Dino-Lite USB microscope (model AM4815ZTL), a new affordable, portable, and non-destructive tool (Druc 2015).

Table 4.2 Total counts of Iruhito and Khonkho Wankane body sherds, diagnostic sherds and sherds photographed with the USB Dino-Lite microscope. (Table 3.1 and 3.2 for the counts of sherds from specific contexts).

Site	Body Sherds	Diagnostics	Total Sherds	Photographed
IRU	700	86	786	132
KW	732	158	890	127
			1676	**259**

Background on the Dino-Lite Microscope

Shepard (1980), Weaver (1963), and Matson (1970[1963]) all recognized the benefit of macroscopic analysis of ceramic pastes and recommended using a binocular microscope. Anna Shepard writes: "The binocular microscope is an essential instrument in the laboratory for preliminary examination and for classification of sherds in quantities sufficient for statistical analysis." (1980:519). She outlines some of the specific ways it can be useful, including as a method for paste classification and identifying paste texture Shepard (1980: 519). Shepard (1980) is also interested in the relationship between pottery, people, and landscapes, she stresses that archaeologists should use images and a combination of macroscopic (hand-lens and binocular) and mineralogical methods to obtain the most information on ceramic pastes. Despite the potential benefits of this method, the binocular microscope never became widespread in ceramic analysis, perhaps due to the issue of travelling with such a tool (Druc 2015:9). Now with the portable digital USB microscope, macroscopic analysis of ceramic pastes can become more readily available and commonly used.

Archaeologists are only beginning to incorporate USB microscopes into their analysis (Druc 2015; McConaughy et al. 2014; Rots et al. 2015; Van de Voorde et al. 2014). Isabelle Druc (2015)'s book *Portable Digital Microscope: Atlas of Ceramic Pastes* is the first manual on using the Dino-Lite microscope for ceramic paste analysis. Druc (2015: 9) stresses that such a tool allows ceramists to analyse a large quantity of sherds and to confirm paste groups. This method can provide a more detailed paste analysis for projects that will not conduct petrographic analysis. The photographs taken with the

Dino-Lite microscope can also help determine which sherds will be selected for further chemical and petrographic analysis.

My study suggests that it is possible to use a semi-quantitative analysis on lower resolution images, and worthwhile to develop a more standardized approach to paste analysis in the Lake Titicaca Basin. This thesis builds on Druc's work on using this USB microscope on ceramics with fresh breaks rather than on laboratory prepared thin-sections or diamond cut sherds. Although petrographic analysis and analysis of thin sections with the USB microscope would be best for quantitative analysis, using the USB microscope on fresh breaks is more cost effective and a less destructive method. In sum, the approach discussed in this thesis builds on a rich tradition in archaeology of tacking between the high tech (petrographic analysis) and more accessible practices of reflected light microscopy (Bishop et al. 1982; Habicht-Mauche 1993; Rivas-Tello and Roddick 2016).

Dino-Lite Procedure

During attribute analysis I selected approximately 10 sherds per context to photograph using the Dino-Lite (AM4815ZTL) USB microscope and analyse using the DinoCapture 2.0 program (AnMO Electronics Corp). I ensured that the fresh break was clean and that the surface was fairly even. In order to create a stable and standardized image, I used a vice to hold the sherd upright. To protect the sherd I wrapped the vice using black fabric. This fabric also reduced any glare from the light on the Dino-Lite microscope off the vice. The Dino-Lite microscope was placed on an adjustable stand (Figure 4.7). I measured and marked five heights on the stand that corresponded to five different magnifications (30x, 40x, 50x, 60x, 90x, and 100x). I calibrated the microscope at these magnifications and heights. Thus if I wanted to photograph sherds at 60x I would set the microscope at height 4, each time and use the saved calibrated measurements on the DinoCapture program. This would ensure that the scale that appears on the DinoCapture 2.0 image was accurate (0.5mm). This process took some trial and error. I found that three magnifications/heights worked best:

1) Overview (30x): this photo was taken with a low magnification in order to obtain a general overview photo of the sherd; similar to what you would see using a hand-lens. These photos were taken using the EDOF (Extended Depth of Field)

setting in the DinoCapture program, which takes multiple photos at several fields of depth, the image was not calibrated and the scale was not included. It did however provide a high-quality and overall in-focus image.

2) General (60x): These photos were taken at a higher magnification. These photos provided more details than the overview photos.
3) Close-up (100x): These photos were taken at a very high magnification. I only took a few photos at this setting.

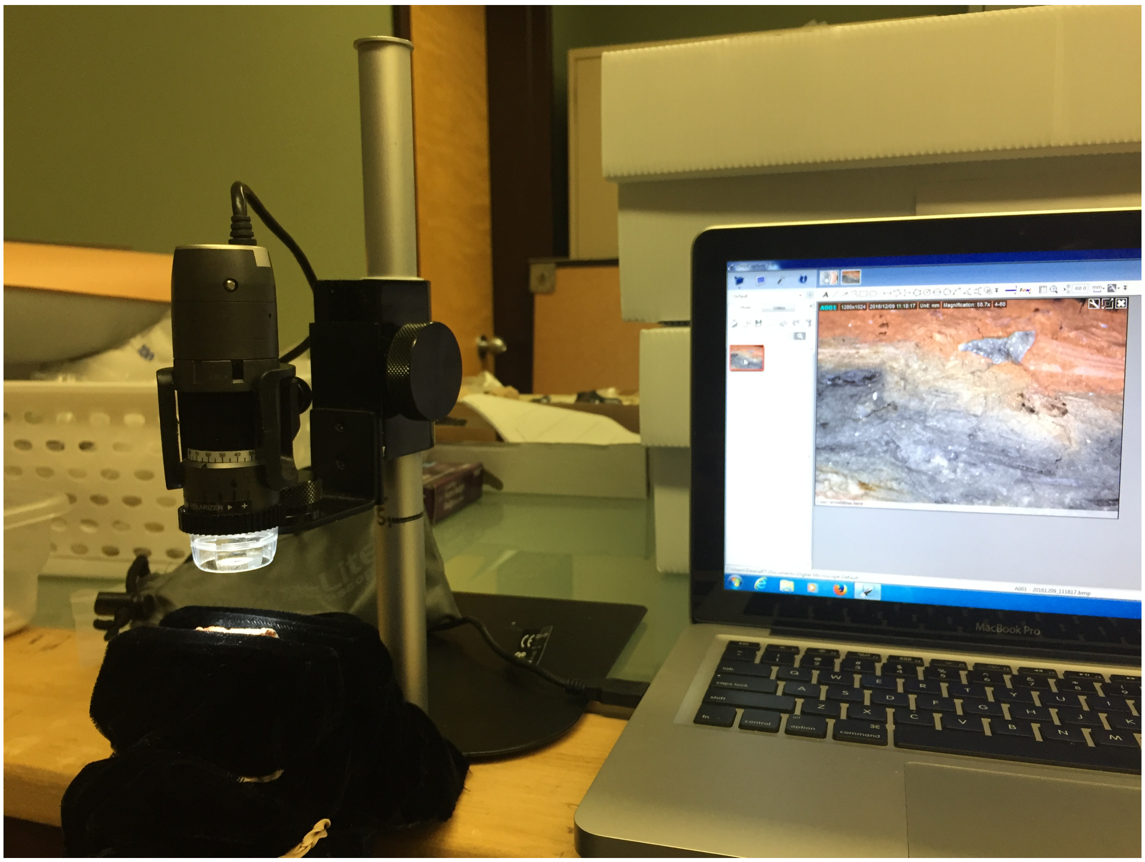

Figure 4.7 Photo of the Dino-Lite microscope, stand and vice used to photograph sherds.

I took approximately three photos at the 'Overview' setting. These photos were later stitched together in *Adobe Photoshop,* resulting in one overview photo of the entire sherd (Figures 5.1-5.3, 5.7-5.9, and Appendix A). I also took three photos at the 'General' level. These photos were best for further image analysis as they provided more detail than 'Overview' photos, and had more of the sherd within the frame than the 'Close-up' photos. I only took two photos per sherd at the 'Close-up' level. Photos taken with the Dino-Lite microscope will be added to a *FileMaker* database that Roddick and I are creating for paste types found in the Titicaca Basin; I will discuss this in further in Chapter 6.

When photographing a sherd, I tried to capture images that best represented the inclusions and texture of the sherd and paste group, I would also include any interesting features/inclusions. Due to the fact that these sherds were not thin sectioned, or diamond-cut sawed, the surface was uneven it was hard to get the whole frame in focus, thus this would determine how and where I photographed the sherd. I did not have this problem with the Overview photos because I took photos of the whole sherd and the EDOF setting superimposed several images at several fields of depth to create the best quality and best focused image. I recorded which sherds were photographed, the image number, and magnifications on an excel spreadsheets. I also renamed the images based on context information, magnification, sherd number and paste group.

4.5 JMicroVision

Images taken at 60x were used for qualitative and semi-quantitative analyses. I applied a similar analysis procedure as the one Druc (2015) uses in her book *Atlas of Ceramic Pastes.* I used the free open accessed program JMicroVision (Roduit 2002-2008 http://www.jmicrovision.com/), to conduct modal analysis and to measure inclusion length. In this section I provide a brief background on JMicroVision program and how its been applied to ceramic analysis. I also outline my protocol for using JMicroVision to analyse paste.

More archaeologists are integrating image analysis into their ceramic analysis than ever before (Daniels and Lipo 2014; De La Fuente and Vera 2015; Druc 2015; Livingood and Cordell 2009; Reedy 2006; Velde and Druc 1999).There are a number of accessible programs available to archaeologists, which allows the manipulation of images, counting, measuring of inclusions and maximizes the information obtained from images of artifacts (i.e. JMicroVision, ImageJ, Image-Pro Plus, Clemex Vision) (De La Fuente and Vera 2015:258; Velde and Druc 1998:245). Digital image analysis has served as an excellent alternative to more traditional studies of ceramic technology such as hand lens and petrographic analysis (De La Fuente and Vera 2015:258; Livingood and Cordell 2009). Archaeologists recognize that digital image analysis of ceramic thin sections or diamond cut sherds, complements traditional methods (Frahm et al. 2008; Livingood and

Cordell 2009; Reedy 2006; Velde and Druc 1996; and Whitbread 1991; discussed in De La Fuente 2015:258).

I applied a similar procedure as Druc (2015). I used the free and open-access program JMicrovision (Roduit 2002-2008 http://www.jmicrovision.com/) to conduct modal analysis and to measure inclusion length. JMicroVision is image analysis software developed by Nicolas Roduit (2002), and used for measuring and quantifying features in high-definition images. This program was initially intended for geological analysis of rock thin-sections images, but can easily be applied to other disciplines. JMicroVision has a simple, user friendly interface for quantifying components, object analysis, classification, image processing and rectification, digital point counting, and image annotation (2002). I decided to primarily use this program because of the point counting and object analysis features.

I began by importing the photos from the DinoCapture 2.0 program, and converting the image to a TIFF file. I calibrated the image (based on the scale captured from within DinoCapture) using the Spatial Calibration setting in the JMicroVision program (Figure 4.8). Once I selected the "Spatial Calibration" setting**,** I used the "Enter a distance, then draw a line" setting and entered the correct scale distance (i.e. 0.5mm). I then drew a line over the scale on the photo, using the "measurement" function. I ensured that the "Output Unit" was set to millimeters.

I used the "Point Count-Random Grid" setting in the JMicroVision program to classify 300 points as mica, quartz, fiber voids, feldspars, rock inclusions or clay matrix. Within JMicroVision I set a "Count Limitation" to notify me once I had reached 300 points. I could also save a "Class List" and use the same categories for all of the images analysed. If the paste had other inclusions not included on this "Class List", I could easily add these new categories (Figure 4.9). Once I identified 300 points, I saved the analysed image with all of the identified points and record the composition and ratio of inclusions within that paste (Figure 4.10).

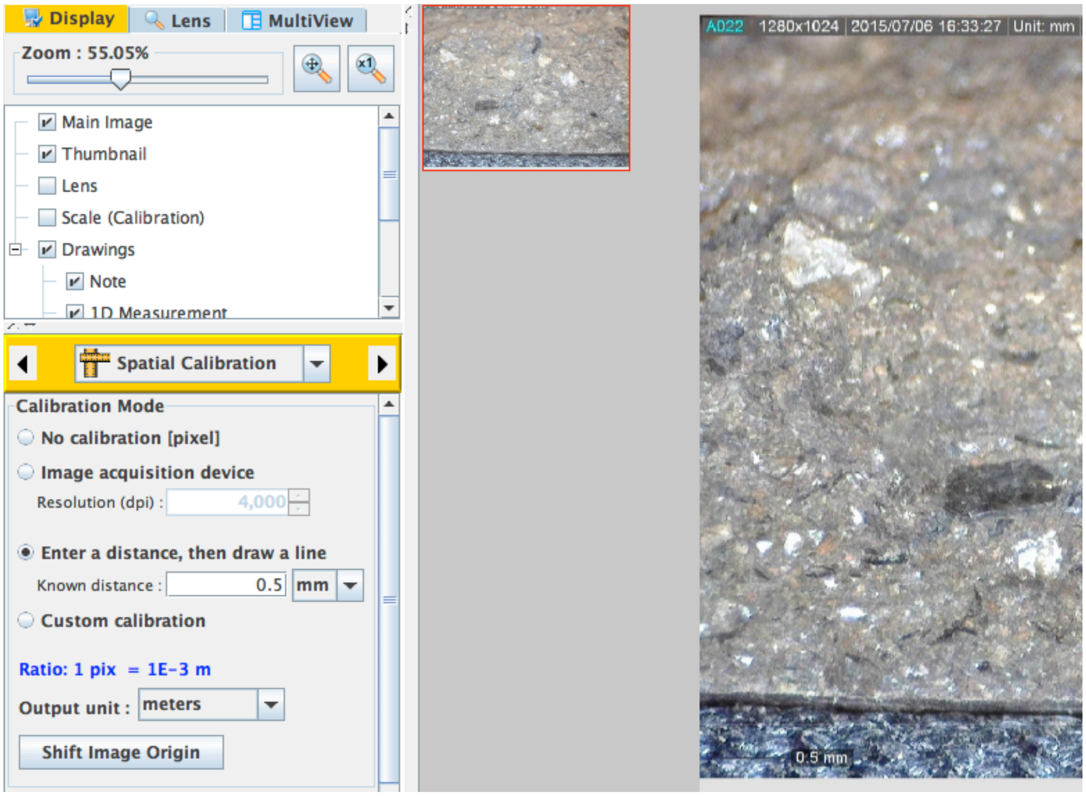

Figure 4.8 JMicroVision software interface: the scale of a sherd photo is being calibrated using the Spatial Calibration setting.

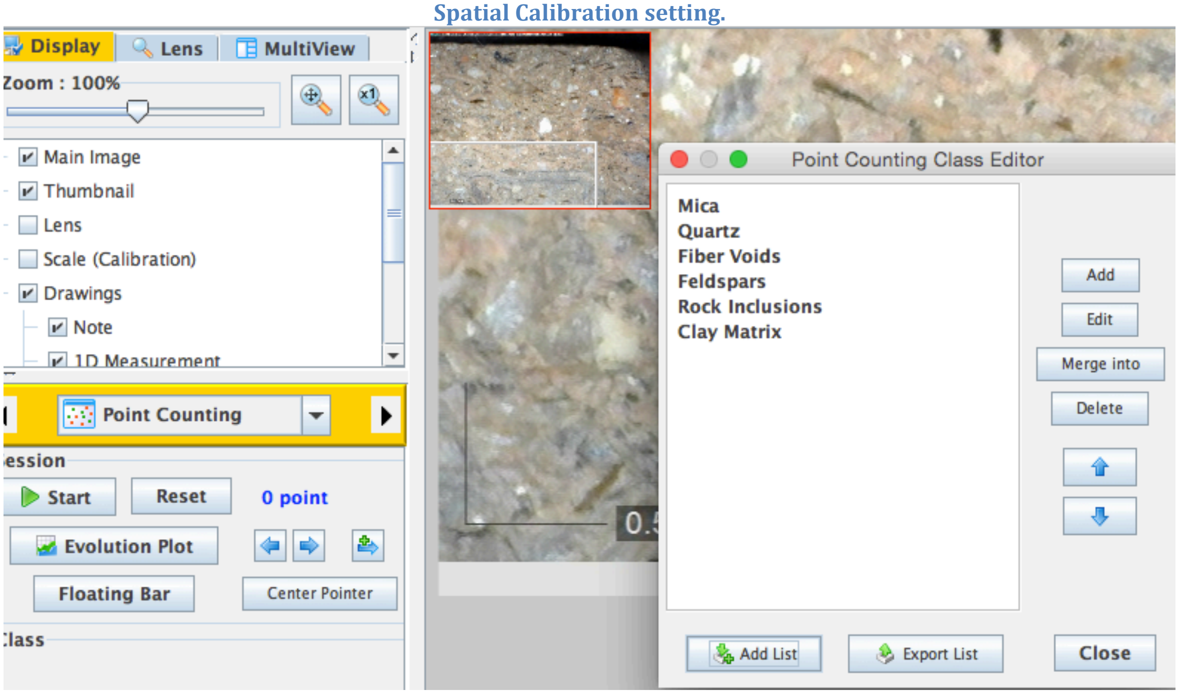

Figure 4.9 Class List setting in the JMicroVision program

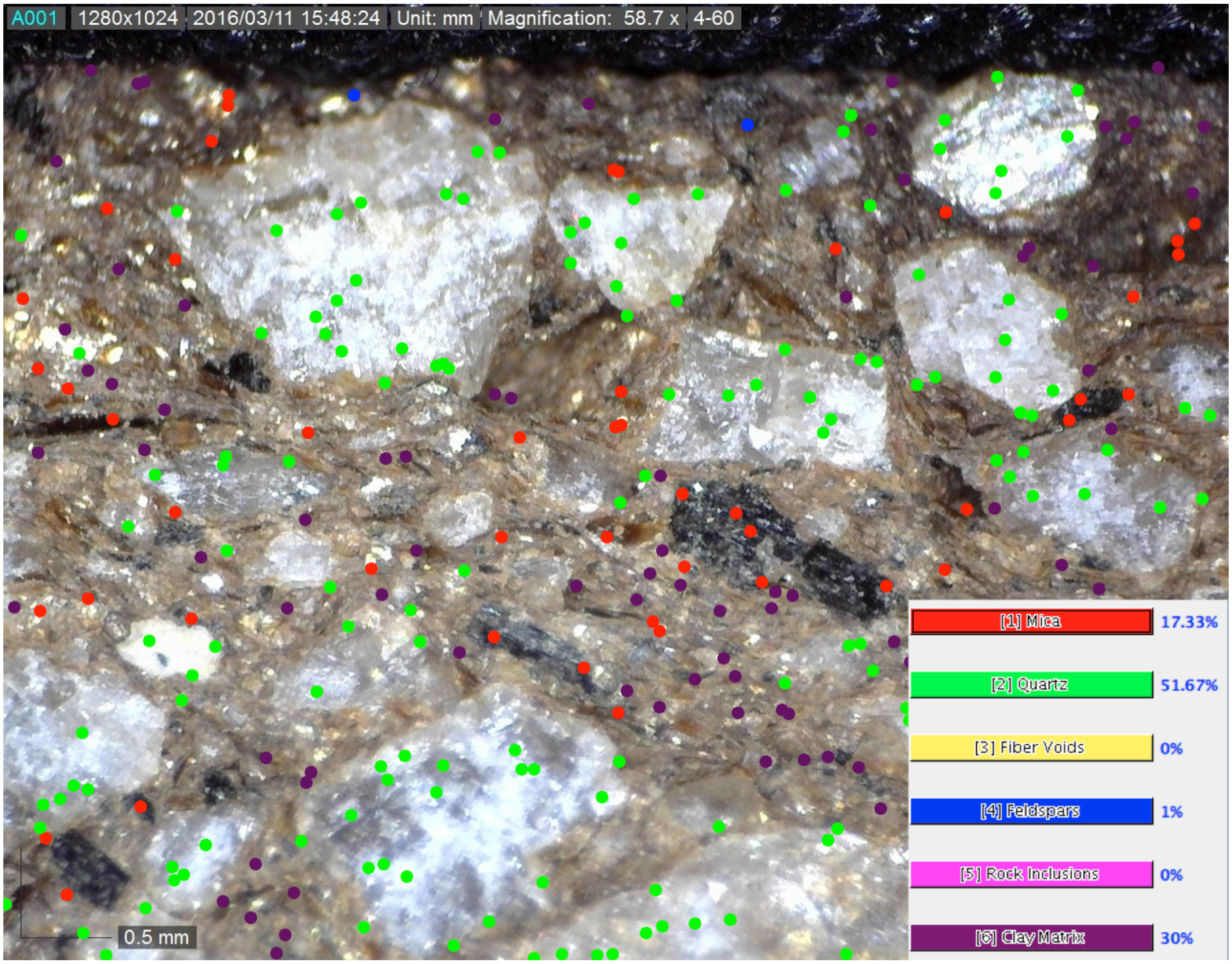

Figure 4.10 Point-count analysis on a sherd (IRU_VIII_LF2_paste19) using the JMicroVision program.

I then used the "1D Measurement" setting to measure the length of each inclusion that I could confidently define the edges of (Figure 4.11). For most images I could measure approximately 100-200 inclusions. I kept track of specific inclusion types by measuring all the inclusions of the same type at once (e.g. quartz first then mica). Once I measured the inclusions, I saved the histogram and scatter chart the program created (Figures 4.12 and 4.13). I recorded my results, including the point count ratios, the A-Attribute analysis information, inclusion maximum length and shapes, on an excel spreadsheet for each sherd analysed. I used Druc's (2015:17) angularity scale to classify the shape of inclusions.

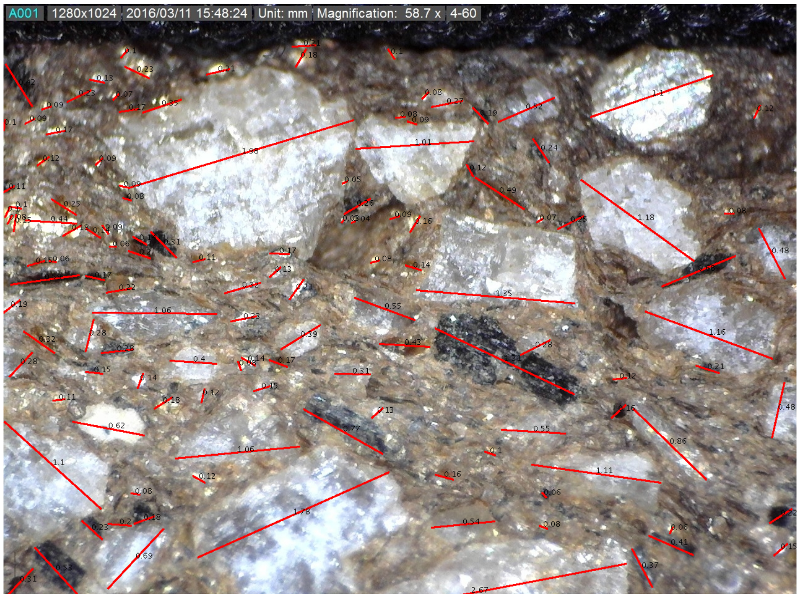

Figure 4.11 Example of the inclusion size measured using JMicroVision 1D Measurement setting (IRU_VIII_LF2_paste19).

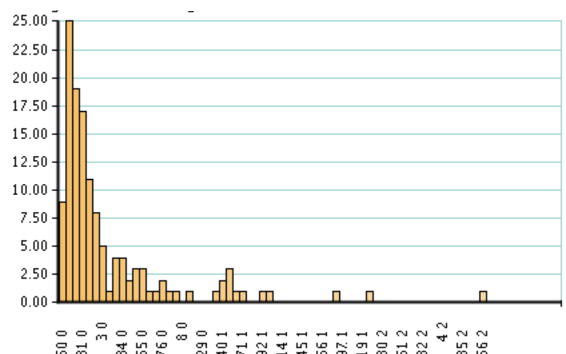

Figure 4.12 Example of a histogram of line length measurements generated by the JMicroVision program. (IRU_VIII_LF2_paste19)

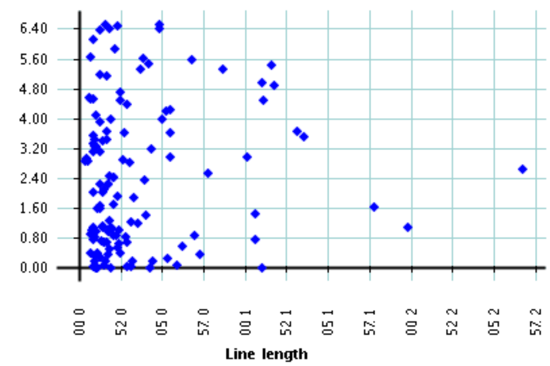

Figure 4.13 Example of a scatter plot of the line length measurements generated by the JMicroVision program. (IRU_VIII_LF2_paste19)

4.6 Methods Summary

In this chapter I presented the methods, procedures and analysis I conducted on ceramic samples from Iruhito and Khonkho Wankane. Andean archaeologists recognize the importance of ceramic pastes and have analysed pastes to observe temporal and spatial changes in pottery production (Roddick 2009: 185; Steadman 1995). Despite being an informative and important ceramic attribute, most projects in the Titicaca Basin only vaguely describe pastes. Roddick (2009) and Steadman (1995) encourage archaeologists to create a paste reference collection to make the classification of pastes easier for future analysts. I also outline how I identified 22 Iruhito and 13 Khonkho

Wankane paste types and how I created paste reference collections for both sites. I also analysed other ceramic attributes (e.g. finish, firing, carbonization, wall thickness, and rim diameters) to interpret ceramic forms and use. To analyse ceramic attributes I applied a modified version of Steadman's TAP attribute system and describe this analysis. Attribute analysis is better suited for this project compared to traditional typological approaches, because this method is sensitive to temporal, spatial and subtle changes in ceramic production.

I included my procedure for applying the Dino-Lite microscope into ceramic paste analysis. This approach builds on Roddick (2009) and Steadman's (1995) goal to make ceramic paste identification easier and replicable, by providing a visual aid to use when classifying ceramic pastes. Together, reference collections, paste descriptions, flowcharts and USB photographs allow future analysts to more reliably and systematically identify pastes in the Upper Desaguadero Valley. I concluded this chapter by presenting my procedure for applying the JMicroVision software to ceramic paste analysis. This approach results in a more semi-quantitative analysis. In the following chapter I summarize the results of ceramic attribute and paste analysis and discuss the major findings I observed in the Iruhito and Khonkho Wankane samples.

Chapter 5: Results and Findings

5.1 Overview

In this chapter I explore if potters from Iruhito and Khonkho Wankane had different production practices and whether inhabitants used domestic pottery differently. It is organized around the three key questions and samples discussed in chapter 3:1) were potters drawing on distinct resources while inhabiting their taskscapes? 2) Were potters producing distinct forms while inhabiting distinct taskscapes? 3) Were people using pots in different ways while inhabiting distinct taskscapes? I analysed a total of 1676 sherds, with 786 from Iruhito and 890 from Khonkho Wankane (Table 3.1, 3.2 and 5.3). To reiterate, my samples were limited as they were the result of different excavation strategies at Iruhito and Khonkho Wankane (see Chapter 3). I could analyse temporal changes in ceramic production and use at Iruhito, while at Khonkho Wankane I focused on spatial distribution of ceramics. I only include Late Formative Period contexts from Iruhito when I compare the two sites in this chapter. Most of the ceramic samples from Iruhito and Khonkho Wankane were composed of body sherds with very few diagnostic sherds. Therefore, I could only analyse a small number of ceramic forms at Khonkho Wankane and Iruhito.

I explore my first question through ceramic pastes, as the choice of raw materials impacts subsequent choices. They are also well preserved. I present my paste groups and subgroups both in terms of macro and micro-descriptions, and discuss the composition and use of common paste types at Iruhito and Khonkho Wankane. I then compare my data produced by the USB microscope. I answer my second question regarding pottery production and vessel forms through an analysis of form, firing cores, and finishing techniques. Despite the small sample of diagnostic sherds from these contexts I was still able to identify temporal and spatial changes in some forms (e.g. ollas, jars, bowls, see Figure 5.19-5.22). To address my third question regarding pottery usage, I turn to data on the use of specific vessel forms (e.g. cooking, storage, serving and ceremonial practices), including patterns in carbonization, and rim sizes. I conclude by briefly summarizing major findings I observed from my analysis.

5.2 Resources Across the Upper Desaguadero Valley: Addressing Paste

In the following sections I analyse ceramic paste to explore if potters from these sites were using different resources when producing pottery. Based on the image analysis I conducted using the software program *JMicroVision*, I summarize the types of inclusions and their ratios, used in the most commonly found pastes at Iruhito and Khonkho Wankane. I analysed how paste tempering changed through time at Iruhito, while at Khonkho Wankane I analysed temporal and spatial change. Finally, I compare the results of ceramic pastes from Iruhito and Khonkho Wankane.

Iruhito Pastes

I identified 22 Iruhito pastes, 9 of which were grouped as fiber-tempered and 13 grouped as mineral-tempered[27]. Similar pastes within these groups were "typed" based on their most identifiable characteristics. For example, Iruhito paste types 19, 20, and 21 are highly micaceous, thus these paste types were grouped into a single sub-group labeled "micaceous paste"[28]. I could identify the paste of 784 out of 786 sherds from Iruhito (see Table 5.1)[29]. The most common pastes groups I identified in Iruhito were pastes 5, 6, 20, 1, 15, 14, 21 and 3, which together accounted for 88.5% of the total sample. I focus on these common pastes and below I provide a detailed description of them. In Figures 5.1-5.3 I provide overview photomicrographs (30x, EDOF) and the results of point count analysis conducted in *JMicroVision*.

For each paste type I conducted point count analysis on sherd samples using the *JMicroVision* program. During this analysis, I identified 300 points per sherd and classified each point as an inclusion, matrix, or void, to calculate the composition of each sherd. I take these compositions and calculate the total average composition across all samples for the entire paste type. Let me begin with my fiber group. Paste 1 had very few inclusions and mostly composed of 62% clay matrix, 22% large fiber voids and 12% quartz inclusions. Paste 5 was similar in composition to Paste 1 but had more quartz (19%) and mica (9%) inclusions as well as smaller fiber voids (9%). Paste 3 had larger opaque white inclusions, medium sized fiber voids (15%) and small black, pink (likely feldspars), and quartz (16%) inclusions. Overall, Paste 3 had a very similar composition

[27] For detailed descriptions of all the Iruhito paste types refer to the Appendix A.
[28] Refer to Figure 4.2 and 4.3 in Chapter 4 for a description of the paste groups, subgroups, and types.
[29] I could not reliably identify the paste of two sherds due to post-breakage firing.

to Paste 1 but with different portions. Although Paste 3 was initially labelled a "coarse" paste I would argue to reclassify it as a "large fiber void" paste along with Paste 1 and 5.

Table 5.1 Count of all the paste groups, subgroups and types identified in Iruhito

Group	Subgroup	Paste type	Count
Fiber	Large Fiber	5	191
Fiber	White Speckled	6	112
Mineral	Micaceous	20	106
Fiber	Large Fiber	1	103
Mineral	White Transparent	15	76
Mineral	White Speckled	14	42
Mineral	Micaceous	21	34
Fiber	Coarse	3	30
Fiber	Coarse	4	20
Fiber	Dense	10	11
Mineral	White Speckled	18	11
Mineral	Dense	22	11
Mineral	Buff	16	8
Mineral	Buff	17	5
Mineral	Dense	23	5
Fiber	Micaceous	7	4
Fiber	Dense	9	4
Mineral	Dense	24	4
Fiber	Dense	8	2
Mineral	Coarse	13	2
Mineral	Dense	25	2
Mineral	Micaceous	19	1
		Total	**784**

For each paste type I conducted point count analysis on sherd samples using the *JMicroVision* program. During this analysis, I identified 300 points per sherd and classified each point as an inclusion, matrix, or void, to calculate the composition of each sherd. I take these compositions and calculate the total average composition across all samples for the entire paste type. Let me begin with my fiber group. Paste 1 had very few inclusions and mostly composed of 62% clay matrix, 22% large fiber voids and 12% quartz inclusions. Paste 5 was similar in composition to Paste 1 but had more quartz (19%) and mica (9%) inclusions as well as smaller fiber voids (9%). Paste 3 had larger opaque white inclusions, medium sized fiber voids (15%) and small black, pink (likely feldspars), and quartz (16%) inclusions. Overall, Paste 3 had a very similar composition to Paste 1 but with different portions. Although Paste 3 was initially labelled a “coarse” paste I would argue to reclassify it as a “large fiber void” paste along with Paste 1 and 5.

Turning to my micaceous pastes, I originally defined three of the Iruhito pastes (19, 20 and 21) in the highly “micaceous” category (see Figure 5.2), but subsequently combined two of these pastes (20 and 21). Although only one sherd was identified as Paste 19, it was quite distinct, with dense coarse inclusions. Quartz makes up 51% of this paste, with 18% mica, 1% feldspar and only 31% clay matrix. The other two micaceous pastes (20 and 21) were very similar in composition and inclusions: clay matrix ratio (71% clay matrix). Paste 20 has approximately 13% mica inclusions and 15% quartz inclusions, while Pastes 21 has 12% mica inclusions and 16% quartz inclusions. It was very challenging distinguishing between Pastes 20 and 21 in the field and based on the point count analysis it seems that Pastes 20 and 21 are almost identical. I argue that these two pastes are not distinct and should be combined into a single paste group.

Other common pastes found in Iruhito were white-speckled pastes (6 and 14) and white-transparent paste15 (Figure 5.3). Paste 6 is a fiber-tempered paste but has a similar composition to Paste 14, a mineral-tempered paste. The fiber voids (6%) in Paste 6 were larger and more abundant than those of Paste 14 (1% fiber voids). Quartz inclusions were more abundant in Paste 14 (30%) compared to Paste 6 (28%). While mica portions were similar in both pastes (Paste 14 has 4%, while Paste 6 has 5%). Paste 6 also had more feldspar (3%) and rock inclusions (2%) compared to Paste 14 (2% feldspar and no rock inclusions). Although these two groups had some similarities I still considered them distinct paste groups. Paste 15 has more quartz inclusions (35%) compared to Pastes 6 and 14 but these quartz inclusions were transparent rather than white. The composition of Paste 15 is like Pastes 6 and 14 but the colour of the quartz is different enough caused me to identify it as a “white-transparent” paste.

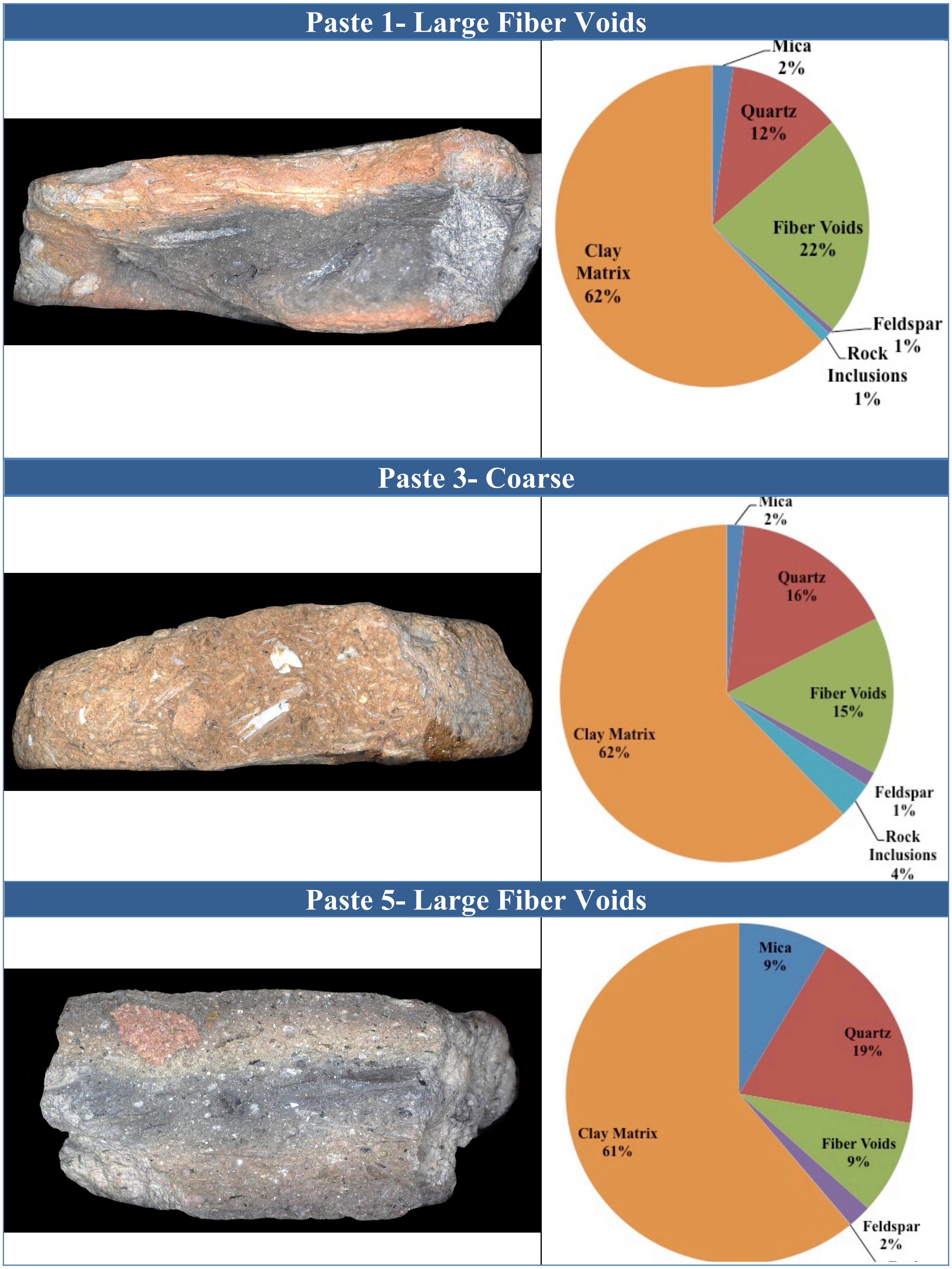

Figure 5.1 Common fiber pastes from Iruhito.

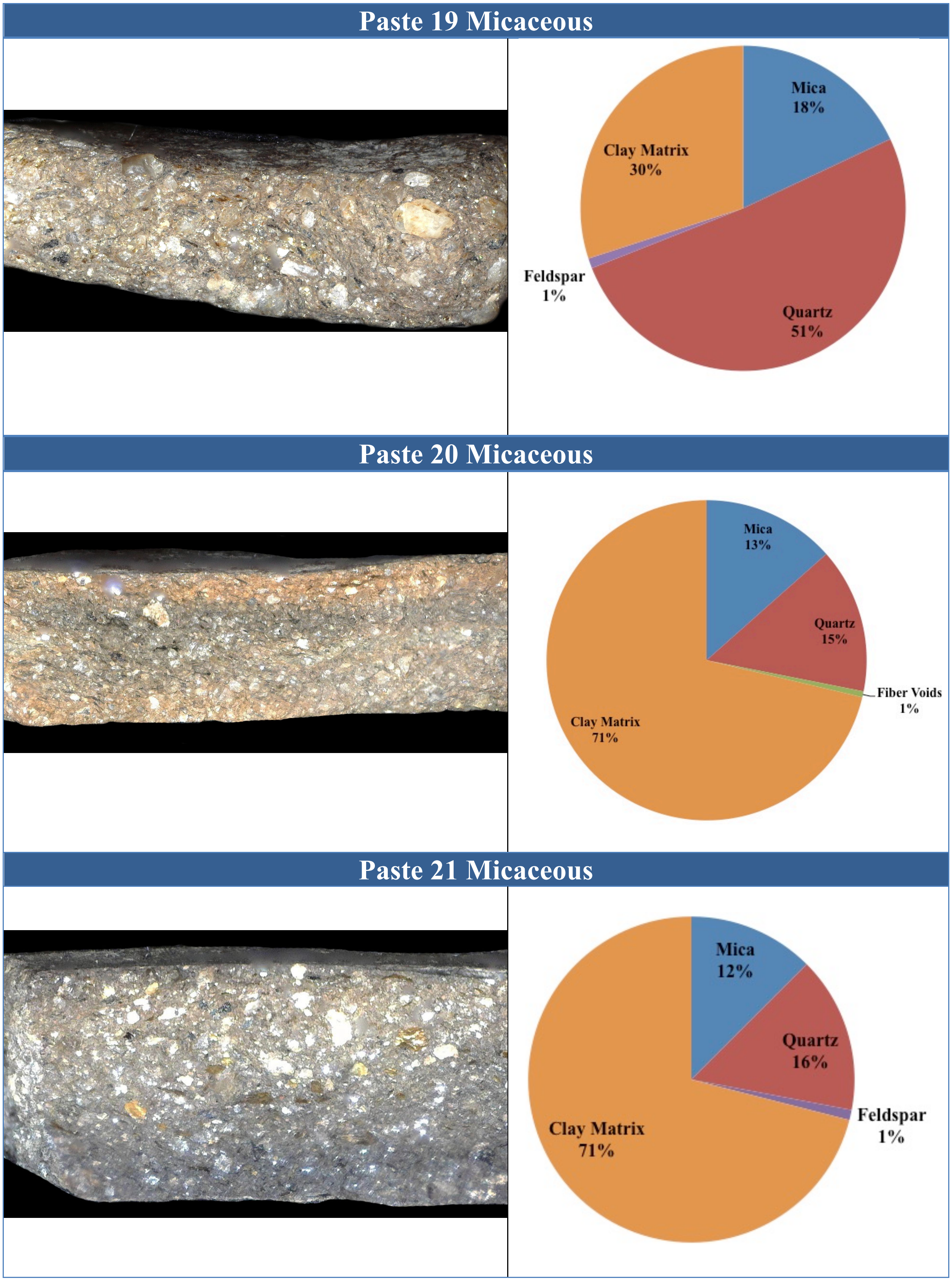

Figure 5.2 Common micaceous pastes from Iruhito

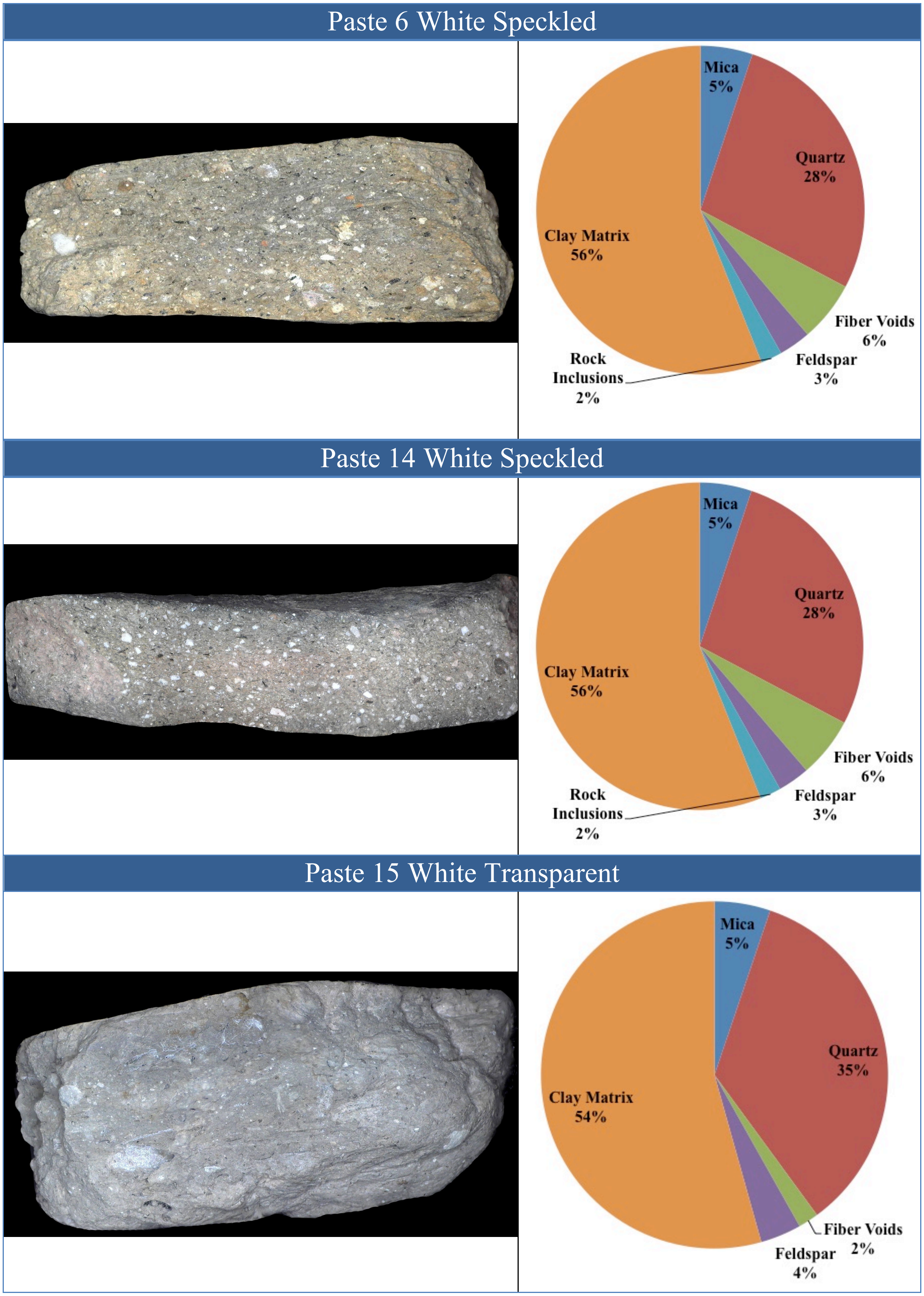

Figure 5.3 Other common pastes from Iruhito

Temporal Changes in Iruhito Paste

I analysed the temporal changes of Iruhito paste to explore if potters from Iruhito and Khonkho Wankane were drawing on different resources and if this was impacted by their social context and taskscapes. Figure 5.4 shows the temporal change of paste tempering at the site of Iruhito. We see an overall shift from fiber-tempered pastes in earlier periods to more mineral-tempered pastes in later periods. Most Middle Formative Period sherds are fiber-tempered, whereas mineral tempering increases in the Late Formative and Tiwanaku periods. A dramatic shift occurs between the Late Formative to Late Formative 2 periods.

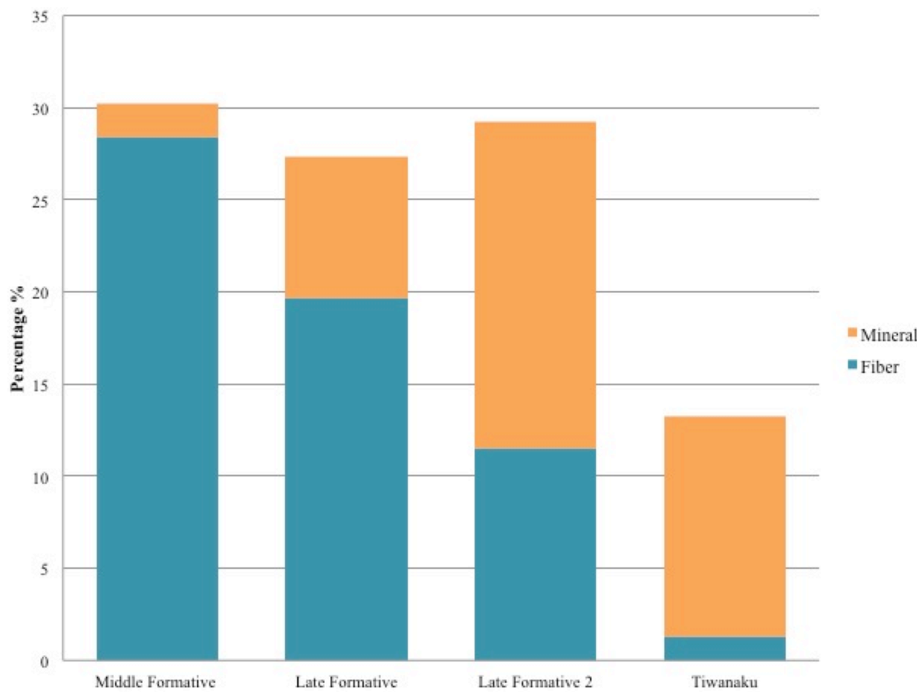

Figure 5.4 Mineral and fiber tempered sherds through time in Iruhito (n=784).

Figures 5.5 and 5.6 show the temporal change of mineral and fiber paste subgroups at Iruhito. Middle Formative sherds had an even distribution of micaceous, white speckled, coarse and white transparent pastes but the overall sample size of mineral pastes in Middle Formative contexts was less than 5%. There was an increase in mineral pastes in the Late Formative period, specifically micaceous pastes. The Late Formative 2 period had the largest mineral-tempered sherd sample and most were micaceous pastes followed by white-transparent, white-speckled, dense, and buff pastes. Most Tiwanaku sherds were also identified as micaceous pastes followed by white-transparent, white-speckled and very few dense pastes.

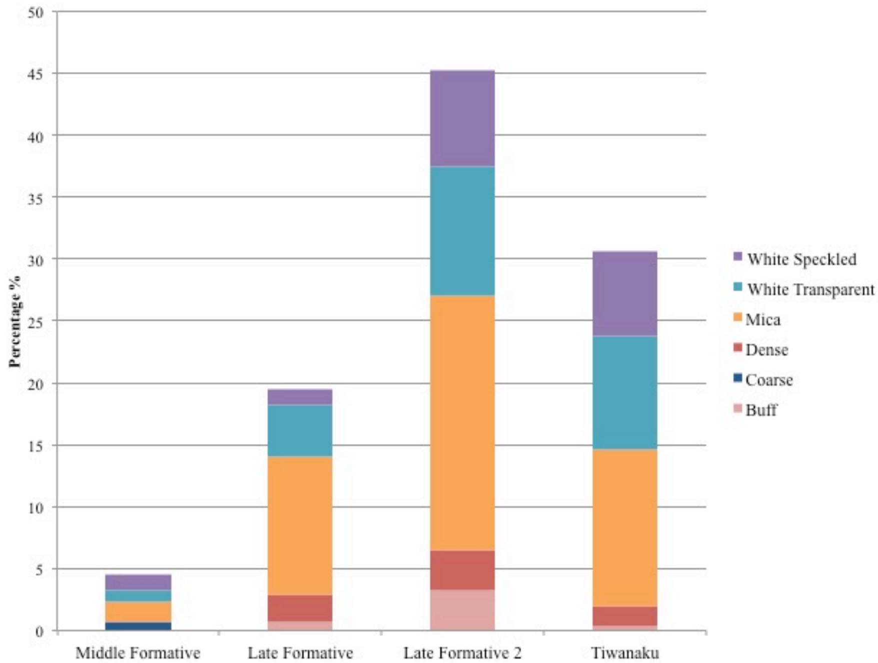

Figure 5.5 Mineral-tempered paste subgroups through time (n=307).

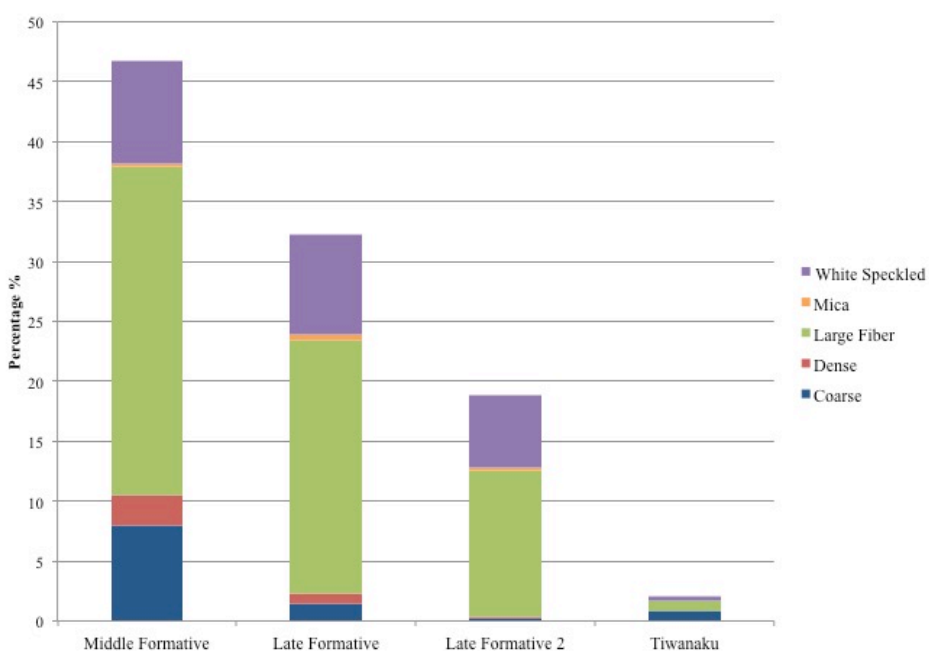

Figure 5.6 Fiber-tempered paste subgroups through time (n=477).

Figure 5.6 shows that the Middle Formative period sample had the largest quantity of fiber-tempered paste groups. I classified the majority of Middle Formative samples as large fiber voids pastes, followed by white specked and coarse pastes. While there was a decrease in fiber tempered sherds in Late Formative 2 sample, this sample did include a large number of sherds with large fiber voids, followed in popularity by white-speckled pastes. The Tiwanaku period had a small sample of with fiber-tempered sherds which may be the result of a very small sample size or less fiber pastes used during this period. There is also the possibility that the few fiber-tempered sherds were intrusive but future analysis comparing fiber pastes from the Formative to Tiwanaku periods would have to be conducted to confirm this.

The trends seen in the Iruhito sample aligns with patterns seen elsewhere in the Southern Lake Titicaca Basin. During the Middle Formative period fiber-tempered pastes were the most common across the region (Roddick 2009:157). Iruhito is no exception and most Middle Formative sherds I analysed were fiber-tempered. Pérez-Arias (2013:50-51) also identified fiber-tempered pastes in these contexts. Scholars have also noted a region shift to mineral-tempered pastes in the Late Formative (Bandy 2001:173; Janusek 2003:51; Lémuz Aguirre 2001:159), with more micaceous pastes in the Late Formative 2 period. Again, these patterns are also found in both my Iruhito sample, and in the work of Pérez-Arias (2013:53-55).

Khonkho Wankane Pastes

I identified 13 Khonkho Wankane paste types, 4 fiber-tempered pastes and 9 mineral-tempered pastes[30]. Like the Iruhito sample I also grouped similar Khonkho Wankane pastes into sub-groups based the most identifiable characteristic of these pastes[31]. I identified the paste for 820 out of the total 821 sherds from Iruhito, one sherd was post-breakage fire-blackened, and thus I could not identify the paste. Table 5.2 list the counts of each paste type. The most common pastes types I identified in Khonkho Wankane were pastes 2, 3, 1, 8, 6, 13, and 14, making up 91% of the total sample. I

[30] For detailed descriptions of Khonkho Wankane paste types refer to the Appendix A.
[31] Refer to Figure 4.4 and 4.5 in Chapter 4 for all of the paste groups, subgroups and types.

decided to focus on these common Khonkho Wankane pastes and provide more detail on them in Figures 5.7-5.9.

Table 5.2 Counts of Iruhito sherds identified per paste group

Group	Subgroup	Paste Type	Count
Mineral	Micaceous	2	294
Mineral	White Speckled	3	143
Mineral	Mica	1	139
Mineral	Buff	8	69
Mineral	White Transparent	6	48
Mineral	White Transparent	7	39
Fiber	Large Fiber	13	34
Fiber	Coarse	14	19
Mineral	Coarse	5	13
Mineral	Dense	9	12
Fiber	Large Fiber	15	4
Mineral	Coarse	4	3
Fiber	Dense	16	3
		Grand Total	820

Paste 13 and 14 were the most common fiber-tempered paste in Khonkho Wankane (Figure 5.7). I only identified 60 sherds (14% of the total Khonkho Wankane sample) with fiber-tempered pastes, thus I had a very small sample of fiber pastes. I classified Paste 13 as a "large fiber void" paste, and the average composition of this paste was 4% fiber voids, 16% quartz, 7% mica, 3% feldspar, and 2% rock inclusions. Compared to Iruhito's large fiber pastes (1 and 5), Khonkho Wankane Paste 13 had less fiber voids, similar amount of quartz and more feldspar and rock inclusions. Although Paste 14 had a similar composition to Paste 13, I classified it as a "coarse fiber" paste because it had more inclusions, specifically mica (14%) and quartz (17%). Overall, these two fiber-tempered paste subgroups are similar but Paste 14 was coarser and had more inclusions.

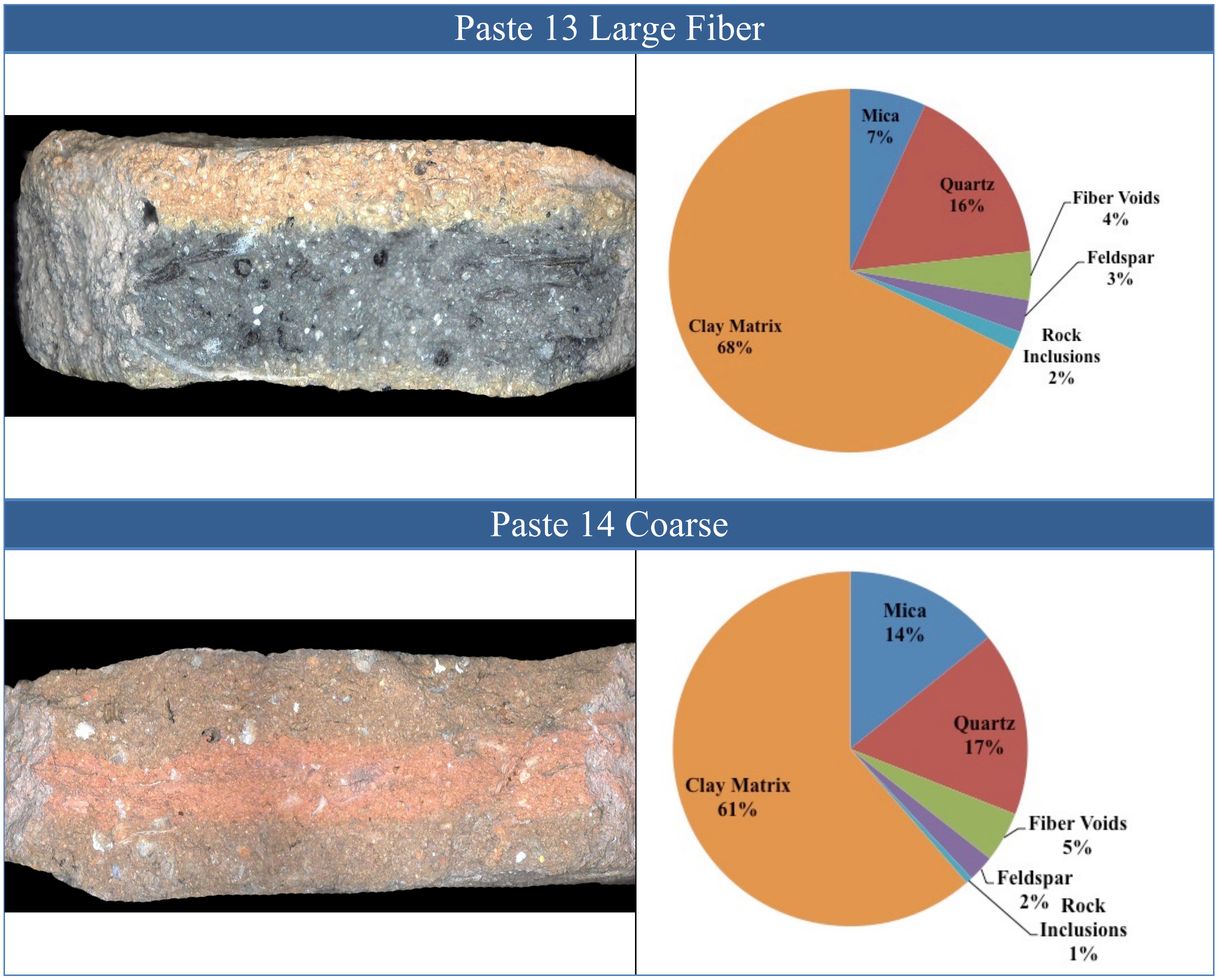

Figure 5.7 Common fiber pastes in Khonkho Wankane.

I classified Khonkho Wankane pastes 1 and 2 as highly "micaceous" (Figure 5.8). Paste 1 was a common micaceous paste and on average was composed of 75% clay matrix, 14% quartz, 9% mica, and very few fiber and feldspars inclusions. Paste 2 had a higher abundance of mica inclusions compared to Paste 1 and was composed of 69% clay matrix, 18% quartz, and 12% mica. Overall, Paste 2 had a very similar composition to Paste 1 but Paste 2 had more inclusions and no fiber voids. An important characteristic of Paste 2 was the high mica density on the sherd surfaces, which was not analysed using the Dino-Lite microscope but only analysed using a hand lens in the field. Based on these observations, I elected to keep them as separate pastes.

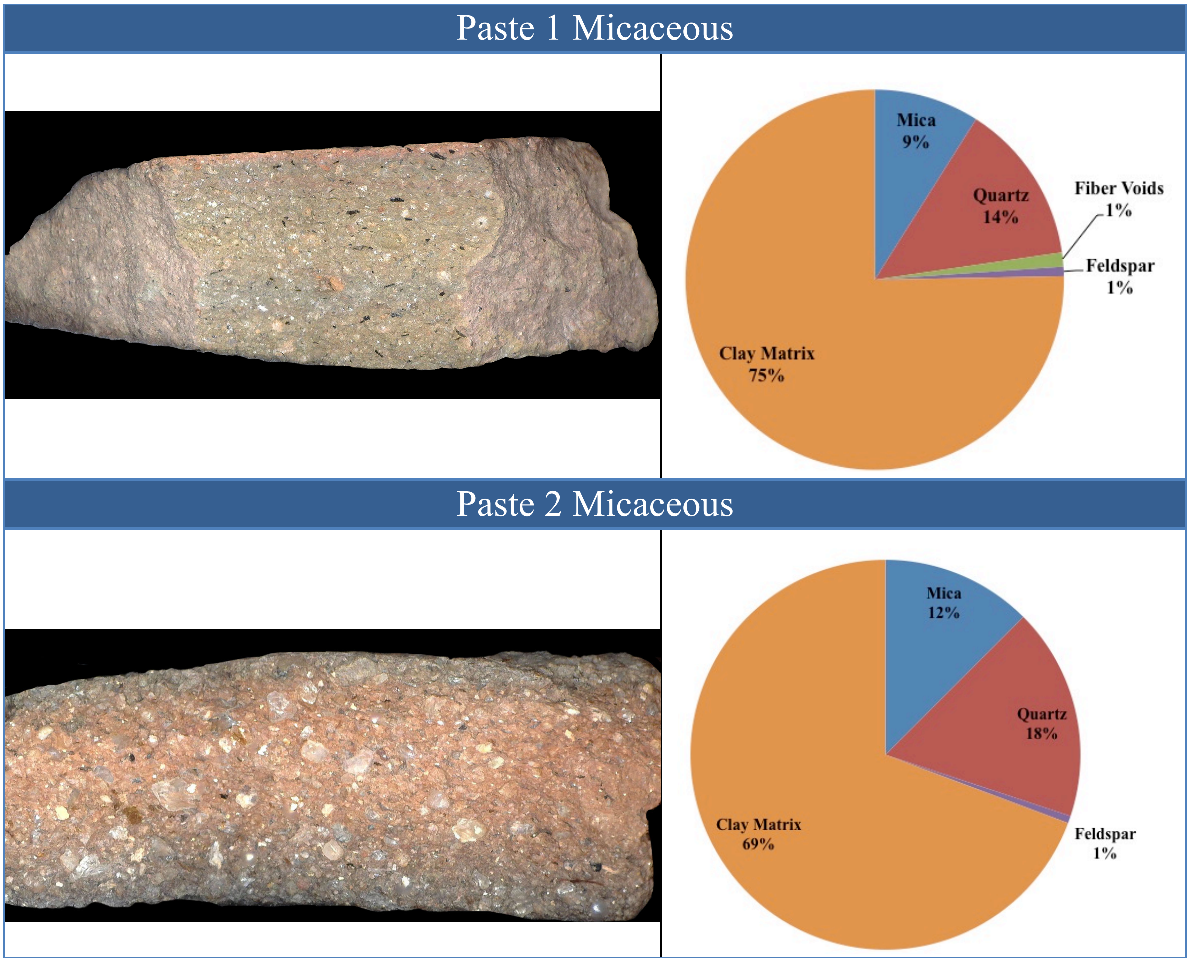

Figure 5.8 Common micaceous pastes in Khonkho Wankane

Three common pastes identified in Khonkho Wankane were Paste 3, 6, and 8 (Figure 5.9). I classified Paste 3 as a white-speckled paste; it is composed of 28% quartz inclusions, 4% mica, 2% feldspar, 2% rocks, 2% fiber voids and 61% clay matrix. This paste had a lot of inclusions but less than Iruhito white-speckled pastes (Paste 14 and 6). I identified Paste 6 as a white-transparent paste, composed of 23% quartz, 7% mica, 3% feldspar, 1% fiber voids, 1% rock inclusions and 68% clay matrix. Compared to Paste 3, Paste 6 had less quartz, mica, rock inclusions and fiber voids, but more mica and feldspar inclusions. Although the composition of Iruhito Paste 15 was like Khonkho Wankane Paste 6, Paste 6 had fewer inclusions. I classified Paste 8 as a "buff" paste and on average 14% of this paste is quartz inclusions, 6% mica, 1% feldspar, 1% rock inclusions and 77% clay matrix. This paste had very few inclusions and was a fairly clean paste. Overall Paste 3 and 6 were similar but had different portions and I would keep these groups separate, while Paste 8 is very distinct and clearly a separate paste type.

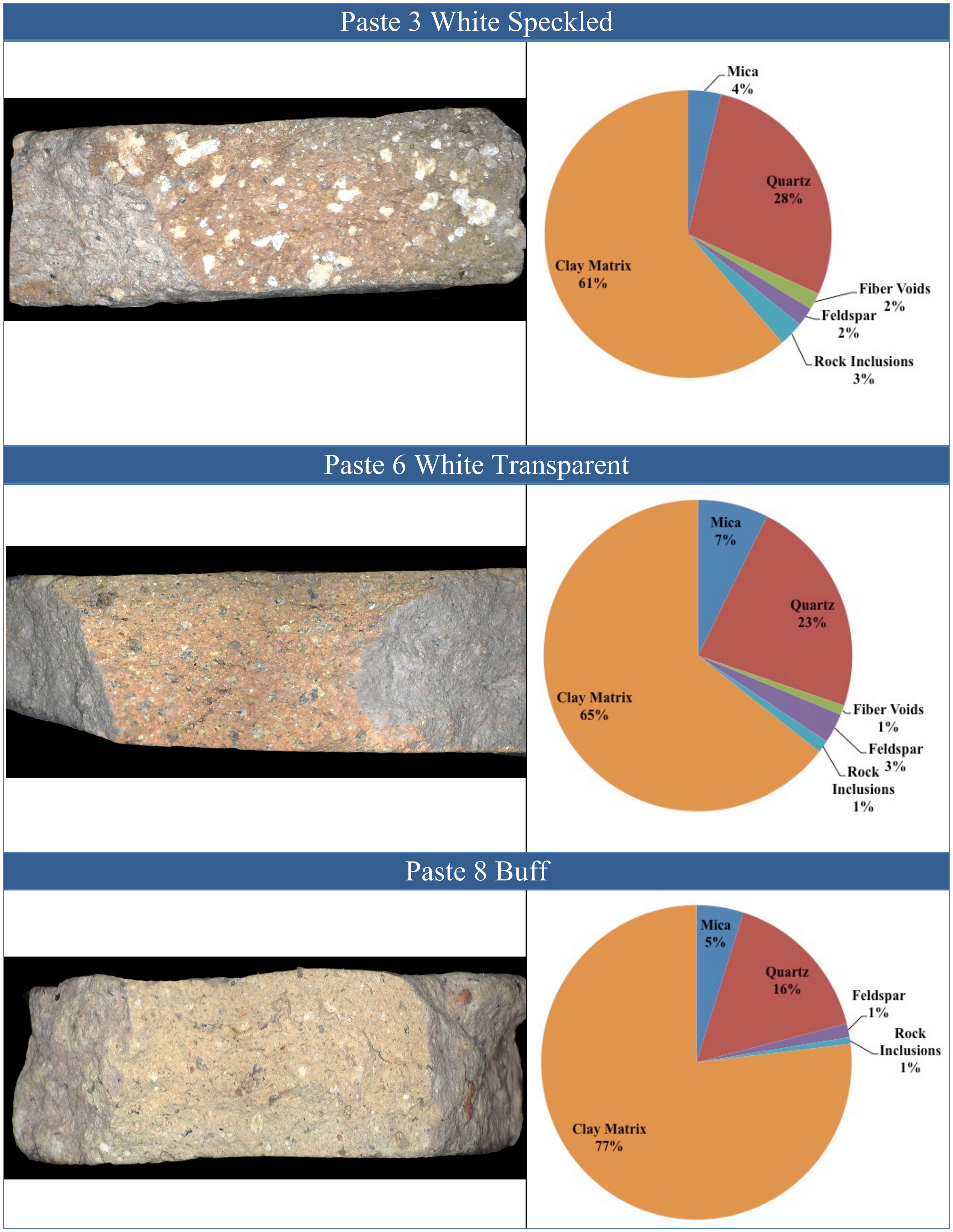

Figure 5.9 Common mineral-tempered pastes in Khonkho Wankane

Temporal and Spatial Changes in Khonkho Wankane Paste

Since most of the contexts I analysed from Khonkho Wankane date to the Late Formative period, I could not analyse the temporal change in paste temper. The sample I analysed from Khonkho Wankane was primarily mineral-tempered (93%) and had very few fiber-tempered sherds (7%) (see Table 5.2). Figure 5.10 shows that micaceous pastes form the majority of sherds for all time periods in Khonkho Wankane. White-speckled, white-transparent, and buff pastes were also found in all of the time perods at Khonkho Wankane. There were fewer sherds with dense pastes, perhaps finer pastes were found in ceremonial areas which was not the focus for this project. In the Late Titicaca Basin "buff" pastes appear in the Late Formative 1 period and continued to be used into the Late Formative 2 period (Janusek 2003:54). Figure 5.10 shows this trend at Khonkho Wankane. There was also increase in micaceous pastes during the Late Formative 2 period at Khonkho Wankane. Overall, the results from Khonkho Wankane fit into regional trends.

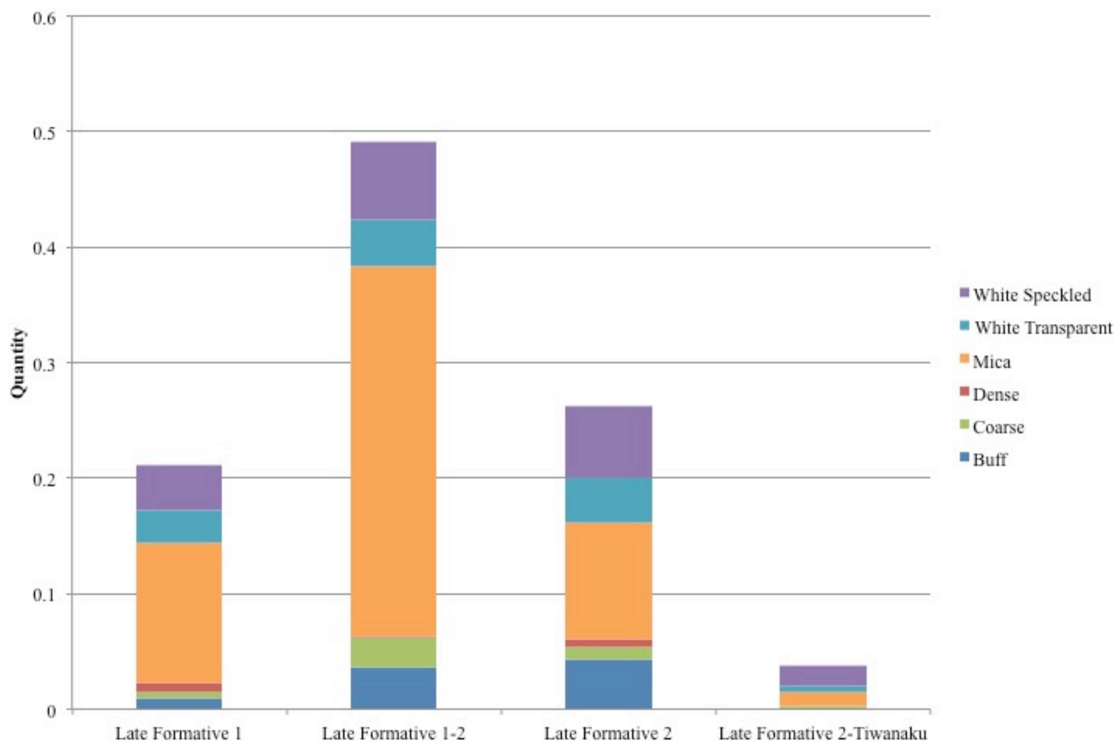

Figure 5.10 Khonkho Wankane mineral paste subgroup distribution through time (n=779).

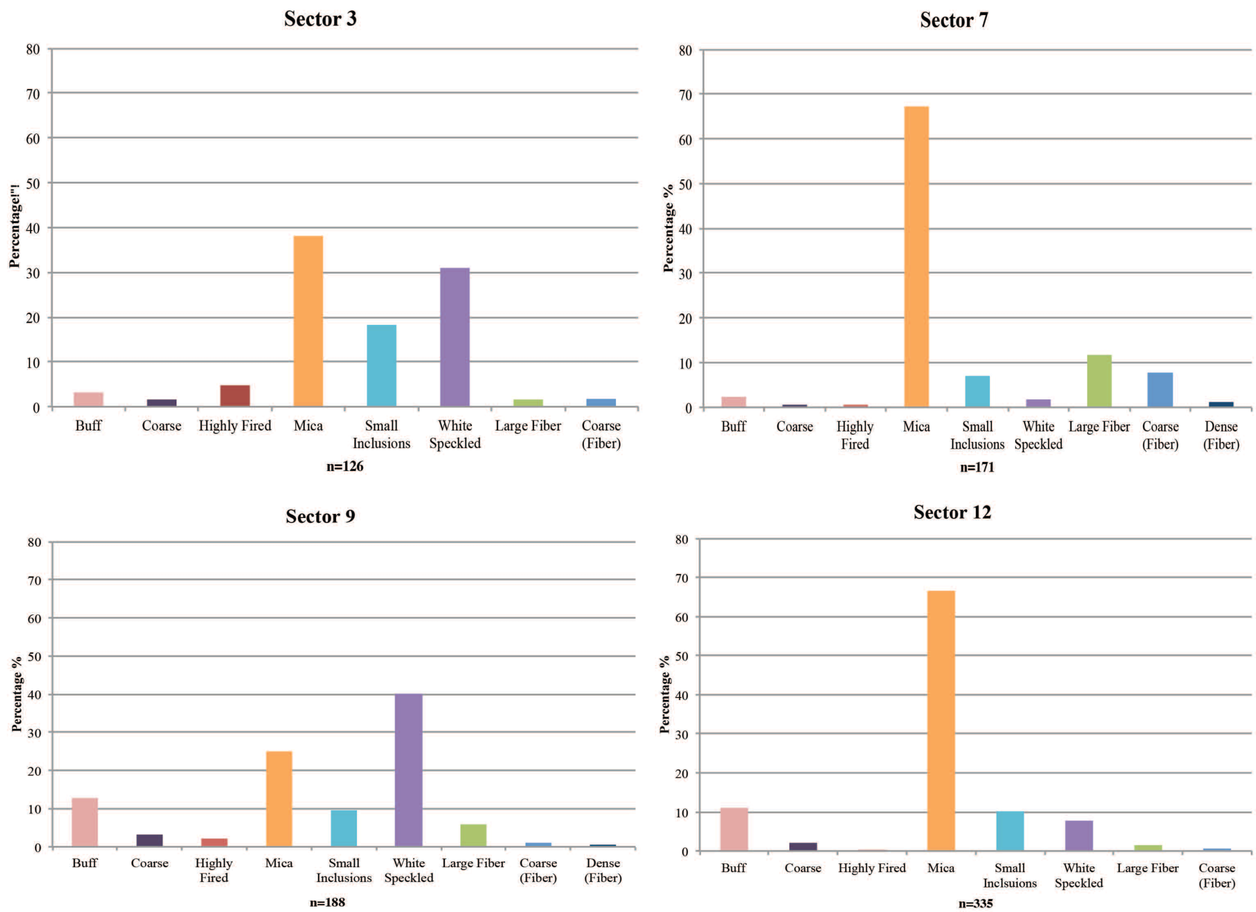

Figure 5.11 Spatial distribution of paste subgroups (1-9, 13-16) in Khonkho Wankane Sectors 3,7,9 and 12.

I compared the spatial distribution of pastes between the different sectors in Khonkho Wankane (Figure 5.11). Most of the sherds analysed in Sector 7 (67%) and Sector 12 (67%) were micaceous pastes. Janusek (2003:52) explains that during the Late Formative period cooking ollas had thinner, burnished walls and mica-rich pastes. Marsh (2012a:345) believes Sector 7 was a domestic area used for food was prepared and cooking[32]. While the function of northern Sector 12 is still undetermined, it is thought to have been a domestic residential area (Gladwell 2006:123). Sector 12 shares several similarities with Sector 7 (e.g. circular structures, micaceous pastes and large quantities of jars/ollas; see Figure 5.24); perhaps Sector 12 was used for domestic practices but more analysis would have to be conducted to confirm this.

[32] Refer to chapter 3 for more background on sectors 3,7,9 and 12.

Sector 3 had the most variability in ceramic pastes than the other three sectors. Micaceous pastes only make up 38% of the sample, followed by 31% white-speckled pastes, 18% white-transparent, 5% dense pastes, and less than 5% buff, large fiber, and coarse pastes. Prior to this project, the ceramics from Sector 3 had not been analysed. Janusek (2005:25) and Ohnstad (2007)believe this sector to be a Late Formative residential area. Sector 3 had very different pastes than Sectors 7 and 12, perhaps because a variety of activities other than cooking were occurring in this sector.

Sector 9 was the only sector with predominantly white-speckled paste (40%), micaceous pastes (25%), buff pastes (12%), white-transparent (9%), fiber (6%), coarse (4%), and dense pastes (4%). While different from the Sectors 7 and 12 assemblages, it was similar to Sector 3 sherds, which weren't exclusively mica-tempered. Archaeologists still disagree about the specific function of the circular structure 9.C1 in Sector 9. Marsh (2012a:266) argues that 9.C1 was a residential area used for cooking and food preparation, whereas Smith (2009:286-298) and Zovar (2009:379–381) believe the space was for the preparation of feasting foods. I return to consider sector 9 and 9.C1 Section 5.5 at the end of this chapter.

Comparing Khonkho Wankane and Iruhito Pastes

Inclusion Size

Druc (2015:14, 79-81) explains that the USB microscope can be used to measure inclusion size (granulometry), which can indicate paste texture, inclusion sorting and how a potter processed inclusions (Quinn 2013:85). Grain-size distributions can indicate whether inclusions were naturally occurring or were intentionally added as temper (Reedy 2006:137; Quinn 2013:85, 161). In petrographic analysis, grain size distribution can be described as unimodal, bimodal and very rarely trimodal (Quinn 2013:85). If a paste has well sorted inclusions with a narrow size range and consistent sizes, then the grain distribution can be described as unimodal (Quinn 2013:85). Naturally occurring inclusions tend to have a unimodal grain size distribution (Reedy 2006:137; Quinn 2013:85). If a paste has poorly sorted inclusions and the grain-distribution has a wider size range and composed of two or more dominant sizes (fine vs. coarse) then it can be described as bimodal (Quinn 2013:85). Petrographers suggest that bimodal distributions can indicate intentional tempering because clays with clear bimodal distributions are uncommon in nature (Quinn 2013:161). When potters add temper to clays, the temper inclusions tend to be coarser and have larger grain sizes than the naturally occurring inclusions (Quinn 2013:161). It is also important to note that fine homogenous pastes may also have a uniformed grain size distribution and appear unimodal, but inclusions could still have been intentionally added (Druc 2015:97). While coarse heterogeneous pastes will have more variation in grain-size distribution (Druc 2015:97).

During image analysis, I used the *JMicroVision* program to measure the maximum length of inclusions. My aim with this analysis was to compare specific inclusion sizes across similar pastes from Iruhito and Khonkho Wankane to determine whether potters were processing similar tempers in similar ways. While Druc (2015) suggests this might be a beneficial approach, to my knowledge this type of analysis using a USB microscope and on a fresh break has not been conducted before. Figures 5.12-5.14 are box plots showing the distribution, minimum, maximum, and mean mica, quartz and fiber void inclusion grain size in common Iruhito and Khonkho Wankane paste types.

The maximum lengths of mica inclusions were fairly consistent between the two sites (see Figure 5.12). There was a difference in mean sizes of mica inclusions across the two sites, but most mica inclusions fall between 0.1mm to 0.3mm. In Figure 5.13 I graphed the distribution of quartz sizes in white-speckled and white-transparent pastes used in Khonkho Wankane (3, 6, and 7) and Iruhito (6, 14, 15 and 18). I found that between Khonkho Wankane and Iruhito the mean size of quartz inclusions were very similar. Most quartz inclusions measured to 0.5mm (0.1mm to 0.03mm). It seems that quartz and mica inclusion size were very consistent between these two sites. The small variation in these grains (quartz and mica) might indicate these were prepared in some way, rather than being natural inclusions. There was a drastic increase in mica during the Late Formative period and the portion of quartz changes depending on the paste type, thus in some cases these inclusions were intentionally added. Perhaps potters from both sites prepared mica and quartz inclusions prior to adding it to their clays, future petrographic analysis could help determine this.

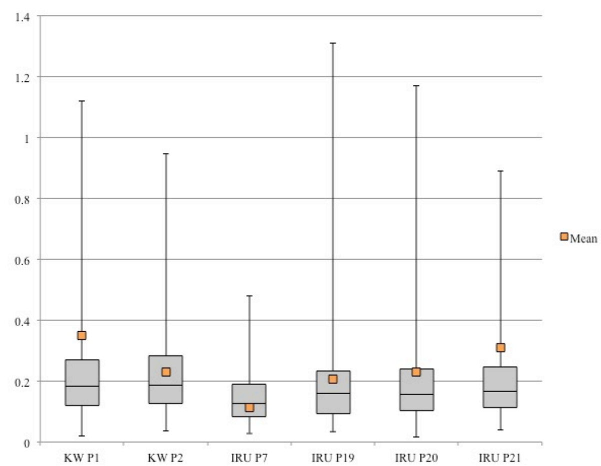

Figure 5.12 Maximum length of mica inclusions in Iruhito and Khonkho Wankane micaceous

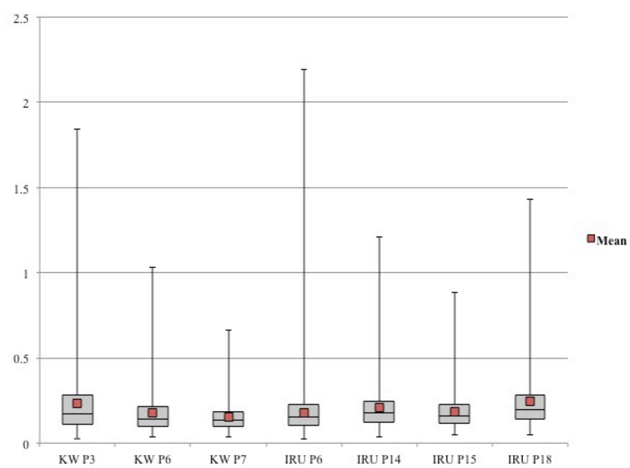

Figure 5.13 Maximum length of quartz inclusions in Iruhito and Khonkho Wankane mineral paste

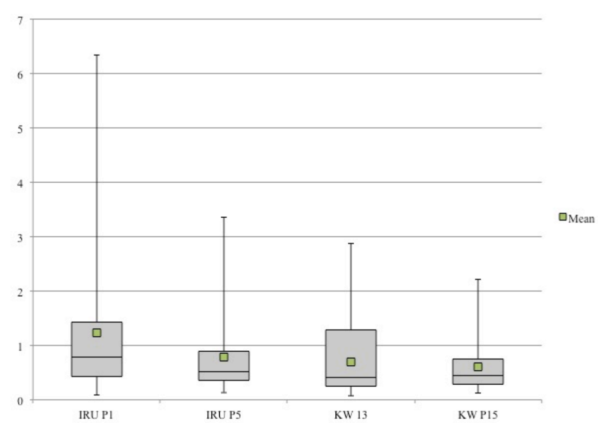

Figure 5.14 Maximum length of fiber voids in Iruhito and Khonkho Wankane large fiber paste

I also measured the length of fiber voids in common fiber-tempered paste from Iruhito (1 and 5) and Khonkho Wankane (13 and 15) (Figure 5.14). Iruhito Paste 1 and Khonkho Wankane Paste 13 were both classified as "large fiber voids" pastes and had similar lengths of fiber voids (ranging from 0.5mm-1.5mm). The mean size of fiber voids in Iruhito Paste 1 was higher than Khonkho Wankane Paste 13. Iruhito Paste 5 (range 0.5mm-0.9mm) and Khonkho Wankane Paste 15 (0.5mm-0.7mm) also had similar results but had smaller fiber voids compared to Iruhito Paste 1 and Khonkho Wankane Paste 13. When it comes to fiber-tempered pastes, potters in Iruhito appear to be using larger fiber inclusions. Overall, potters from these two sites appeared to have processed their fiber inclusions differently, or had access to different types of plant fiber[33].

Paste and Wall Thickness

Wall thickness can affect how a vessel is used (Rice 1987:227). Thicker walls work best for storage vessels because they can keep out moisture, while thinner walls are best for cooking practices because they can heat up fast and increase thermal shock resistance (Rice 1987:227-229). Wall thickness can also be influenced by several factors including form, size and the type of paste used for a vessel (Rice 1987:227). In this section I explore how paste affected wall thickness at Iruhito and Khonkho Wankane. Figures 5.15 and 5.16 show the thickness of five common Iruhito and Khonkho Wankane pastes (coarse, white-speckled, white-transparent, micaceous, and fiber pastes). Mineral tempered vessels in Iruhito had thinner walls (5-7 mm) compared to fiber-tempered vessels (6-9mm). In the Iruhito sample, most of the micaceous and white speckled pastes had a wall thickness of 5mm, 6mm for white speckled paste, 7.5mm for fiber pastes, and 9mm for coarse paste. While in Khonkho Wankane most of the micaceous and white speckled sherds had a thickness of 5mm, and 6mm for white transparent, coarse and fiber tempered pastes. The wall thickness of Khonkho Wankane appears to be fairly consistent between the different paste subgroups. While in the Iruhito sample wall thickness varies depending on paste subgroups, most notably fiber and coarse paste have thicker sherds, which is likely caused by the larger inclusions in these pastes (Figure 5.14; Roddick 2009:188).

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[33] Chavez Mohr (1966:33-34) did work with botanists to identify the different kinds of plant fibers and grasses found in Chiripa pastes, thus future work could include this type of analysis.

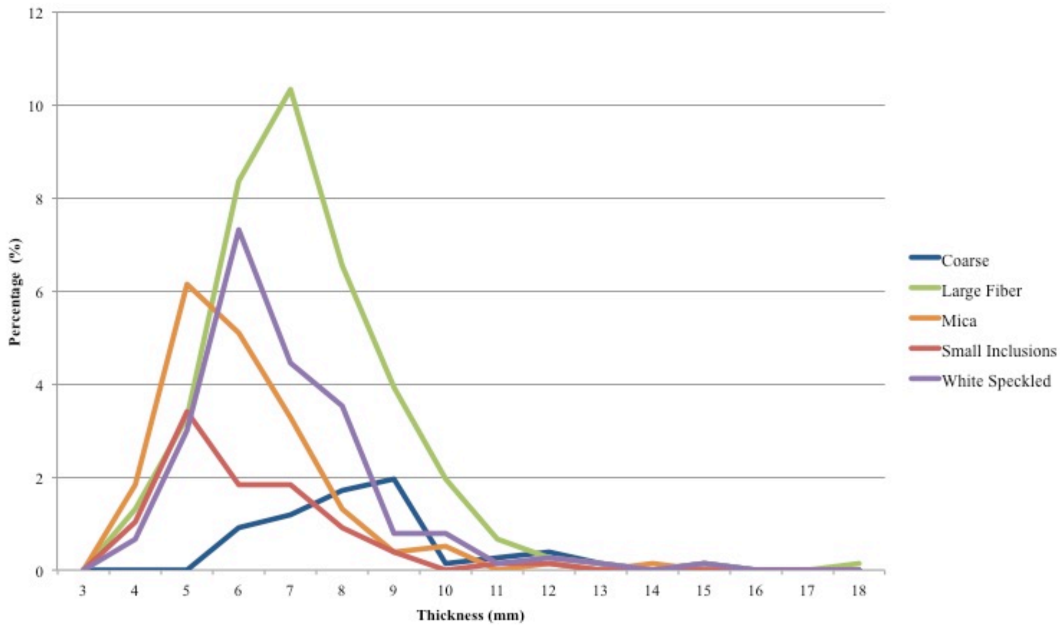

Figure 5.15 Relative percentage of Iruhito pastes by wall thickness (n=786)

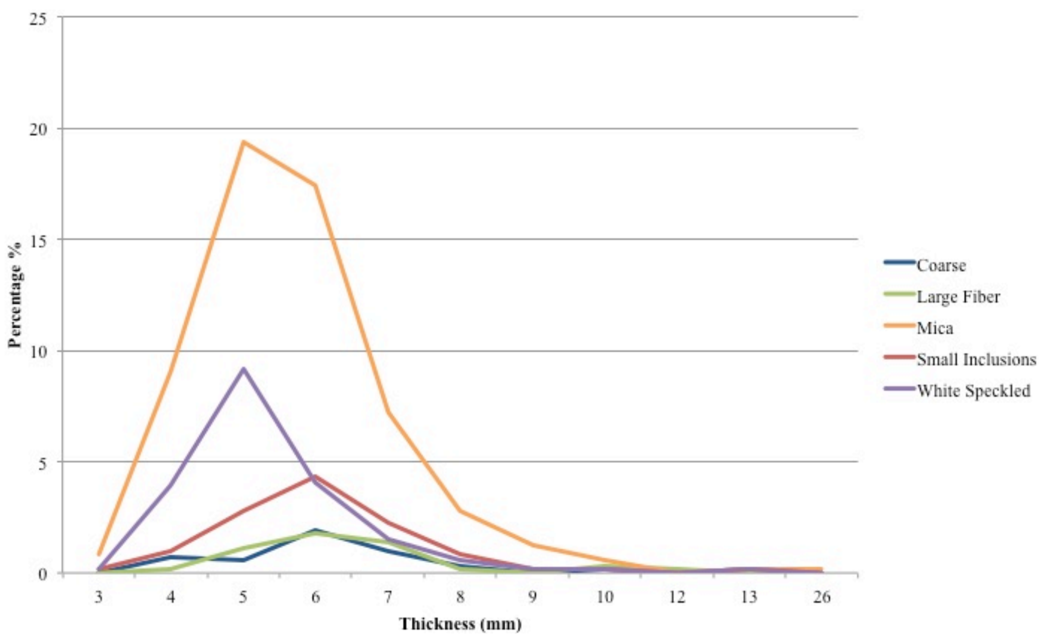

Figure 5.16 Relative percentage of Khonkho Wankane paste according to wall thickness (n=718)

Paste and carbonization

Certain pastes are better suited for cooking practices (Rice 1987:229). To investigate whether particular pastes were used for cooking practices, I analysed soot and carbon deposits on the most common pastes at Iruhito and Khonkho Wankane. Figure 5.17 shows that in the Iruhito sample large fiber pastes had the highest quantity of carbonized sherds, followed by micaceous, white-transparent and white-speckled pastes.

While in Khonkho Wankane (see Figure 5.18) carbonized sherds were predominantly micaceous pastes, followed by white-speckled and white-transparent. At both sites, sherds with buff and dense pastes had very little carbon or sooty residue. Buff and dense pastes are compact and have few inclusions, making them unsuitable for cooking practices. Compact pastes lack pores, which prevent gases from escaping and relieving thermal stress (Rice 1987:230-232). The lack of soot evidence on sherds made with buff and dense paste may due to the fact these pastes were most used to make bowls and other serving vessels. At both Khonkho Wankane and Iruhito, buff and dense pastes were used to make bowls, bases, decorated body sherds, and non-vessel forms, all of which likely not used for cooking practices (see section 5.3.5). Overall it appears that Iruhito and Khonkho Wankane ceramic recipes did follow certain regional trends but also had some differences, which I will revisit in the conclusion of this chapter.

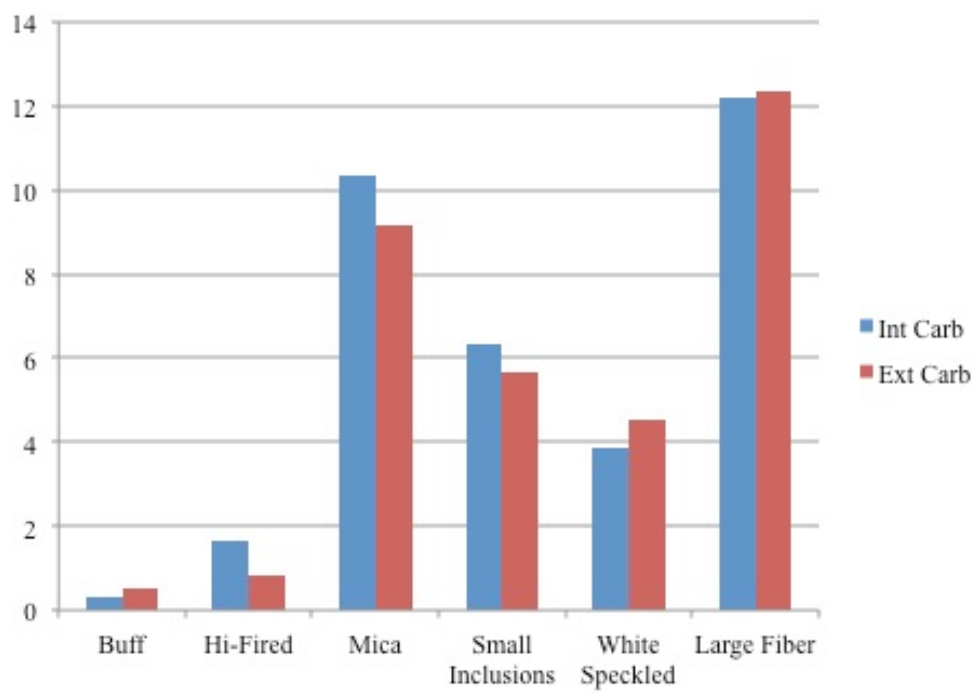

Figure 5.17 Percentage of carbonized sherds based on paste subgroups at Iruhito n=599

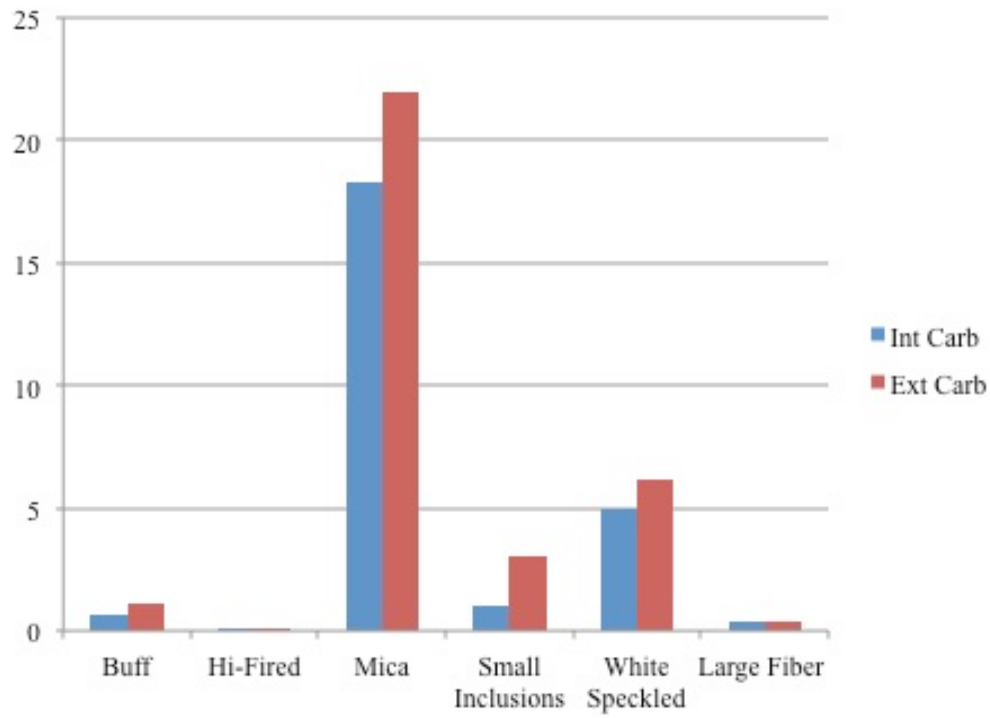

Figure 5.18 Percentage of carbonized sherds based on paste subgroups at Khonkho Wankane

5.3 Forms Across Space and Time

In the following sections I explore if potters from these sites were producing distinct forms while inhabiting distinct taskscapes? Although I compared ceramic forms from both sites, at Iruhito I analyse the temporal variation in ceramic forms, whereas at Khonkho Wankane I focused on the spatial distribution of forms. Most samples I analysed from Iruhito and Khonkho Wankane were body sherds and I could only identify a few forms, thus my analysis of domestic forms at these sites is very limited[34]. To identify vessel forms I measured the orifice diameter of rim sherds using a diameter chart (Orton et al. 2013: Figure 13.2). If a sherd had not enough of the neck/body and was less than 5% of the diameter I could not identify the form. In Table 5.3, I list the counts of the sherd IDs (body, rim, neck, handle, base, polishing tools, spindle whorls or *sahumador*) identified in the Iruhito and Khonkho Wankane samples[35].

Table 5.3 shows that most Iruhito samples were body sherds (89%) and I could only identify the specific form of 43 rim sherds (ollas, jars, and bowls; refer to Figure

[34] For more information on forms from these sites refer Janusek (2003), Pérez-Arias (2013), Marsh (2012a), and Smith (2009)
[35] Sahumador are Tiwanaku period ceremonial incense burners.

5.19-5.22). In other words, I could ascertain form in 5% of the total Iruhito sample. None of the bases (2.3%) I analysed had enough of a wall to reliably identify the vessel form. Most Khonkho Wankane ceramics are body sherds (85.5%). Only 9% of this sample is composed of rim sherds and only 55 rims could be identified to specific forms (6.7% of the total sample). This is common in Formative Period assemblages in the Titicaca Basin, where high fragmentation rates restrict the ability to explore form in the same detail as other attributes (Roddick 2009:17).

Table 5.3 Sherd IDs and types identified in Iruhito and Khonkho Wankane

Iruhito

Sherd ID	Type	Count
Body	Body (698) Decorated Body (1)	699
Rim	Rim (53) Rim and Vertical Handle (1) Rim Loop (3)	57
Neck		2
Handle	Handle (1) Horizontal Handle (1) Vertical Handle (3)	5
Base	Wall near base (1) Flat Base (7) Thickened Edge Base (7) Indented Base (1) Ring Base (2)	18
Polishing Tool		1
Sahumador		1
Spindle Whorl		1
Grand Total		**785**

Khonkho Wankane

Sherd ID	Type	Count
Body	Body (685) Body w/ Repair Hole (2) Decorated Body (15)	702
Rim	Rim (73) Rim w/ Loop (1)	74
Neck	Neck (6) Neck w/ rim (3) Neck curved Body (1)	10
Handle		3
Base	Flat Base (19) Wall near Base (1) Thickened Edge Base (7) Ring Base (2)	29
Polishing Tool		3
Grand Total		**821**

Defining Domestic Vessels Forms in the Southern Titicaca Basin

Domestic pottery, those vessels used for quotidian practices, can be used to store, transform, and transport contents (Rice 1987:208). Depending on attributes such as shape, finish and paste, certain vessels are better suited for certain tasks. For instance, a domestic vessel may be formed differently if the contents held in the vessel are liquid or dry, whether they will be heated, if users will place their hands inside of the vessel, and the duration of use and distance of travel (Rice 1987:208). Janusek (2003:35) suggests that while cooking, storage, serving/ceremonial, and ceremonial vessels were fairly clear in the Tiwanaku phases, such distinctions were more fluid in the Late Formative period. It is difficult to distinguish between cooking and storage because certain vessels could have been used for both practices or the function of vessel may have changed throughout the object's use-life (Janusek 2003:35). Ollas were commonly used for cooking practices but also doubled as storage vessels (Figure 5.19). Types of ollas include short-necked ollas (globular bodies with or without handles and restricted necks measuring less than 2cm) and medium necked ollas (pear-shaped bodies, straight or slightly flared necks measuring 2.1cm to 3.9cm) (Janusek 2003:40-41).

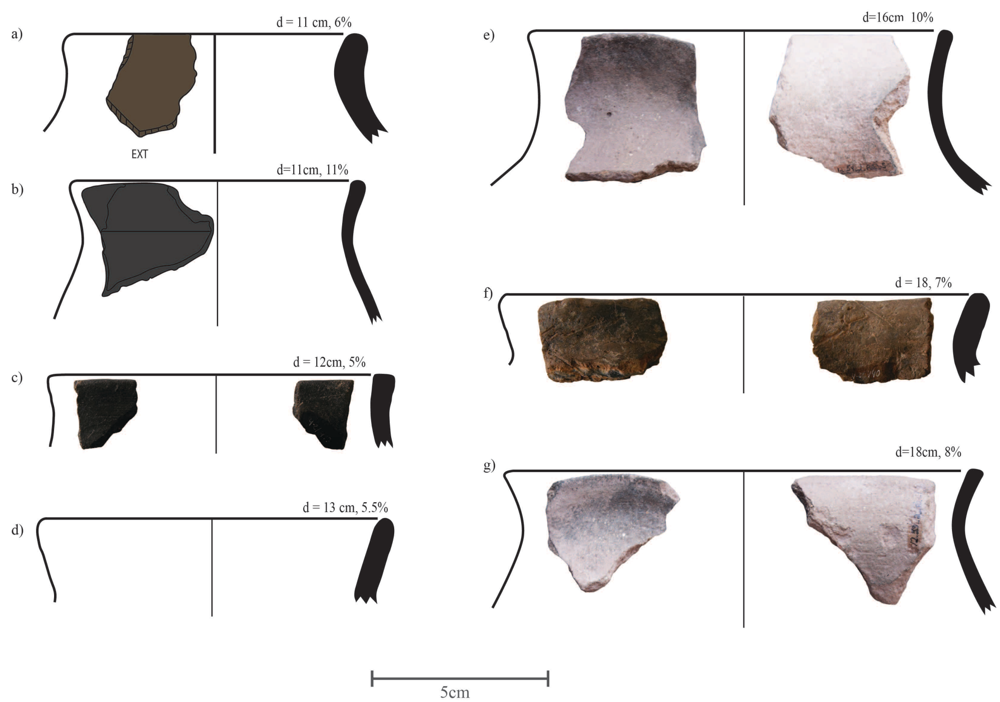

Figure 5.19 Iruhito and Khonkho Wankane Ollas: a) & f) Short slightly flared neck; b), d), e) & g) medium slightly flared neck; c) short straight neck. A, c, d and f, are from Iruhito and b, e and g are from Khonkho Wankane. Note the drawings/photographs are positioned with the exterior on the left and interior on the right. For illustrations of sherds without photos I used a Munsell to RGB conversion chart (WallkillColor 2006) to generated colours.

Jars were primarily used for the storage of liquids and grains (Figure 5.20) (Janusek 2003:57-59). Types of jars include short-necked jars (slightly flared necks measuring between 4-5.9cm and globular bodies) and tall-necked jars (slightly flared necks measuring over 6cm). It was difficult to distinguish between ollas and jars likely because these vessel forms had overlapping functions as cooking and storage vessels due to this I identified some vessels as jars/ollas (Figure 5.21) (Janusek 2003:41).

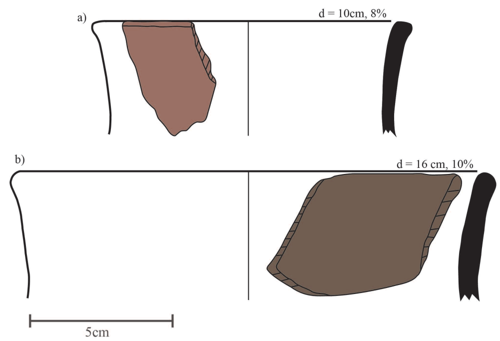

Figure 5.20 Iruhito Jars: a) Medium slightly flared neck and b) Medium straight neck. Both sherds are from Iruhito unit 5-1 level IX. Note the drawings/photographs are positioned with the exterior on the left and interior on the right. I used a Munsell to RGB conversion chart (WallkillColor 2006) to generated colours of sherds.

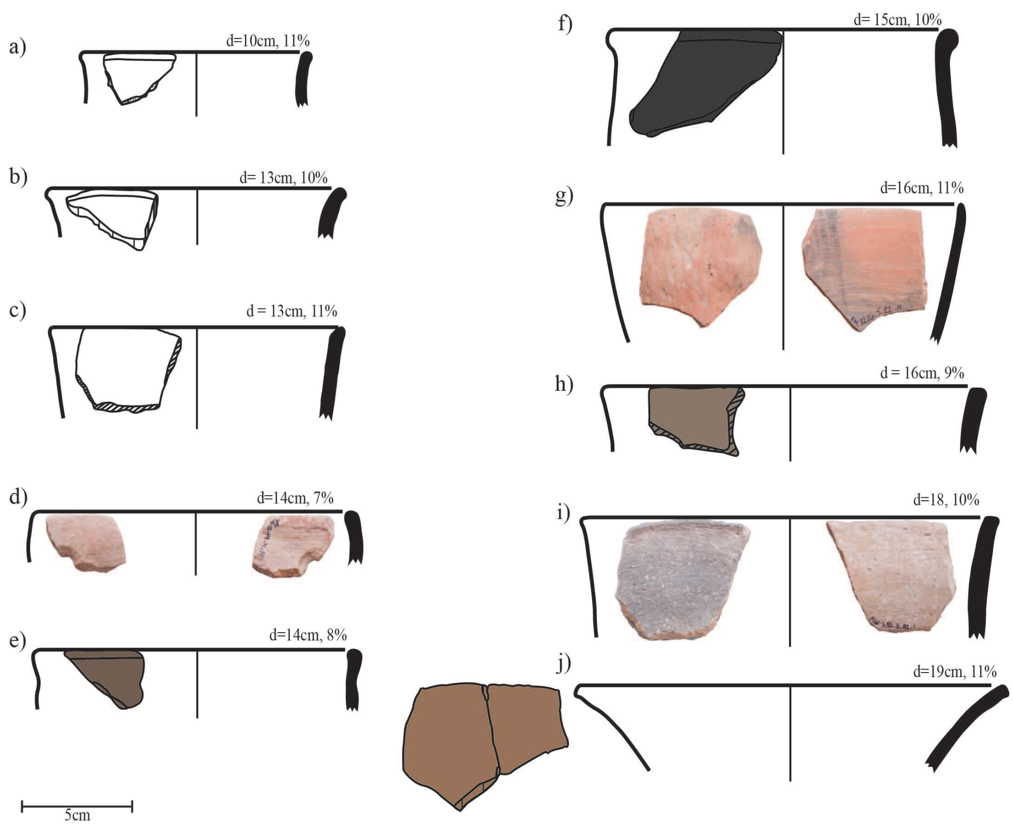

Figure 5.21 Iruhito and Khonkho Wankane Jars/Ollas: a), b), d), e) & j) Medium neck. C), f), g)-i) Medium straight neck. C and e are from Iruhito, a, b, d, f and g are from Khonkho Wankane. Note the drawings/photographs are positioned with the exterior on the left and interior on the right. For illustrations of sherds without photos I used a Munsell to RGB conversion chart (WallkillColor 2006) to generated colours.

Serving and ceremonial vessels are also difficult to distinguish because certain vessels may have been used for both practices (Janusek 2003:35). Serving and ceremonial vessels include bowls and *sahumadores* (Janusek 2003:35,41,70). Bowls in the Titicaca

Basin are highly varied; these vessels have an unrestricted orifice (mouth opening) and can have vertical, flared, carinated or convex walls (Figure 5.22). Janusek (2003:35) defines ceremonial vessels as discrete and used for specifically for ceremonial purposes and not serving (e.g. *keros*[36])(Janusek 2003:35).

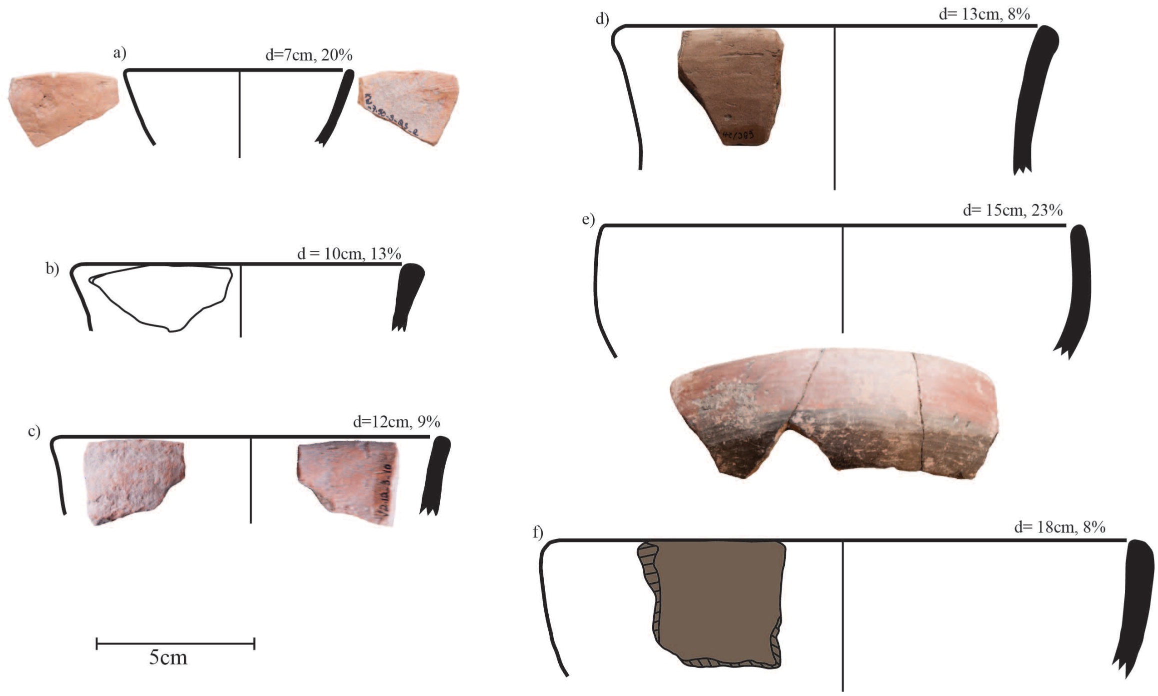

Figure 5.22 Iruhito and Khonkho Wankane bowls: a) & b) slightly flared bowl, c) possible vertical sided bowl, d) & f) vertical sided bowl, e) slightly convex bowl with vertical sides. Note the drawings/photographs are positioned with the exterior on the left and interior on the right. For illustrations of sherds without photos I used a Munsell to RGB conversion chart (WallkillColor 2006) to generated colours.

Iruhito Forms

Although there were few diagnostics, I did identify some forms in the Iruhito assemblage, and several non-vessel forms including spindle whorls (Table 5.3, Figure 5.19-5.22; see Pérez Arias 2013: 45-58 for more). Only eight Middle Formative sherds could be attributed to specific forms; three jar/ollas, three bowls and two ollas. Due to the small sample size, I could not say much on Middle Formative forms but Pérez-Arias (2013:16-17) has conducted ceramic analysis on a larger sample[37] and argues that there is evidence for domestic activities. Specifically he identified jars, ollas, and bowls, which he considered utilitarian and domestic materials, used for cooking.

[36] Keros are Tiwanaku period drinking goblets used to consume fermented drinks (Jaunsek 2003:60).

[37] In total Pérez-Arias (2006) analysed 2363 sherds from Iruhito. A total of 1354 sherds were analysed from unit 4-2 and 1009 sherds from unit 5-1. The exact counts for each level were unavailable.

As it was difficult to distinguish between Late Formative 1 and 2 in Ribera unit 4-2, I decided to combine these two Late Formative periods in my analysis. Here I could distinguish the form for 35 Late Formative sherds, making it the largest sample size of forms from the Iruhito assemblage. Jars/ollas (48%), bowls (26%), ollas (8%), jars (6%), necked vessel (6%), a decorated body sherd (3%), and a spindle whorl (3%) made up this assemblage. Pérez-Arias (2013:53-55) also analysed Late Formative Period ceramics from Iruhito; he identified jars, bowls, and very few ollas. Pérez-Arias (2013:54) found no Late Formative fine wares (Kalasasaya or Qeya-styled ceramics) in Ribera's Late Formative contexts. Overall most Late Formative forms were also cooking/ storage vessels and domestic tools followed by serving vessels.

Figure 5.23 Image of a scalloped sherd from a sahumador, found in Iruhito Montículo 5-1 unit level VI.

I also analysed a small number of Tiwanaku period forms (n=3) at Iruhito. I identified these three sherds as jar/ollas, bowls and a scalloped sherd from a *sahumador* (ceremonial burner; Figure 5.23), a ceramic type found during Tiwanaku phases (Janusek 2003:70). Most of the Tiwanaku sample consists of serving and ceremonial vessels, followed by cooking/storage vessels. Pérez-Arias (2013:56) analysed ceramics from this period and found a number of new forms that were introduced during the Tiwanaku period, including jars, tinajas, ollas, decorated keros, and tazones. Other Tiwanaku-style material found at Iruhito include pedestals, and *chachapumas* which are figurines of kneeling warriors wearing feline mask- a clear representation of Tiwanaku's political influence in Iruhito (Pérez-Arias 2013:28-29). During the Tiwanaku Period, Sector del Montículo was primarily used for ceremonial activity at Iruhito. Before the Tiwanaku period it appears that most ceramics from Iruhito were cooking/storage vessels and few serving vessels.

Khonkho Wankane Forms

Unlike the Iruhito sample, the Khonkho Wankane sample was almost exclusively from the Late Formative Period. Therefore, I analysed the spatial distribution of forms from Sectors 3, 7, 9 and 12 (Figure 5.24) rather than the temporal changes in forms. I could identify the form of 73 sherds from Khonkho Wankane. In Sector 3 I identified the form of only five sherds, and most of these were domestic (two jar/ollas). It appears that Janusek (2005:25) and Ohnstad's (2007) are correct in designating this sector as a Late Formative period residential area. As this is the first detailed ceramic analysis conducted on this sector (and a very small sample at that), more ceramics ought to be analysed for a more robust interpretation.

I identified the form of 12 sherds from the Sector 7 sample. Eight sherds in Sector 7 were jar/ollas followed by three bowls and a polishing tool. The units I selected from Sector 7 "Patio Group" all came from one circular structure, 7.C9 (Marsh 2013:45). Inside of structure 7.C9, also known as the "East Kitchen", Marsh (2012a:345) identified jars, ollas, jar/ollas, and three unusual forms: "a ring base, a gray bowl with a beveled rim, and a wide basin". Smith (2009:287, Table 4.8) also analysed ceramics from structure 7.C9 and identified ollas, jar/olla, and vasijas [38] vessels. Most vessels from within 7.C9, along with the two *batánes*[39], and two hammer stones, are evidence that this area was used for food preparation and cooking (Marsh 2012a:344). Most of the sherds I identified appear to be cooking/storage and serving vessels, which supports the idea that this area was used for food preparation, and cooking. (See section 5.4.2 for discussion of carbon patterns).

I identified 24 forms in Sector 9, including 14 jars/ollas, 6 bowls, 3 decorated body sherds and 1 jar. I selected contexts in Sector 9 from within structure 9.C1, located in a residential area (Marsh 2011: 108; 2012:193; Smith 2011:83; Zovar 2009:373). The PAJAMA team has found large quantities of camelid bones, ground stones, midden and ash deposits (Zovar 2006:127). Both Marsh (2012a:265) and Smith (2009:287) have analysed ceramics from structure 9.C1, and identified jars, ollas, and jar/ollas. Three *batánes* found in this sector may also indicate evidence of food preparation activities

[38] Vasijas (pitchers) are small globular jars with narrow necks, flat bases and single handles. They can be used as simple domestic vessels or elaborately decorated (refer to Janusek 2003:38-40).
[39] A batán is a millstone/grinding stone.

(2012:265). Smith (2009:287) found a large quantity of "specialized" olla sherds with thin walls and less permeable interior surfaces resulting in better cooking vessels for soups and stews (Rice 1987:226-233). Smith believes that an increase in these specialized ollas was in response to an increase in people visiting the site for ceremonial activities (2009:298).

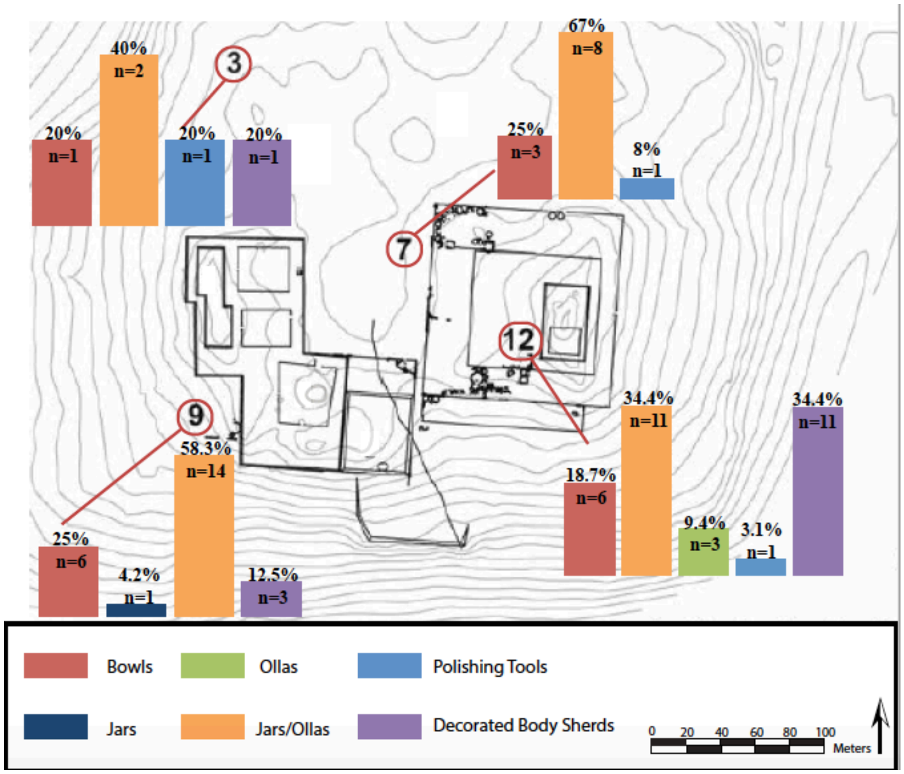

Figure 5.24 Spatial distribution of ceramic forms across Sectors 3, 7, 9 and 12 in Khonkho Wankane (n= 73). (Map modified from Smith 2016)

It is currently unclear how structure 9.C1 was used; Marsh (2012a:266) argues that during the Late Formative period 9.C1 was used for domestic activities such as food preparation, cooking, serving and residence. Smith (2009:286-298) and Zovar (2009:379-381) believe 9.C1 was used for ritual activities and food preparation for feasting. Most forms I identified were cooking/storage and serving vessels (see Figure 5.24), which should seem to suggest that food was being prepared, cooked and served, but I cannot comment on whether ritual and feasts were occurring at 9.C1.

I identified the 32 forms in Sector 12, with 11 jars/ollas, 11 decorated body sherds, 6 bowls, 3 ollas, and 1 polishing tool. No ceramic analysis has been conducted on units from the northern part of Sector 12 (12.12, 12.13, 12.14, 12.16). But Smith (2009) has conducted some ceramic analysis on structures (in the Southern portion of Sector 12) associated with units 12.59 (rectangular structure 12.R1) and 12.67 (square structure 12.S2). Smith (2009:283) identified bowls, jars, jar/ollas, vasijas and a high quantity of ollas in structure 12.R1. Within structure 12.S2, Smith (2009:893) identified jars, ollas, jar/ollas, and vasijas.

The northern part of Sector 12 is thought to have been a domestic residential area based on materials found by the PAJAMA team (e.g. large rocks thought to hold ollas, faunal remains, lithics and carbon) (Gladwell 2006:123). Despite the small number of diagnostic sherds in this Sector 12, I identified cooking/storage vessels, as well as serving and decorated vessels. More analysis should be done to determine the kind of activities occurring in the northern part of sector 12. Overall, ceramics from Sector 12 had the most variability compared to the other sectors I analysed. Jar/ollas were the most frequently occurring forms found in Sectors 3, 7, 9 and 12.

Comparison of Iruhito and Khonkho Wankane Forms

Paste and Form

In the following sections I explore if paste was used differently between Iruhito and Khonkho Wankane. This comparison can indicate whether certain paste types were preferred for specific forms and tasks. The major difference between these two sites is that Iruhito has more fiber-tempered pastes compared to Khonkho Wankane. For example, in the Iruhito sample bases, bowls, jar/ollas, ollas, non-vessels and unknown had some fiber-tempered sherds (18% total), while only bases, jar/ollas and unknown Khonkho Wankane sherds had fiber-tempered sherds (5.5% total). Bowls at Iruhito were made with buff paste (4%), fiber paste (8%) and micaceous paste (1%). In Khonkho Wankane bowls were made with primarily buff pastes (8%), followed by white-speckled (3%) and micaceous paste (1.6%). Jars/ollas were made using fiber-tempered, micaceous, white-transparent and white-speckled pastes at both sites, but Khonkho Wankane jar/ollas were mostly micaceous paste (12%), while Iruhito had an even distribution.

During the Late Formative period ollas had thinner walls, burnished finish and mica-rich pastes (Janusek 2003:52). Micaceous pastes are advantages for cooking vessels because the sheet-like cleavage allows for the mica plates to slip between each other and relief stress during cooking (Roddick 2009:188). Fiber-tempered pastes are also appropriate for cooking, the pores allow gases to escape without cracking the vessel and while the voids allow for crystals to expand, relieving stress (Bronitsky and Hamer 1986; Roddick 2009; Skibo et al. 1989). Thus, potters from these two sites appear to have been using pastes suitable for cooking practices on jar/ollas and ollas. Overall, there does appear to be a difference in which pastes were used for certain forms between the two sites.

Firing Atmosphere

To date no Formative period firing areas have been found in the Southern Titicaca Basin (Roddick 2009:195). Prior to Spanish contact, most parts of the Andes used bonfire open firings making the recovery of such contexts difficult (Roddick 2009:195). I analysed sherds cores to track whether Iruhito and Khonkho Wankane ceramics shared or differed in firing practices. In Figure 5.25, I present the relative percentage of firing atmospheres (oxidized, partly oxidized, reduced and various) based on sherd core colour identified in the Iruhito and Khonkho Wankane samples.

The colour of ceramic cores, specifically the patterning of black, red brown, brown and light brown, can help track the oxidation environment (Rice 1987:333; Shepard 1980:105, 217; Steadman 1995). During firing tasks carbonaceous material burns off and iron is completely oxidized, resulting in a core with a red brown or light brown colour (Rice 1987:335; Shepard 1956:105-107, 219). When a sherd has a red brown middle core and dark brown or black interior, it underwent an incomplete oxidation (Shepard 1980:105-105, 221). Incomplete oxidizations are the result of either a short firing time, low temperature or insufficient oxygen (Roddick 2009:196; Shepard 1980: 103-104). One can determine how the oxidation occurred in partly oxidized cores. For example a sharp contrast between the red brown core and dark interior suggest a brief period of oxidation- perhaps the vessel was removed from a fire and cooling quickly (Shepard 1980:193). Rye (1981:118) suggests that sharp boundaries are only possible in open firing methods, as kiln firings require extended cooling times. A black surface and a black core is an indication of smudging (Obstler 2000; Orton et al. 2013:133; Rice 1987:158,335,345; Rye 1981; Shepard 1980:88,106). Smudging is when a fire is intentional smothered with organic material, prevents oxidization and causes carbon to be deposited on the surface a vessel (Rice 1987:335; Shepard 1980:88). This process may also result in a brown or gray colour if the smothering was brief (Rice 1987: 158, 335, 345; Shepard 1980: 88, 106). Completely black cores may be caused by smudging, incompletely oxidized highly carbonaceous clay, or from use as cooking vessels (Rice 1987:334-335; Shepard 1980:88, 105-106).

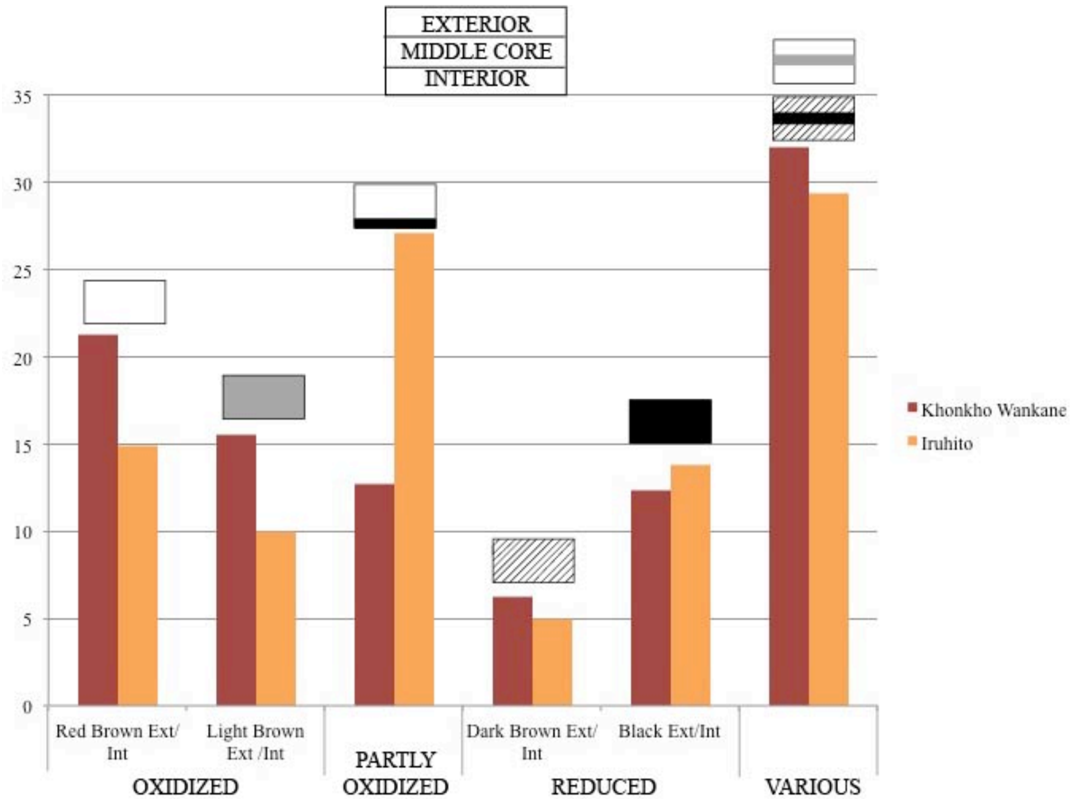

Figure 5.25 Distribution of Iruhito (n=786) and Khonkho Wankane firing cores (n=821).

Oxidized sherds were the most common core colours in the Khonkho Wankane sample 36.8%, while Iruhito had 24% of its sample identified as oxidized. In the Iruhito sample I identified 27.1% of the sample was partly oxidized, while in the Khonkho Wankane sample had 12.7% partly oxidized cores. In both the Khonkho Wankane and Iruhito samples 18% of the sherds were identified with reduced cores. The remainder of the sample was from Khonkho Wankane (32%) and Iruhito (29.3%) had various core colour patterning. Overall, these two samples demonstrate that different firing atmospheres were occurring at Khonkho Wankane and Iruhito. Khonkho Wankane ceramics were fired in oxidized atmospheres, while in Iruhito most vessels were fired in various atmospheres and partly oxidized atmospheres. [40]

Finishing Techniques

I examine ceramic surface finish at both sites to further analyse differences in production practices. Following Steadman's (1995:61-68) surface classification system I identified different combinations of seven finishing techniques, on the interior and exterior surface of all sherds from the Iruhito and Khonkho Wankane samples. Finishing techniques can also indicate the intended use of a vessel (Rice 1987:232). For example, burnished surfaces are best for liquid storage because the smoother surface makes the vessel less porous and impermeable (Rice 1987:231-232). While rougher and uneven surfaces increase the vessel's surface area, making them well suited for cooking and heating over a fire (Herron 1986; Rice 1987: 232).

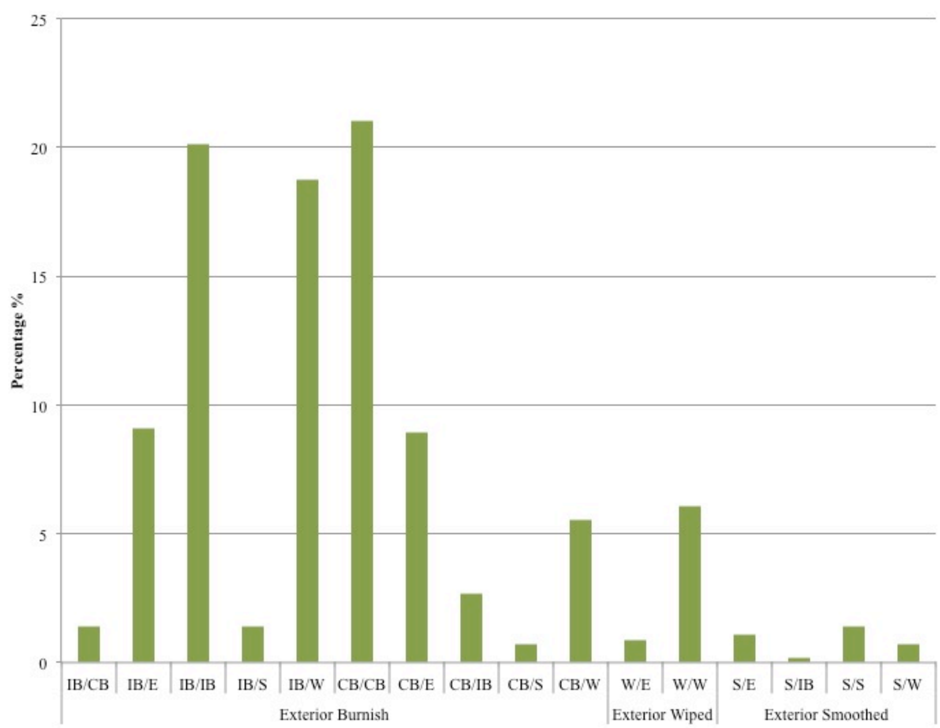

Figure 5.26 The relative percentage of particular finishes used on ceramics from Iruhito (n=561). CB= Complete Burnished, IB=Incomplete Burnished, W=Wiped, S=Smoothed, E=Eroded)

40 Refer to Chapter 6 for a further discussion on these patterns.

Figure 5.26 shows the 16 most common finishing techniques used on ceramics from Iruhito. A potter burnishes a pot using a hard and smooth tool such as pebble to smooth the vessel's firm clay surface (Rice 1987:138). When the entire vessel is worked with a smooth tool, resulting in an even and lustrous surface, I classified it as completely burnished (Rice 1987:138; Rye 1981: 90). If a surface had spaces of 1 to 5mm between brush strokes, I classified it as incompletely burnished (Roddick 2009:194). Combining all exterior-burnishing techniques, 90% of Iruhito sherds had burnished surfaces.

Wiped surfaces are identified when fine ridges are evident on the surface; this is the result of potters using a cloth or their hand to wipe the plastic surface (Rice 1987:150; Steadman 1995: 65). In Figure 5.26, 7% of the Iruhito sherds had wiped exterior surfaces. When a potter rubs the vessel surface with a soft tool (such as cloth or skin) it creates a matte surface classified as smoothed (Rice 1987:138; Shepard 1980: 121, 191; Steadman 1995: 64). There were a small number (3%) of smoothed surfaces in the Iruhito sample. Overall, pottery found in Iruhito primarily had burnished surfaces and the most common combination was complete burnishing on both interior and exterior surfaces (21%).

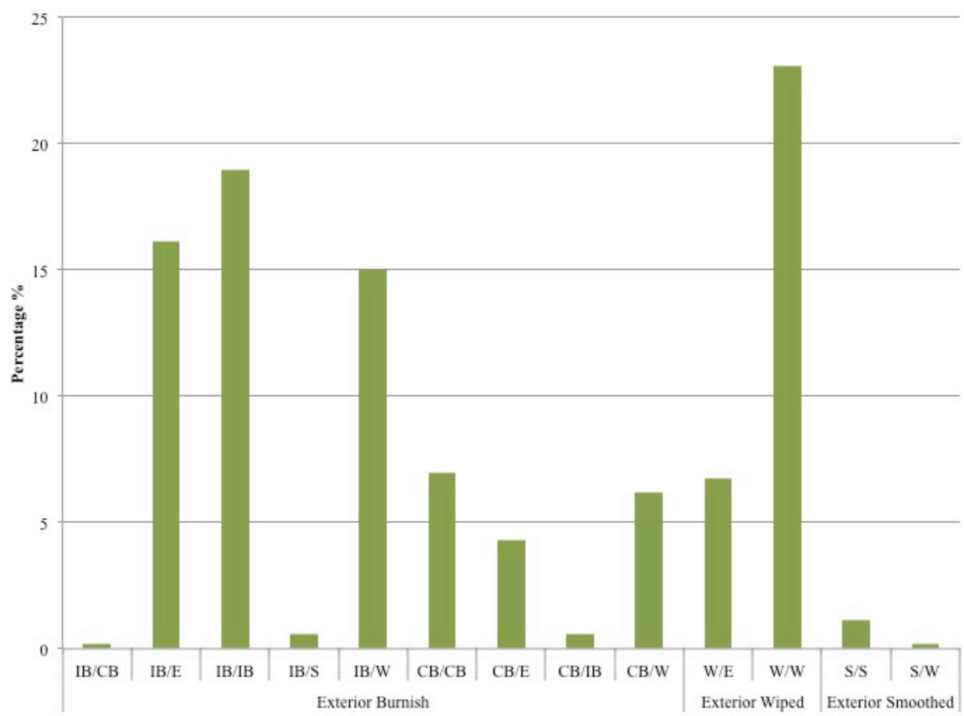

Figure 5.27 The relative percentage of particular finishes used on ceramics from Khonkho Wankane (n=533). CB= Complete Burnished, IB=Incomplete Burnished, W=Wiped, S=Smoothed, E=Eroded)

Figure 5.27 shows the 13 most common finishing techniques used on ceramics from Khonkho Wankane. When all exterior burnished surfaces are combined, the majority (69%) of the Khonkho Wankane sample was burnished. The next most common finishing technique in the Khonkho Wankane sample was wiped surfaces (30%). The most common combination in Khonkho Wankane was wiped interior and exterior surfaces (23%). Finally only 1% of the sample from Khonkho Wankane had smoothed surfaces. Overall, pottery found at Khonkho Wankane appears to have a variety of finishing techniques and the most common were burnished and wiped surfaces.

When it comes to finishing techniques used at Khonkho Wankane and Iruhito the majority of the sherds from both samples had burnished exterior surfaces (69% at Khonkho Wankane and 90% at Iruhito). While Khonkho Wankane sherds had more exterior wiped surfaces (30%) compared to Iruhito sherds (only 7%). Finally samples from both sites had very few exterior smoothed surfaces, only 3% in the Iruhito sample and 1% in the Khonkho Wankane sample. Overall, it appears that there is a difference when it comes to finishing techniques on ceramics from of these sites. Khonkho Wankane sherds had more variety when it comes to finishes, while sherds from Iruhito were mostly burnished.

5.4 Household Tasks and the Use of Vessels

In the following section I address my final question whether people from these sites were using pots in different ways while inhabiting distinct taskscapes? Pottery usage is important to consider because the taskscape is made up of daily tasks and pots were used during those daily tasks.

Ceramicists analyse the traces of carbonization and soot to interpret whether a vessel was used for cooking practices (Rice 1987:235; Skibo 2013:63). I analysed carbonization and soot evidence on sherds from Iruhito and Khonkho Wankane to investigate which site had evidence of cooking and where these cooking tasks were taking place on the site. It is sometimes difficult to distinguish sooting from carbonization. Rice (1987:235) explains that exterior soot deposit is the by-product of fuel combustion. Depending on the temperature and duration of cooking, exterior soot deposits can range from a black powder, to encrustations (which are fuel remains adhering to the cooler surface) and to completely oxidized vessel surfaces (resulting from very high cooking temperatures) (Skibo 2013:91). While carbonization can occur both on the interior and exterior, evidence of interior carbonization is the result of chard food adhering to the surface due to a lack of water (Skibo 2013:85). Entire or large portions of a vessel are necessary to indicate how a vessel was placed over a fire. Since my sample was mostly composed of body sherds I decided to track the presence of interior, exterior and both interior/exterior carbonization and soot deposits on all sherds. I recorded five types of carbonization (powdered, encrustation, scorched, and fire blackened) on all sherds, and in total 384 Iruhito sherds and 413 Khonkho Wankane sherds had evidence of carbonization and soot.

Soot and Carbonization Deposits on Iruhito Sherds

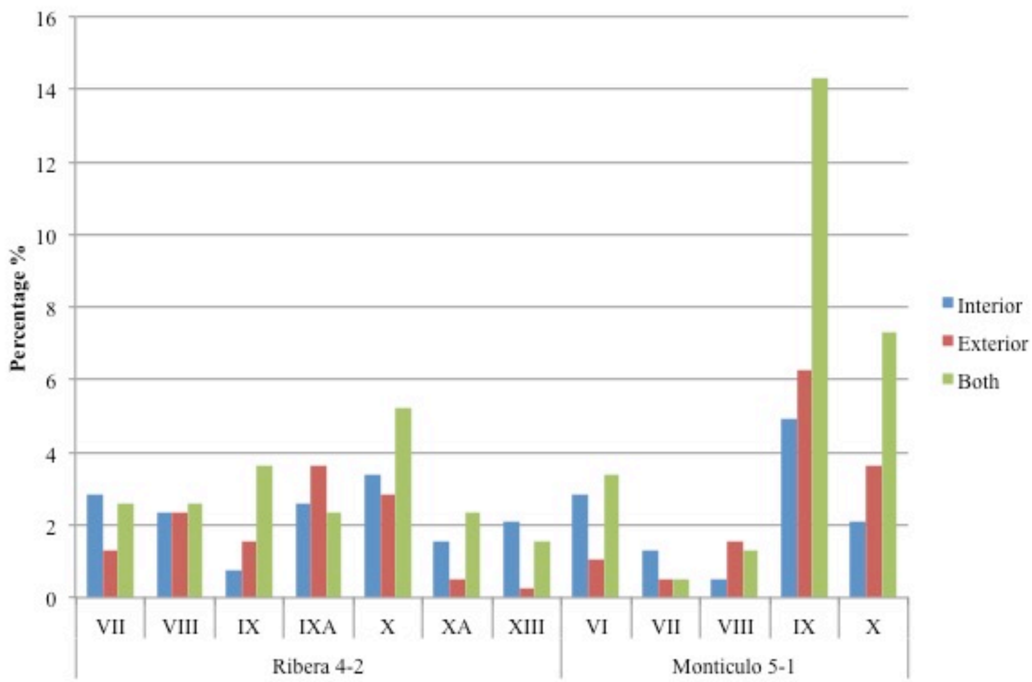

Figure 5.28 Iruhito carbonized and sooted sherds in Ribera and Montículo units (n= 384).

Figure 5.28 shows that level IX in unit 5-1, a Late Formative context, has the highest amount of carbonized sherds in my sample (total interior, exterior, and interior/exterior is 25.5%). Feature IX is a midden 15cm deep and found 121cm below the surface (Pérez-Arias 2007:229). This feature was composed of a dark loose matrix with a "medium amount of artifacts" (Pérez-Arias 2007:229 [translation by author]). Along with Late Formative period ceramics, the PAJAMA team also recovered large quantities of bird bones, fish bones and eggshells in midden IX (Pérez-Arias 2007:229).

These remains and the high quantity of carbonized sherds I identified from levels IX and X may indicate that large amounts of food was processed and cooked during this time period.

The rest of the levels in Iruhito had fairly consistent amounts of carbonized sherds, except for levels VII and VIII in Montículo unit 5-1, which had the lowest amount of carbonized sherds (2% from VII and 3% from VIII). Pérez-Arias (2013) believes that during the Late Formative period domestic activities such as cooking were occurring in the Montículo Sector, while more ceremonial activities were occurring in the Tiwanaku period. My results support Pérez-Arias interpretations of unit 5-1. Overall, the quantity of carbonized sherds in Ribera unit 4-2 was also consistent. Pérez-Arias (2013:16) considers this sector to be primarily used for domestic activities, perhaps cooking practices remained consistent in unit 4-2.

Soot and Carbonization Deposits on Khonkho Wankane Sherds

Figure 5.29, shows that unit 7.50 in Khonkho Wankane had the highest amount (total interior, exterior, and interior/exterior is 19%) of carbonized sherds in this sample. Unit 7.50 is located within structure 7.C9 or the "East Kitchen" and the PAJAMA team recovered ollas, jar/olla, vasijas, grinding stones, and handstones within this structure (Smith 2009:287). Based on this evidence Marsh (2012a) believes this area was used for food preparation and cooking practices. Most of the sherds I analysed from 7.50 appear to be cooking/storage and serving vessels (Figure 5.29). My analysis of pottery form and carbonization from Sector 7 support the idea that this area was used for food preparation and cooking.

In Sector 12, units 12.67 (total 13%), and 12.16 (total 11%) have the highest number of carbonized sherds. The rest of the units were about the same, except for units 12.12 (total 3%) and 12.13 (total 2%), which had the lowest amounts of carbonized sherds. The northern part of Sector 12 is thought to be a domestic residential area. Two circular structures (12.C1 and 12.C2) were found in units 12.13 and 12.14. Attached to structure 12.C2 was a storage annex filled with rich ash, organic material and large rocks perhaps used to support cooking vessels over a fire (Gladwell 2006:119; Smith 2009:116). Also within unit 12.14 were ceramics (8% of sherds had carbon and soot deposits), faunal remains, lithics, carbon, burned soil and limestone were also recovered

(Gladwell 2006:123). Based on the PAJAMA excavations and my analysis of carbonization, cooking practices were taking place in these units but less than in other areas (i.e. unit 7.50).

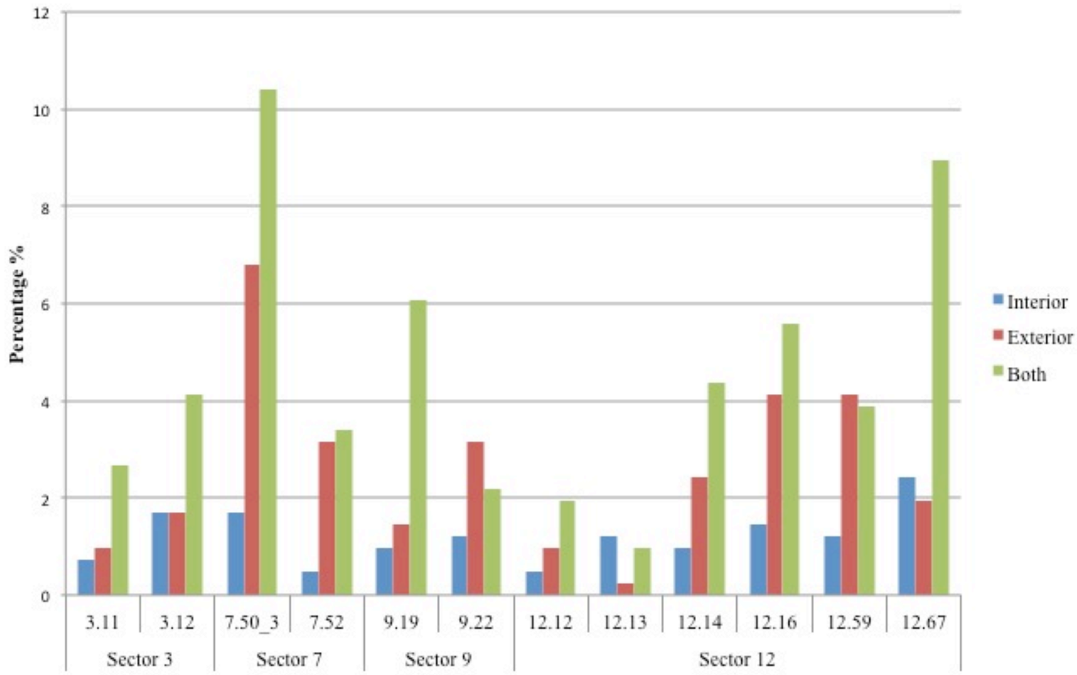

Figure 5.29 Khonkho Wankane carbonized and sooted sherds in Sectors (n=413).

In the southern portion of Sector 12, units 12.59 and 12.67 are located to the east of structure 12.C9 a large circular structure. Smith (2009:283) has identified bowls, jars, and a high quantity of ollas in structures associated with these units. Structure 12.C9 is considered to be a specialized space used to process human bones and coat them with a white chalky clay (Smith and Pérez-Arias 2015:113,118). The PAJAMA team excavated a large hearth west of structure 12.C9, which they believe was not only used for cooking but also as a lime kiln to produce the white coating used on human remains (Smith and Pérez-Arias 2015:113). It seems that the southern part of Sector 12 had more sherds with carbon and soot deposits than the northern portion. Perhaps the higher amount of carbonized sherds is a result of more specialized tasks and cooking practices occurring in the southern portion of Sector 12. While northern units were used for more residential tasks and the cooking practices happening there were not as concentrated and specialized.

Units in Sector 3 had a lower amount of carbonized sherds (4% from unit 3.11 and 7% from unit 3.12). It appears that some cooking practices were happening in Sector

3 but not as much as in Sector 7. This sector is located outside of the principle Wankane Mound and has been interpreted as a permanent and semi-permanent Late Formative period residential area (Janusek 2005:25, 144;Ohnstad 2007). Most forms I identified from this sector were domestic vessels (two jar/ollas; Figure 5.24). Perhaps the smaller number of carbonized sherds may be related to the fact that this sector is located outside of the site's core and potentially occupied semi-permanently; therefore cooking practices were less consistent in this area.

Sector 9 has a higher amount (8% from 9.19 and 7% from 9.22) of carbonized sherds compared to Sector 3 (11% total) but less than Sector 7 (25% total). Sector 9 was located on the Wankane Mound and the PAJAMA team believes cooking and food preparation tasks were happening in this area (Marsh 2011:108, Fig 6, 2012a:193; Smith 2011:83, Fig 9 and 10, 2013:31; Zovar 2009:373, Fig 7). Excavations by the PAJAMA team revealed a large circular structure 9.C1 (within units 9.19 and 9.22), a hearth, large quantities of camelid bones, grinding stones, ollas, jars, bowls, a midden and ash deposits (Marsh 2012a:265; Smith 2013:32; Zovar 2006:127, 130). Marsh (2012a:258) hypothesizes that Sector 9 was a residential area; while other archaeologists (Smith 2009:286-298; Zovar 2009:379-381) have proposed that structure 9.C1 was used for ritual activities and food preparation for feasting (Marsh 2012a:267). Sector 9 has more sherds with carbon and soot deposits compared to Sector 3 but I cannot determine if this is because Sector 9 could have been used for ritual and feasting activity and Sector 3 was not. Or because this sector was located on the Wankane Mound (the site core) and was consistently occupied resulted in more cooking activity than Sector 3. What my analysis does demonstrate is that cooking practices were occurring in Sector 9. Overall, all of the units in the Khonkho Wankane sample had some evidence of carbonized sherds, likely indicating cooking activities in these areas. When it comes to carbon and soot evidence, all contexts from Iruhito and Khonkho Wankane had evidence of cooking practices taking place. This is likely the result of my sampling procedure; my focus was on domestic areas and I intentionally selected contexts with evidence of cooking.

Comparing Iruhito and Khonkho Wankane Pottery Usage

Rim Diameters

In this section I compare rim diameters of vessels from Iruhito and Khonkho Wankane to examine if there was significant difference in orifice size, which could also indicate the size and intended use of a vessel. During attribute analysis I measured the orifice diameter of rim sherds by using a standard diameter-measurement chart (Orton et al. 1993: Figure 13.2). The most important characteristic of the orifice size is the relationship to maximum diameter of the vessel (Rice 1987:212; Shepard 1980:245). If the orifice diameter is equal or greater to the maximum diameter than the vessel has an unrestricted orifice (e.g. bowls) (Rice 1987:212; Shepard 1980:228). Unrestricted vessels are suited for display, drying of contents or tasks that require the use of hands inside the vessels (Shepard 1980:228). If the orifice diameter is less than the maximum diameter, than the vessel has a restricted orifice (e.g. jars and ollas) (Shepard 1980:228; Rice 1987:212). Restricted vessels are suited for retaining contents within the vessel and for storage (Shepard 1980:228). The orifice diameter, maximum diameter and vessel height can indicate the size and function of a vessel (Rice 1987:215; Shepard 1980:238-240). However there are several limitations with these calculations, the first being that enough of the sherd is needed to determine the vessel height and correct orientation of the orifice is essential to accurately determine the shape and orifice size (Rice 1987:223; Shepard 1980: 246). This is especially problematic if the rim sherd is small and asymmetrical which makes the height of vessel difficult to determine. In total I was only able to identify the form and measure the orifice diameter of 23 sherds from Iruhito, and 24 sherds from Khonkho Wankane (Figure 5.19-5.22).

Jar/ollas makes up most of the Late Formative Iruhito and Khonkho Wankane forms (Figure 5.21). The average rim diameter for both Iruhito and Khonkho Wankane jars/ollas is 15.7 cm. It seems that jar/ollas were being produced in similar sizes between the two sites. The average rim diameter for bowls in Iruhito is 11.6cm, but 7cm and 12cm is the most frequently occurring diameter in this group. Khonkho Wankane bowl diameters were on average 13.4 cm and the most frequently occurring diameter is 12cm. Between Iruhito and Khonkho Wankane, Iruhito bowls were smaller in size (11.6cm) while Khonkho Wankane bowls were fairly consistent in size (12 cm) (Figure 5.22). The smallest bowls from both sites were 7cm in diameter. Jars in Iruhito had an average size of 13cm, similar to Iruhito ollas average size of 13.5cm (Figure 5.20). Ollas in Khonkho Wankane had an average rim diameter of 15cm and were larger than the ollas in Iruhito (Figure 5.19). Jar/ollas had similar diameters in both sites, but overall vessels in Khonkho Wankane appear to be slightly larger compared to Iruhito vessels.

5.5 Results and Findings Summary

In this chapter I present some of the results and findings of the paste and ceramic attribute analysis I conducted on Iruhito and Khonkho Wankane samples. In section 5.2, I summarized the composition of the most commonly used pastes. I also analysed the temporal and spatial changes of paste used at Iruhito and Khonkho Wankane. In sections 5.3 and 5.4 I examine the attributes of form, rim diameter, wall thickness, finish, core firing, deposition, and carbonization, to investigate how potters were producing pots and how people were using domestic pottery. These results allow me to address the following three questions:

1) ***Were potters drawing on distinct resources while inhabiting their taskscapes?***

When it comes to paste tempering of sherds from these sites it appears that potters were following regional trends and perhaps sharing potting traditions. A temporal shift occurs from fiber-tempered sherds in the Middle Formative to mineral-tempered sherds in the Late Formative and Tiwanaku periods at Iruhito. Meanwhile, at Khonkho Wankane we see an increase in micaceous paste from the Late Formative 1 to the Late Formative 2 periods. I also analysed spatial distribution of paste at Khonkho Wankane and found that sherds from Sector 7 and 12 had mostly micaceous pastes, Sector 3 had an even distribution between micaceous, white-transparent and white-speckled paste, while the majority of Sector 9 sherds had white-speckled pastes. Overall, Iruhito sherds had a variety of fiber pastes, while Khonkho Wankane sherds were almost exclusively mineral-tempered pastes and specifically micaceous pastes.

After completing my paste analysis I found that image analysis does confirm the paste groups and descriptions I made in the field with the hand lens. Based on the inclusion lengths, I found that there was little difference in size between mica and quartz inclusions; perhaps these inclusions were prepared before they were added to the clay at both sites. Potters in Iruhito appear to be using larger fiber inclusions. It appears that

Iruhito potters used more fiber temper compared to Khonkho Wankane potters, yet grasses were readily available at both sites thus the ecology did not dictate this trend. Perhaps Iruhito potters viewed fiber as appropriate temper material and this difference is a result of these sites distinct taskscapes.

2) Were potters producing distinct forms while inhabiting distinct taskscapes?

Potters from Iruhito and Khonkho Wankane appear to be producing similar domestic forms but differ in production practices. Because I had very little information on ceramic forms from Khonkho Wankane (6.7%) and Iruhito (5%), I could only get a glimpse on how forms changed and were used at these sites. The majority of Middle and Late Formative objects identified in Iruhito were cooking/ storage vessels and domestic tools (jars and olla), which fits with Pérez-Arias (2013) interpretations. During the Tiwanaku period new forms were introduced (*sahumador)* and more serving/ceremonial vessels were identified, likely because the Montículo area was used for ceremonial tasks.

In the Khonkho Wankane sample, jar/ollas were the most frequently occurring forms found in Sectors 3, 7, 9 and 12. The majority of the forms I identified from Sectors 3, 7 and 9 were cooking/storage vessels with few serving vessels. Ceramics from Sector 12 had the most variability in ceramic forms, as well as a high frequency of decorated and serving sherds. Ceramics from these two sites demonstrate different firing atmospheres. It appears that the majority of vessels in Khonkho Wankane were fired in oxidized atmospheres and very few vessels were partly oxidized. While in Iruhito the majority of vessels were fired in various atmospheres and partly oxidized atmospheres. Perhaps potters in Iruhito would remove vessels from fires prior to cooling, had different firing skills, or intentionally wanted partly oxidized vessels.

When it comes to finishing techniques sherds from Khonkho Wankane have a variety of finishes, while sherds from Iruhito were primarily burnished. Burnished and wiped surfaces made up the majority of Khonkho Wankane sample and there were very few smoothed sherds from both of these sites. Wiped surfaces are better suited for cooking vessels because this finish technique increases surface area (Rice 1987: 232). Burnished surfaces are better suited for storage vessels containing liquids because the vessel surface will be less porous and impermeable with this finish (Rice 1987:231-232). Perhaps these findings indicate that the intended uses of Khonkho Wankane vessels were for cooking and storage practices, while the intended use of Iruhito vessels were for storage practices, however this interpretation is limited due to sample size and may not be a representative of these sites.

3) Were people using pots in different ways while inhabiting distinct taskscapes?

There appears to be a correlation between wall thickness and paste type used at Khonkho Wankane and Iruhito. The Iruhito sample had more fiber-temper sherds (55% of the Late Formative sherds) compared to Khonkho Wankane (7%). Because fiber inclusions are larger, the wall thickness will be thicker, while finer mineral inclusions will result in thinner walls (Roddick 2009:188). In the Iruhito sample, fiber-tempered sherds had the most soot evidence. Fiber tempered pastes are suitable for cooking and are readily available at Iruhito, which could be why Iruhito potters fiber-tempered cooking forms. In the Khonkho Wankane sample, the majority of carbonized sherds were made with micaceous pastes. As mentioned above, micaceous pastes are also suitable for cooking practices. Janusek (2003:52) and Smith (2009:287) found that cooking vessels (specifically ollas) were made with micaceous pastes in Khonkho Wankane during the Late Formative.

At the site of Iruhito the highest quantity of carbonized sherds were from levels IX and X in Montículo unit 5-1. Perhaps large amounts of food were processed and cooked in this sector during the Late Formative period. The rest of the levels in Iruhito had fairly consistent amounts of carbonized sherds, except for Tiwanaku levels VII and VIII in Montículo unit 5-1, which had the lowest amount of carbonized sherds. These findings fit with Pérez-Arias (2013) interpretations that during the Late Formative period domestic activities were occurring in the Montículo Sector but more ceremonial activities were occurring during the Tiwanaku period. The quantity of carbonized sherds in unit 4-2 remained fairly consistent also fitting with Pérez-Arias (2013:16) interpretation that this area was used for domestic activities.

In the Khonkho Wankane the largest quantity of carbonized sherds were found in unit 7.50 inside of 7.C9. It appears that much cooking activity was happening in this structure known, as the “Eastern Kitchen”. Sector 7 appears to be an area used for food preparation and cooking. Based on my analysis it seems that southern part of Sector 12 had more carbonized sherds than in the northern units. The southern part of Sector 12 could have been used for more specialized tasks (i.e. processing white clay used to coat human remains) and cooking practices, while northern units were used for more residential tasks and the cooking. Units in Sector 3 had a lower amount of carbonized sherds, likely related to the fact that this sector was outside of the site's core and semi-permanently occupied. My analysis also demonstrates that cooking practices were occurring in Sector 9 but I cannot confidently comment on whether this sector was used for feasting and food preparation or a residential area.

When it comes to vessels used at these sites, Khonkho Wankane had more cooking activity and consistency in paste types (micaceous) and wall thickness. Perhaps Khonkho Wankane had specialized cooking vessels as Smith (2009:287) suggests. While in the Iruhito sample there is more variation, specifically in paste and wall thickness, of domestic forms. In the next chapter I explore these questions further and work towards understanding how different the Iruhito and Khonkho Wankane taskscapes were.

Chapter 6: Discussion and Conclusions

6.1 Thesis Overview

The relationship between people and landscapes is complex and influenced all aspects of past cultures (e.g. social, cultural, political, and economic processes) (Knapp and Ashmore 1999:1). To some degree archaeologists are always considering and studying this relationship (Knapp and Ashmore 1999:1). In this thesis I studied social landscapes to explore how people dwelled in their landscape and how they perceived their landscapes. To date the focus of archaeological projects in the Southern Titicaca Basin have been on larger social-political processes (i.e. the rise of social complexity and the Tiwanaku state) and at larger temporal scales (i.e. understanding the culture history of time periods). But these larger processes would have affected and been maintained through daily tasks. By examining the material remains of these tasks we can observe the manifestation and subtle variation of these larger processes but at a smaller micro-scale (i.e. site level). Potting traditions can reveal bodily movement and the spread of potting knowledge across the region (i.e. the interaction between people and communities) (Roddick and Stahl 2016).

I examined variations in Late Formative Period (200 B.C.- A.D. 500) Upper Desaguadero Valley landscapes through ceramics, exploring how potter's production practices were part of inhabitants' taskscapes, and how inhabitants used pottery in their daily tasks. Similarly, the traces of use on pottery and ceramic pastes provide a glimpse into past taskscapes. I believe my research is important for understanding past cultures in the Upper Desaguadero Valley because the performance of daily tasks involving pottery are affected by the social-political context, ecological/geological features, economic situation and cultural worldviews. I conducted detailed ceramic attribute and paste analysis on pottery from two recently excavated sites, Iruhito and Khonkho Wankane. I expected inhabitants from these two sites to have had very different taskscapes. Scholars believe Iruhito located near the Desaguadero River, was a small fishing community, whereas they believe Khonkho Wankane, located inland near the Quimsachata mountain range, was a ceremonial center. I found that there were certainly were distinct aspects of the production and use of pottery between these sites, they also share a broader tradition.

Another aim of this thesis was to work towards a more systematic paste analysis in the Southern Titicaca Basin (Roddick 2009; Steadman 1995). I created two paste systems and reference collections for the sites of Iruhito and Khonkho Wankane. I also employed a Dino-Lite digital USB microscope to conduct the first detailed paste analysis in the Upper Desaguadero Valley. Using this new tool I confirmed paste identifications I made in the field, conducted semi-quantitative analysis, and took detailed photographs to assist future researchers. This promising method encourages standardization and inter-site comparisons in ceramic analysis. The digital USB microscope is portable, affordable and time efficient, allowing for analysis to be conducted in the field and is suitable for a variety of archaeological materials.

In this last chapter, I contextualize my findings within the broader regional patterns of the Titicaca Basin, ceramic analyses and social landscape studies. I encountered several challenges in developing the taskscape framework, which I summarize here. I then describe the differences in these taskscapes in regards to my three research questions. Ultimately, I argue that my methodology resulted in data useful for understanding the taskscapes of the Late Formative Desaguadero Valley. I briefly discuss the potential of the Dino-Lite microscope for paste analysis, before providing an inter-regional perspective on Late Formative ceramic data. I end by offering some suggestions for future research into taskscapes in the Lake Titicaca Basin.

6.2 Theoretical Implications: Exploring Past Taskscapes

My overarching question asked how ceramics might inform us of the variability in taskscapes in the Desaguadero Valley. There were several challenges I faced in exploring this question:

1. *Cartesian worldview.* Although I worked to move beyond a Cartesian worldview that relies on a firm distinction between nature and culture, I still found myself working within this dichotomy, inadvertently separating ecological landscapes from social landscapes. This is common slip in much archaeological practice. When archaeologists write about their projects they usually separate the “regional ecology” background into its own section isolated from the “culture history” information, much like I do here. The problem is that it is very hard to observe

archaeologically the complexity of a site's taskscape and the interconnectedness and overlapping of tasks through text. The tasks and overall taskscape of a specific site and time period are not isolated; archaeologists cannot feasibly analyse this complex meshwork and are forced to draw boundaries and compartmentalize components of the taskscape.

2. *Environmental determinism.* In exploring my data, I found it difficult to avoid the kind of environmental determinism associated with ceramic ecology (see Chapter 2). Materials for pottery production are accessed from a landscape defined by particular constraints, but certainly such ecological limitations are not the only factor. Potters must have considered both technological qualities and efficiency but also social and political factors (Druc 2013; Gosselain and Livingstone Smith 1998:157-158; Sillar 2000:69). Potters often chose the less readily available materials as the choice of mica-temper over the readily available fiber-temper shows (discussed further below). And when potters did use readily available resources they may have done not simply because they were close and thus it was an efficient choice.
3. *Romanticizing the past.* Another issue I faced when applying a taskscape approach is that I did find myself romanticizing the past (Conneller 2009) and I could have engaged with the political and social context more. I found this challenging because I analysed one task and material in so much detail that the scope and time frame of my project did not allow me to deeply engage with how the political and social life of the potter could affect their tasks. Yet this is an important factor that archaeologists engaging with this concept should consider.

Despite these challenges I was still able to examine a small portion of Iruhito and Khonkho Wankane inhabitants' past taskscapes. I specifically focused on the potter and their daily tasks. By analysing pottery in detail, I could consider some of their daily tasks and begin to sketch some details of these taskscapes. Based on the ecology, inferences made on the social contexts, and my analysis of ceramics I would say the taskscapes of these sites were different in some aspects but potters and other inhabitants did share some traditions and this was evident through ceramics. I demonstrated this difference through my attribute and paste analysis results, which I summarize below.

Forming Pottery and Taskscapes

To address the question of whether potters from these sites had different production practices, I analysed vessel form and core colour, surface finish and wall thickness. Pots were produced and used during daily tasks, thus the taskscape impacted how pottery was made and used. I predicted that if Iruhito and Khonkho Wankane had different taskscapes this would result in different forms and production practices, but if form and production practices were similar, then these potters shared common traditions. My findings show that pots found in Iruhito and Khonkho Wankane were similar in form. Based on my small sample, the majority of both Khonkho Wankane and Iruhito diagnostic sherds I sampled were jars/ollas vessels typically used for cooking and storage practices. Both assemblages had very few decorated or ceremonial forms, although this is likely due to my sampling procedure (i.e. I focused on domestic contexts). Others who have analysed ceramics from these contexts (Marsh 2012a; Pérez-Arias 2013; Smith 2009) have identified a similar set of forms.

Despite Iruhito and Khonkho Wankane potters producing similar forms, they did differ in terms of production practices. My findings indicate that potters in Khonkho were firing vessels in oxidizing environments, while potters in Iruhito appear to be firing vessels in partly oxidized environments. Differences in firing could be the result of firing duration (i.e. potters could be removing vessels at different times), different firing skills, or intentionally created these firing atmospheres. When it comes to finishing techniques Iruhito potters primarily burnished their pottery, while Khonkho Wankane potters burnished and wiped their pottery.

Another attribute that indicated differences in pottery production between Iruhito and Khonkho Wankane potters was wall thickness. It seems that potters from Khonkho Wankane were fairly consistent when forming vessels and produced thinner walls compared to Iruhito potters. This difference in wall thickness may be the result of the potter's skill, the intended use of vessel and type of paste used. Iruhito sherds differ in terms of wall thickness depending on the paste temper; mineral sherds had thinner walls while fiber sherds had thicker walls. Since Khonkho Wankane sherds are almost exclusively made with mineral pastes this likely resulted in thinner and consistent vessel walls, while Iruhito sherds had a higher number of fiber tempered vessels, which resulted in thicker walls.

Potters from Khonkho Wankane and Iruhito were likely producing similar domestic forms but employing slightly different production practices. It appears there were regional traditions in vessel form, and these did not drastically change between sites. Potters likely knew inhabitants of this region and viewed certain forms as appropriate for cooking, storage and serving practices. The slight difference in production practices may be the result of different levels of skill, distinct resources available at these settlements, or personal preferences of the potter. I would argue that differences in production practices indicate that the daily tasks of the potter were slightly different at these sites and would have contributed to or were influenced by the taskscape. My sample of diagnostic sherds was quite small, and certainly further analysis of vessel forms could better address this question.

Pottery Use and Taskscapes

I examined whether people from Iruhito and Khonkho Wankane used pots differently while inhabiting their taskscape. I addressed this question by examining the deposition of pots on the site and carbon residue. The way pots are used is related to daily tasks and thus evidence of use can provide us with information on the taskscape. I expected a difference in domestic pottery usage between Iruhito and Khonkho Wankane, but if usage was similar then similar tasks were likely taking place.

I found that the majority of the carbonized Iruhito sherds were made with fiber-tempered pastes, while the majority of the carbonized Khonkho Wankane sherds were made with micaceous pastes. It appears that Khonkho Wankane potters made cooking vessels with micaceous pastes, thinner walls and wiped or burnished exterior surfaces. This fits with Smith's (2009:404) and Janusek's (2003:52) suggestions that there could have been specialized cooking ollas used in this period at Khonkho Wankane. Smith (2009:404) notes that there was an increase in cooking ollas at Khonkho Wankane perhaps due to an increased emphasis on soups and stews for larger groups of people arriving from other sites via llama caravans. Iruhito potters made cooking vessels with fiber temper, thicker walls and exterior burnished surfaces. Fiber tempered vessels would have been suitable for cooking practices but the burnished finish is well suited for storage vessels. Perhaps these Iruhito vessels were used for multiple purposes, including cooking and storage practices.

I was able to observe a temporal change in pottery use at Iruhito. It appears that Late Formative levels in the Montículo unit (5-1) had the highest quantity of carbonized sherds. During the Tiwanaku period, this number decreases. This corresponds to Pérez-Arias (2013:65) interpretations of this unit that during the Late Formative period the Montículo Sector was used for domestic activity and later used for ceremonial practices during the Tiwanaku period. In the Ribera unit (4-2) the quantity of carbonized sherds remain consistent from the Middle Formative to the Late Formative period and corresponds with Pérez-Arias (2013:65) work that the Ribera unit was used for domestic practices.

At Khonkho Wankane I was able to examine spatial changes in vessel deposition and use. I found that Sector 3 had the smallest number of carbonized sherds, perhaps indicating that very little cooking was happening here. Janusek (2005:144) and Ohnstad (2007) have described this sector as a permanent/semi-permanent residential area and in later periods used as a burial area. Perhaps the small number of carbonized sheds is related to the fact that this sector was occupied inconsistently and located on the periphery of the site. This analysis was small in number, and more analysis in needed to understand tasks taking place in this sector.

Sector 7 had the largest number of carbonized sherds, which may indicate a concentration of cooking practices occurring in this sector. Both Marsh (2012a) and Smith (2009) have suggested that the Patio Group in Sector 7 was used for food preparation and consumption. According to Smith (2009:401), ceramics from the Patio Group during the Late Formative 1 period indicate that food consumption was an important part of rituals at Khonkho Wankane and was emphasized in this area. Smith (2009:401) believes that these rituals were organized at a community level rather than a family level. My findings appear to support observations made by Marsh (2012a) and Smith (2009) that Sector 7 was an area where food was processed and cooked in large quantities.

Sector 9 had less carbonized sherds compared to Sector 7 but more than Sector 3. Currently it is unclear which tasks took place in Sector 9. Marsh (2012a:266) believes that Sector 9 was a residential area, while Smith (2009:286-298) and Zovar (2009:379-381) believe Sector 9 was used to prepare food for ritual feasting. I would agree that food was prepared and cooked in this sector but further research would have to be conducted to determine if this was the result of residential activity or ritual feasting preparation.

The southern part of Sector 12 had more sherds with carbon deposits compared to the northern part. This ceramic evidence, along with 900 human remains (some coated with white plaster) suggest that this area could have been used for both cooking practices and specialized processing of human remains and plaster (i.e. ritual activity) (Smith and Perez-Arias 2015). Gladwell (2006:123) has interpreted the northern part of Sector 12 as a residential area according to other archaeological material (i.e. rocks to support vessels over a fire, lithics and faunal remains). My analysis of carbonized sherds agrees with this interpretation.

Paste and Taskscapes

To address whether potters from Iruhito and Khonkho Wankane were drawing from distinct resources, I conducted detailed analysis on ceramic pastes, which was my primary focus and my strongest dataset. As shown in Chapter 2, paste recipes can help us identify which materials potters used in the past, but also reveal much about their taskscapes. These raw materials come from the surrounding landscape and were selected by potters likely based on their traditions, social and political context, available resources and particular movement through the landscape (Gosselain and Livingstone Smith 1998:157-158). The procurement of raw materials would have been a daily task interconnected with other tasks (i.e. fishing, herding, and rituals). I predicted that there likely would be a difference between Iruhito and Khonkho Wankane paste recipes. My results confirm this hypothesis.

The most noticeable difference was that Khonkho Wankane potters used almost exclusively mineral-temper, specifically micaceous materials, in their pottery. While Iruhito potters used both fiber and mineral tempered pastes, they preferred fiber-tempered pastes. My results fit with Pérez-Arias' (2013:50-51) previous work analyzing Iruhito pottery, where he identified a large quantity of fiber-tempered sherds. My findings from Khonkho Wankane fit with Janusek's (2003:52) observations that during the Late Formative 1 to 2 more micaceous-tempered, thin-walled ollas were produced, and with

Smith's (2009:287) work who also found this trend during his analysis of Khonkho Wankane ceramics. This temporal pattern in paste tempering is useful because taskscapes are not just influenced by the social landscape but also regional and temporal changes in technology and this finding demonstrates this. In short, potters likely were moving through the landscape differently in the later phases.

Iruhito potters may have used more plant fiber in early tempering practices because plants such as grasses (i.e. aquatic resource found near the Lake Titicaca and the Desaguadero River) were readily available. The river and its resources would have been part of the Iruhito potter's taskscape. Khonkho Wankane potters also had access to readily available fiber material (i.e. grasses) yet there were very few fiber-tempered sherds in this sample. Instead Khonkho Wankane potters used mineral resources (specifically sandstone and quartz) from in the Quimsachata Mountain range. It seems that Khonkho Wankane potters viewed certain sand and mineral outcrops located on the Quimsachata Mountain range as appropriate sources for paste tempering despite having access to plant fiber. Smith (2009:402) believes that the Quimsachata could have been viewed as place of origin for people, camelid and crops, and part of rituals to honour ancestors. There is also evidence that the people from Khonkho Wankane relied on pastoralism. Perhaps pastoralists would take their camelid herds to the Quimsachata range to graze, thus this range would have been an important part of the taskscape and related to several tasks. Whether Khonkho Wankane potters utilized local materials available in the hills could be determined with future petrographic analysis (Roddick 2014; Rivas-Tello and Roddick 2016) and analysis of raw materials collected by Arik Ohnstad and currently housed in the Laboratory for the Interdisciplinary Research of Archaeological Ceramics (LIRAC) at McMaster University.

Although Iruhito potters and Khonkho Wankane potters used different quantities of fiber and mineral tempers, they were still creating similar kinds of pastes. For example, I identified highly micaceous, white-speckled, white-transparent, coarse and buff pastes at both sites. Temporal changes in paste tempering at Iruhito and Khonkho Wankane appear to follow regional trends, specifically the shift from fiber tempering to mineral tempering between the Middle Formative to the Late Formative and the increase of micaceous paste in the Late Formative 2 period (Bandy 2001:173; Janusek 2003:51;

Lemuz Aguirre 2001:159). My research demonstrates that when it comes to their recipes, potters from Iruhito and Khonkho Wankane shared some traditions and regional potting practices but differed in terms of their day-to-day activity (i.e. taskscape) and views on appropriate specific quarries and outcrops. My analysis of paste using the Dino-Lite microscope allowed me to trace these patterns in pastes without conducting petrographic analysis.

6.3 Contributions to Ceramic Paste Analysis

As discussed in Chapter 4, archaeologists working in the Southern Titicaca Basin have used ceramic paste as a marker for shifts in pottery production across space and time (Roddick 2009:185). Despite archaeologists recognizing the benefit of this ceramic attribute, paste analysis in this region has remained subjective, descriptive and inconsistent. This project builds on the work done by Steadman (1995) and Roddick (2009) to create a more systematic way of identifying pastes in the field. This system only examines attributes related to the creation of pastes (clay, inclusions and voids), including inclusion size, shape, grain abundance, texture and compactness. This system does not consider core colour because this attribute is affected more by firing processing and thus core colour is not a reliable marker for identifying pastes (Roddick 2009:223).

Currently projects that examine paste in the Southern Titicaca Basin have their own system to analyse pastes, which makes inter-site and inter-regional comparisons difficult. Similar pastes from two sites might be described very differently. By applying Steadman's (1995) method and creating paste reference collections, pastes across the region can become more comparable and easily identifiable. My project was the first to conduct detailed paste and ceramic attribute analysis on pottery from Iruhito and Khonkho Wankane. As a result, I created detailed paste descriptions and paste reference collections for both sites. This means that paste identification at these sites and others in the Upper Desaguadero Valley can be more systematic and comparable which allows further investigations on regional pottery production, social interactions, economy, and broader ecological and social landscapes.

Despite Steadman's (1995) standardized system for identifying pastes in the Southern Titicaca Basin, paste identification in the field can still be problematic. This is where the Dino-Lite USB portable microscope and the method I created can contribute to not only the Southern Titicaca Basin but also to archaeological ceramic analysis in general. As discussed in Chapter 4, the Dino-Lite microscope can be used to systematically analyse and quantify grain abundance, inclusion size and shape used in a paste, which allows archaeologists to identify patterns between different pastes. Together with the paste descriptions, paste box and USB microscope photos, paste analysis can not only become easier but also more comparable. This means that future researchers, who are not trained by the creator of a site's paste system, do not have to rely on vague written descriptions but can also use the paste reference collection and microscope photos as a visual aid.

These detailed Dino-Lite photos also allow for more semi-quantitative analysis via image analysis software (e.g. JMicroVision and ImageJ-see Appendix B). The photos can be used for detailed analysis of paste composition, which is especially beneficial for projects that cannot conduct petrographic analysis. I used these photos to confirm paste groups made in the field and I was able to correct descriptions and regroup pastes more accurately. For example in the field I identified two moderately micaceous paste types (20 and 21) but once I analysed the images in the lab I found that these pastes were almost identical in composition and thus should be considered a single paste type. This tool could also be used to sample sherds for further analysis, including petrographic analysis. Petrographic analysis for pottery in this region requires that sherds be exported and thin sectioned (via destructive methods). It is also very costly, takes time and a level of experience, thus projects select a small number of sherds for further analysis. The Dino-Lite microscope and my procedure allows for projects to be make informed decisions when selecting sherds to analyse petrographically.

There are some challenges using this tool. Inclusions are tridimensional objects and when you cross-section a sherd, you can only see part of the inclusion (Druc 2015:18). Therefore, my "maximum length" of inclusions may not be exact. I also found it challenging to accurately identify inclusion types. For example depending on how light reflects off mica inclusions it can appear as black (i.e. biotite) or white/gold (i.e. muscovite) therefore I could only identify these inclusions as general micas. I found that fiber voids, quartz, feldspars, plagioclase, were relatively easily identified but rock inclusions could rarely be identified and only categorized as general rock inclusion. There were certain paste types/characteristics that work best with this approach. It was easier to identify pastes with fewer inclusions, larger inclusions (i.e. chunky/coarse pastes), homogenous pastes, fine pastes (i.e. buff), and large-fiber void pastes. It was more challenging to analyse pastes with smaller inclusions, a high density of inclusions, and heterogeneous pastes. The USB microscope cannot be used to address some questions of provenience and key inclusions (regionally specific metamorphic rock, volcanic rocks, and pumice) cannot be observed using this tool (Rivas-Tello and Roddick 2016). To date some petrographic analysis has been conducted on small samples from Iruhito but none on Khonkho Wankane samples (Rivas-Tello and Roddick 2016). Thus further petrographic analysis would have to be conducted in the future to determine the provenience of raw materials.

This sample preparation was less destructive and more time efficient compared to petrographic analysis. However, the uneven surface from fresh break did provide challenges, the major problem was that these photos were harder to focus which decreases the amount of inclusions that can be confidently identify. While the Dino-Lite software (*DinoCapture 2.0*) offers Extended Depth of Field (EDOF), this step precludes measurement of inclusions. We conducted a small case study to compare the analysis of thin-sectioned sherds with the USB microscope and a polarized light microscope. Overall, we found that you can identify the same type of inclusions and shape with the USB microscope on both the fresh break sherds and diamond-sawed sherds. Researchers do not necessarily have to thin-section sherds to better analysis paste using the USB microscope but similar results can be obtained with fresh break sherds (Rivas-Tello and Roddick 2016).

During my analysis I considered using the digital image analysis software *ImageJ* (http://imagej.net/) to analyse images of the pastes (Appendix B). This program automatically measures inclusion size, shape, distribution, area percentage, length, and distance between inclusions. Other projects have conducted textural analysis on images of ceramic thin sections, using *ImageJ* (Cropley 2014; De La Fuente and Vera 2015;

Reedy 2006) but none have done so on sherds with fresh breaks. I also created a protocol for analysing sherds with fresh breaks using *ImageJ* but ultimately could not find a way to incorporate it into this study. Still this program seems promising and could make the analysis of inclusions quick and more reliable.

Roddick and I have begun creating a sharable database of ceramic pastes found in the Southern Titicaca Basin. Using the *FileMaker* program, we will upload the paste descriptions (macroscopic and petrographic), USB photos, petrography photos, and other general information (e.g. common vessels with this paste, time period and area used). This will be a valuable teaching aid and create more standardization, but it will also promote inter-site and inter-regional comparisons of ceramic paste. With this *FileMaker* database researchers can compare pastes and note temporal and spatial changes in the paste recipe, which could indicate shared traditions between potters across the region. These studies could address questions on pottery production, social interactions, trade, economy, and social landscapes of the past. Databases such as the one Roddick and I are creating for the Southern Titicaca Basin, can be created and applied to globally for any archaeological project that recovers pottery. Future researchers could also create similar databases for other archaeological materials (e.g. lithics, bone tools, metals objects, jewelry, textiles and bones), thus these tools (the FileMaker database and Dino-Lite microscope) are very applicable to the entire discipline of archaeology. Despite some problems, this method is still promising for future ceramic analysis encouraging standardization and inter-site comparisons, and ultimately providing insights into past social landscapes.

6.4 Inter-Regional Comparison

Roddick (2009) also conducted detailed ceramic attribute and paste analysis on Late Formative samples from the Southern Titicaca Basin, specifically the Taraco Peninsula (Figure 1.1). I will briefly examine the similarities and differences between my data and this comparative dataset from a different region. Roddick notes that Middle Formative potters in the Taraco Peninsula used fiber and sand temper while in the Late Formative potters focused on sand temper (primarily micaceous sands), which again was similar to tempering shifts in the Upper Desaguadero Valley. Roddick (2009:382) found Late Formative pottery production in the Taraco Peninsula was also embedded with other daily activities occurring in the taskscape. TAP excavations reveal that ceramic production tools were also associated with other tasks (i.e. stone hoes and bone scrapers) (Roddick 2009:382, 2013:298). This argument also fits with my observations on the Upper Desaguadero Valley, that pottery production was interconnected with other daily tasks (i.e. herding, fishing and ceremonies).

When it comes to form and production, Roddick (2009:382) found that Late Formative Taraco forms included jars, ollas and bowls, some decorated with red bands or incision and undecorated sherds with burnished exteriors and wiped interiors. These vessel forms and finishes are similar to those I observed from Iruhito and Khonkho Wankane pottery. Taraco vessels were fired in the oxidizing and partly oxidizing atmospheres of burning dung (Roddick 2009:382-383). The majority of firing cores in the Upper Desaguadero Valley are also oxidized and partly oxidized, suggesting a similar firing regime between these regions. Roddick suggest that vessels such as ollas and bowls could have been used for both group consumption and domestic activity. In other words, the same vessel could be used for multiple tasks perhaps similar to how Iruhito potters may have been using domestic pots. There appears to be little variation in ceramic attributes between Taraco sites and the consistency of "learned bodily practices" and paste preparation is likely evidence of "skilled" potters at these sites (Roddick 2009:383). These potters were not involved in large-scale production, but were skilled craftspeople nevertheless (Roddick 2009:382). I would agree with Roddick's argument that Late Formative potters in the Southern Titicaca Basin were skilled craftspeople. It seems that potters from the Upper Desaguadero Valley and Taraco Peninsula were likely interacting and sharing potting traditions[41]. Perhaps there was a regional Southern Titicaca way of potting during the Late Formative, with some variations of production between sites and depending on their taskscapes.

6.5 Future Directions

Based on my findings and the findings of others in the region I am able to describe a small portion of Late Formative Iruhito and Khonkho Wankane taskscapes. Since I was

[41] I draw from Roddick and Hastorf (2010:157-159) definition of tradition as "active and socially embedded" practices. Thus by shared potting tradition I mean referring to both the discursive and non-discursive sharing of potting practices.

limited by data and the scope of this project I end here by providing my recommendations for further research.

Potters working in or near Iruhito would have been involved in several daily tasks and the Desaguadero River would have been a key aspect of their taskscape. No evidence of pottery workshops have been found at Iruhito or other Late Formative sites in the Southern Titicaca Basin (Lemuz 2001; Stanish et al. 1997; Stanish and Steadman 1994; Steadman 1995). I therefore cannot confirm where, exactly, at Iruhito or Khonkho Wankane pottery was produced. I suggest future researchers re-examine materials from these sites for potential tools used in potter production. Iruhito potters may have participated in fishing activities (perhaps identifying as potters/fishers) or have interacted with fishers. To confirm this idea, tools used for both fishing and pottery practices would have to be identified similar to Moore's (2013:15) work on identifying shared tools between potting and food production practices in Late Formative period contexts in the Taraco Peninsula. Moore (2013:15) found that mandible bone scrapers were used for both ceramic production and food preparation as well as signalling the presence of herding activities. Moore (2013:15) argues a "tightly bound cycle" of food and animal production, resource procurement, and craft production, is represented by the use bone tools, and thus the analysis of both materials could reveal much about taskscapes.

Entangled within fishing and other riverside tasks (e.g. harvesting totora reeds to build houses and boats, hunting aquatic birds, and collecting water) would have meant that the potter's day-to-day life included the river and its resources. Roddick (2013:303-304) argues that researchers working in the Southern Titicaca Basin and interested in taskscapes should consider the rhythms of the Lake Titicaca, which also affected the rhythm of the Desaguadero River. He explains that daily rhythms were likely impacted by the Lake Titicaca (Roddick 2013:293). Due to the scope of my project I only minimally engaged with the rhythms of the Desaguadero River and the affect on past Iruhito potters. These rhythms may have affected past people in similar ways to how contemporary inhabitants of Iruhito are affected who "follow the water" during periods of low water levels (Smith personal communication 2016). Future research into Southern Titicaca Basin taskscapes might explore more research into lake and river levels (Erickson 1999). We do have evidence of Late Formative period diet and consumption from Iruhito. In her isotope analysis of two adult individuals from Iruhito, Berryman (2010:215-217) found maize was a major component of the local diet. Maize was being imported from the lowlands in the Late Formative period and Iruhito mazie might have arrived from other river communities Berryman (2010:216). Thus the river was also an avenue for trade and interactions with other communities, which of course was part of the taskscape.

Based on my paste analysis it is possible that materials such as plant materials (i.e. grasses) and in later periods sands, could have been coming from near the river, and that Iruhito potters viewed river resources as suitable for potting material. To process and shape the clay into a familiar form (recognizable across the Southern Titicaca Basin) potters, much like contemporary potters in the town of Tiwanaku (Roddick personal communication 2016), would have used the Desaguadero River for raw materials, including clays, tempers, and water.

Iruhito potters would have considered the needs of others in the community (e.g. cooks, fishers and leaders) when forming these vessels into a pot suitable for multiple daily activities (likely jars/ollas based on my findings). Once the vessel was formed and left to dry the potter may have used a stone/pebble (perhaps collected from the river edge) to burnish vessels. Based my results and Roddick's findings (2009:382), such finishing practices might have been shared by others in the region. Future researchers could further confirm this potting task by revisiting the archaeological assemblage from Iruhito and looking for smoothed tools or polished pebbles.

After making several vessels the potter would have gathered the pots and fired them. Perhaps the potter used camelid dung to create an open-pit fire; camelid remains have been found at Iruhito (Pérez-Arias 2013:32) and dung was likely used at other Formative sites (Roddick 2009). This fire may have burned overnight with the potter keeping a close eye on the vessels and after a suitable amount of time pulled out each vessel. The potter would have distributed the vessels to other inhabitants based on social relations (e.g. family relations or social status) and economical needs. These vessels would have been used for a variety of activities, each time leaving a trace of their use on the vessel, until finally the vessel had outlived its use-life and was disposed of or repurposed. Isotopic analysis has been conducted on Middle Formative and Late

Formative materials found within ceramics from the Taraco Peninsula (Miller 2005; Miller et al. 2008 as cited in Roddick and Hastorf 2010:168). It appears that diet remained consistent throughout the Formative periods in the Taraco Peninsula, evidence of cooking maize were found and high amounts of camelid consumption was occurring in ceremonial contexts (Miller 2005 as cited Roddick Hastorf 2010:168). Analysis such as these could be conducted on Iruhito samples to determine which resources were being cooked in ceramic vessels.

The taskscape for potters working in or near Khonkho Wankane would have looked differently compared to Iruhito potters. The day-to-day lives of Khonkho Wankane potters would have involved the Quimsachata mountain range, pastoralism and specialized activities. Due to the high quantity of camelid remains found in Khonkho Wankane, the PAJAMA has interpreted pastoralism as a principle resource for this site (Janusek 2004b: 271; Smith 2009:417). Potters entangled within herding practices (perhaps identifying as potters/herders) would have meant that the potter's daily life included their surrounding landscape and its resources as well as the rhythms of pastoralism and llama caravans arriving to the site. The paste analysis I conducted revealed that mica and quartz inclusions were used in Khonkho Wankane sherds, which may indicate potters/herders traveled to the foothills of the Quimsachata to retrieve potting material (sandstone quarries containing mica and quartz outcrops - Figure 3.5) and to graze camelid herds. According to Smith (2009:402) the Quimsachata could have been viewed as a significant place of origin, thus it could have been viewed as an appropriate outcrop for potting material, rather than using the readily available grasses. Future petrographic analysis could determine if clays and temper used in Khonkho Wankane pottery come from the Quimsachata as well as identify regionally specific metamorphic rock, volcanic rocks, and pumice (Rivas-Tello and Roddick 2016). Clays from the Quimsachata range have been collected and are awaiting further analysis (Roddick personal communication 2016).

The Khonkho Wankane potter may have collected water from nearby streams (also connected to the mountain range) and used this water to form their vessels. Due to the consistency in wall thickness, potting material and the variety of activities (i.e. feasting and specialized processing of human remains) occurring in Khonkho Wankane

(Smith 2009:404; Smith and Pérez-Arias 2015) it is possible that potters created vessels best suited for specific tasks. Based on my analysis of form, these vessels would have looked familiar to other potters in the region. My analysis of finishing techniques reveals that vessels would have been wiped with a cloth or rubbed with a stone. Future researchers may want to revisit archaeological materials from Khonkho Wankane and look for tools used in pottery production. Due to the scope of this project I was only able to analyse one material (i.e. ceramics) in detail. In order to get the "panoramic view" of a site's taskscape and the interconnectedness of several tasks, other materials (e.g. lithics, faunal remains, monoliths and plants) should be analysed in detail but also comparatively. A solution to this problem of over-specialization could be collaborative projects with other researchers. Berryman's (2010:210-211) isotope analysis of four individuals from Khonkho Wankane suggests that maize played a key role in inhabitants' diet. In fact, Upper Desaguadero Valley dwellers consumed more maize during the Late Formative period than those living in the nearby Tiwanaku and Katari valleys. Maize was imported from lowland regions via llama caravans and was likely a resource used in daily tasks at Khonkho Wankane specifically feasting and political activities (Berryman 2010:216-217).

After several vessels were made the Khonkho Wankane, potters would have gathered them and create an open-pit fire, perhaps using llama dung to fire the vessels. Once the firing process was complete, pots were likely distributed to other inhabitants who required those specific kinds of vessels. Individual may have used cooking ollas for the preparing of soups or stews, and to feed visitors from other sites (Smith 2009:404). Cooking ollas may also have been used by ritual specialists to process materials used to coat human remains of the ancestors of these out of town visitors (Smith and Pérez-Arias 2015). This could be tested in the future by analysing phytoliths from the interior of unwashed sherds or from charred materials inside vessels, much like Millers' (2005) work at Formative period sites on the Taraco Peninsula (Roddick and Hastorf 2010:163). Once the vessel had outlived its life use the user may have disposed of the pot or repurposed it.

The relationship between these two sites and their potters was complex, differing in some aspects and similar in others. Despite facing challenges with this taskscape framework I argue that I have made a small step towards understanding past taskscapes in the Upper Desaguadero Valley. Yet more work and further research on daily activities needs to be conducted at these sites and based on my experiences I suggested some future directions researchers could explore. To conclude, this project used a social archaeological framework and applied new methodological tools to analyse the relationship between pottery, people, and place.

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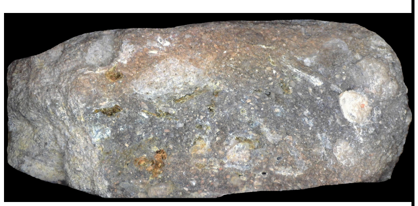
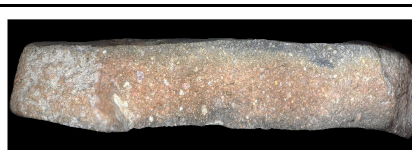
Appendix A

Table A. 1 Paste type numbers, USB photographs and descriptions for the site of Iruhito

Paste/ Temper	USB Photographs 30x EDOF	Description
1 Fiber		Large fiber voids, very few inclusions (5%). Occasional small, sub-angular whites and translucent. Medium texture and subcompact.
3 Fiber		Few large angular/ sub-angular opaque white inclusions. Otherwise a clean paste (15%). Small sub-angular whites, blacks, pinks, and translucent. Medium sized fiber voids. Medium texture and subcompact.
4 Fiber		Very coarse paste with a lot of inclusions (45%). Large angular/ sub angular whites, translucent, pinks and blacks. Also has small sub-rounded whites, pinks, and translucent. Coarse texture and subcompact.
5 Fiber		Similar to paste 1 but more inclusions (10-20%) and smaller fiber voids. Small sub-rounded translucent inclusions. Medium texture and subcompact.
6 Fiber		Speckled white paste. Small to medium sub-angular whites. Small rounded/ sub-rounded translucent, whites, pinks, blacks. Fiber voids. Medium texture and subcompact/ compact. (20-30%)
7 Fiber		Moderate amount of mica. This paste has the most mica out of all the fiber pastes. Small sub-angular, blacks, whites, pinks and translucent. Medium texture and subcompact/ compact (35%).

8 Fiber		Highly fired and dense paste, with a lot of inclusions (45%). White speckled. Small, sub-angular black. Medium sub-angular translucent. Medium texture and compact.
9 Fiber		Highly fired fiber paste. Very few (5%) and small sub-rounded whites, and blacks. Clean paste. Very fine and compact.
10 Fiber		Highly fired, dense fiber paste. With few (10%) large and chunky angular translucent, white and yellows inclusions. Few small white. Fine and compact.
13 Mineral		Medium to large, sub-angular whites, translucent, and pinks. Small to medium, sub-rounded whites. This paste has chunky inclusion and some voids. Coarse to medium texture, and subcompact (45%).
14 Mineral		White speckled paste, similar to paste18 but smaller white inclusions. Small to medium sized, sub-rounded/rounded translucent and whites. Medium texture and subcompact/compact (20%).
15 Mineral		Small to medium sized, sub-rounded whites, and translucent. Medium texture and subcompact (30%).
16 Mineral		Buff paste, with very few inclusions (5%). Very clean paste. Occasional small translucent. Fine texture and compact.

17 Mineral		Buff paste with small to large sub-rounded reds. Occasional small whites and blacks. Similar to 23, but 23 is highly fired. Fine texture and compact (5%)
18 Mineral		Similar to 14 but larger white speckles. Medium to large sized sub-rounded translucent. Medium texture and subcompact (25%).
19 Mineral		Medium to high-density mica. Medium sized, sub-angular translucent. Medium to large, angular/sub-angular, whites. Occasional small, sub-angular pink. Medium to coarse texture and subcompact (45%).
20 Mineral (20 and 21 combined)		Medium to high-density mica. Small to medium sized, sub-angular/ sub-rounded, translucent. Small sized, sub-rounded whites. Occasional, sub-angular pink. Medium texture and subcompact/compact (30%).
22 Mineral		Highly fired paste. Small sub-rounded whites, translucents and blacks. Fine texture and compact (10%).
23 Mineral		Similar to 17 but highly fired. Small to medium, reds. Rare translucent and whites. Fine texture and compact (5%).
24 Mineral		Small sized, rounded translucent and whites. Occasional small sized, sub-rounded blacks. Medium to fine texture and subcompact (40-45%).

25 Mineral		Highly fired, clean paste. Very small sized opaque white and blacks. Very fine texture and compact (10%).

Table A. 2 Paste type numbers, USB photographs and descriptions for pastes in Khonkho Wankane

Paste/ temper	USB Photograph 30x EDOF	Description
1 Mineral		Medium to large, angular, transparent. Moderate mica. Small, sub-angular, transparent, blacks. Occasional whites. Medium texture and subcompact. 45%
2 Mineral		Highly micaeous paste. A lot of mica on the surface and cross section. Medium to large, angular transparent. Small, angular blacks. Occasional whites. Medium texture and subcompact. 45%
3 Mineral		White speckled paste. Medium to large angular whites (high density of whites), and transparent. Occasional small orange/pink inclusions (potential grog/clay inclusions). Some mica. Medium texture and subcompact. 45%
4 Mineral		Coarse paste. Large angular, whites. Medium to large angular transparent. Coarse texture and subcompact. 15%-20% Equivalent to Iruhito paste 3.

5 Mineral		Chunky paste. Large to medium, sub-rounded transparent, whites, blacks. Relatively well sorted. Coarse texture and subcompact. 50%
6 Mineral		Small to medium sub-rounded/ sub-angular, transparent, whites, very few blacks and mica. Medium texture to fine. Subcompact. 20%
7 Mineral		Small, but lots of rounded transparent. Some small rounded blacks, whites, and pinks. Fine texture, subcompact/ compact. 50%
8 Mineral		Small rounded, transparents and whites. Very few inclusions. Buff, clean paste. Fine texture and compact. 5%.
9 Mineral		Highly fired, dense paste. Few, very small inclusions (transparent). Fine texture, and very compact/ dense. Less than 5%
13 Fiber		Large to medium angular whites. Small sub-angular transparents. Few Larger fiber voids. Medium texture and subcompact. 30-40%
14 Fiber		Small to medium angular, transparents and pinks. Few fiber voids. Medium texture and subcompact. 30%?

15 Fiber		Large to medium rounded to sub-rounded whites and transparents. Occasional blacks. Large fiber voids (fairly porous). A lot of fiber voids. Medium to coarse texture. Subcompact 45%
16 Fiber		Compact fiber paste. Few, small, transparent inclusions. Fine and compact,/dense. 5%.

All attribute analysis forms were taken 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

TAP a-analysis body sherd 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 _________
____

Tap non-drawn diagnostic form

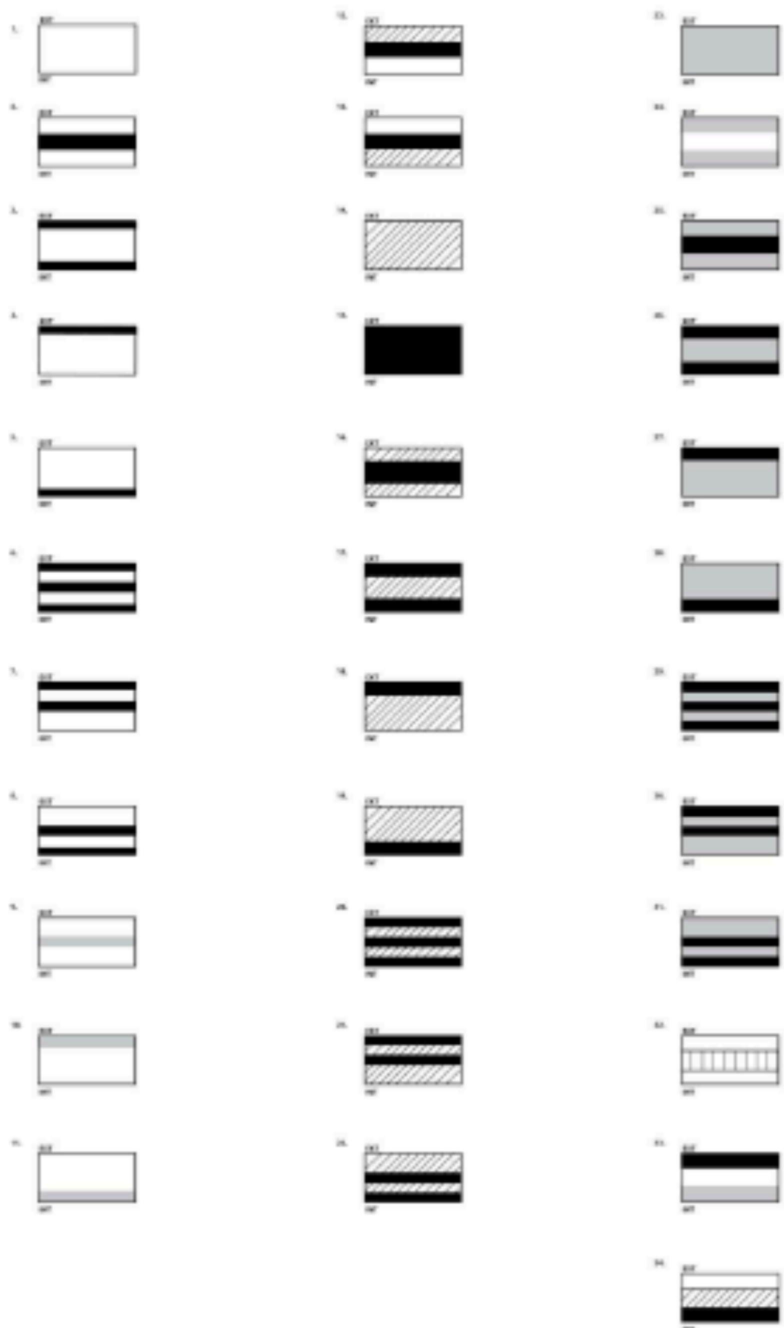
Taraco Archaeological Project

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 ____

TAP drawn diagnostic form



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		
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 continued

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	motiled black, brown and red brown	30	cream on red
7	motiled brown and red brown	31	cream on red brown
8	red orange	32	black on red
9	motiled 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 motiled	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 motiled	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 continued

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 colours continued

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

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 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 tall medium necked vessels (jars/ollas)

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

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 olla codes

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 (T1a)
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 bowl codes

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 bowl codes continued

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 other various forms

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 base codes

Appendix B
ImageJ Protocol

ImageJ is a free open source image-processing program developed by Wayne Rasband of National Institute of Health (USA) in 1987 (Ferreira and Rasband: 2012:1). ImageJ was initially intended for the medical sciences, but has been applied to multiple disciplines, including archaeology (Ferreira and Rasband: 2012:1). Archaeologists have used ImageJ for photographs of thin-sectioned sherds analysed petrographically (Daniels and Lipo 2014; De La Fuente and Vera 2015; Livingood and Cordell 2009; Reedy 2006). I decided to test the effectiveness of using the program with photos sherds with fresh breaks and captured with the relatively cheap Dino-Lite microscope. I was mostly interested in using the program to analyse the texture of the paste. I specifically used ImageJ's maximum length, area, and circularity, to understand the average size of all of the inclusions in pastes and the shape of the grains, thus getting a general sense of these pastes texture. Below is the protocol I created based off of De La Fuente and Vera (2014) and Andrew Roddick and Gregory Braun's work at the LIRAC lab at McMaster, University.

Photos taken of fresh break have very low contrast compared to thin-section images taken under polarized light. The ImageJ program requires higher contrast between the clay and inclusions to identify and quantify the different inclusions. Working with volunteers, I cropped the sherd photo to a standardized size (16:9 preset) in *Adobe Photoshop*. This was necessary as sherds vary in thickness. Thicker sherds have more inclusions visible in the frame compared to thinner sherds. By cropping the images to the same size the frame size is standardized and differences in inclusion abundance reflects the paste type and texture not the thickness of the sherd. In *Photoshop* the brightness of the clay matrix was reduced, creating higher contrast between the inclusions and clay matrix. I increased the brightness of the inclusions to created clear/crisp boundaries. The modified image was then saved as a TIFF file.

I then imported the TIFF image into ImageJ and calibrated the scale. I used the line tool to draw a line over the scale. Image J is able to calculate the number of pixels (189.0002) in this known distance of 0.5mm. Since I only used the Dino-Lite setting 60x (refer to Chapter 4) calibrating was the same for all of the images, thus this calibration setting was used for all of the images analysed (Figure B.1). In order to analyse the image I had to convert the image to grey scale 8-bit (Figure B.2). I then made the image into a threshold, using the "isodata" and "B&W" settings (Figure B.3).

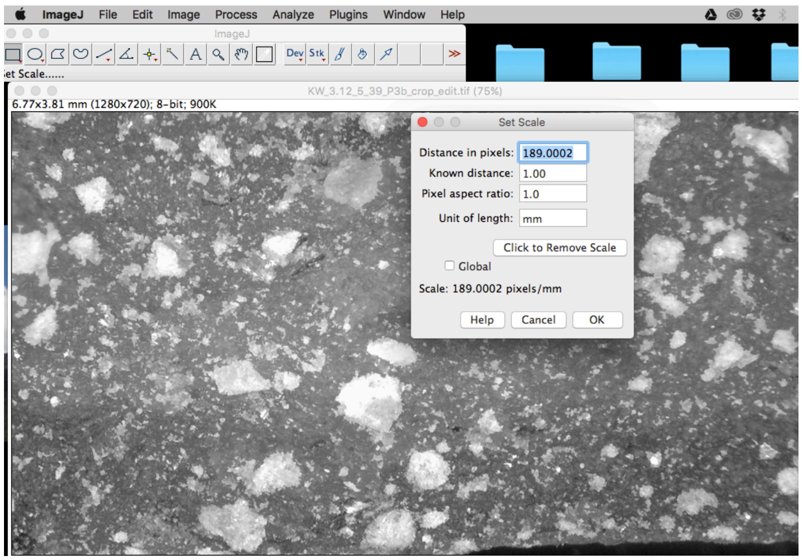


Figure B. 1 Measurement calibration in the ImageJ program.

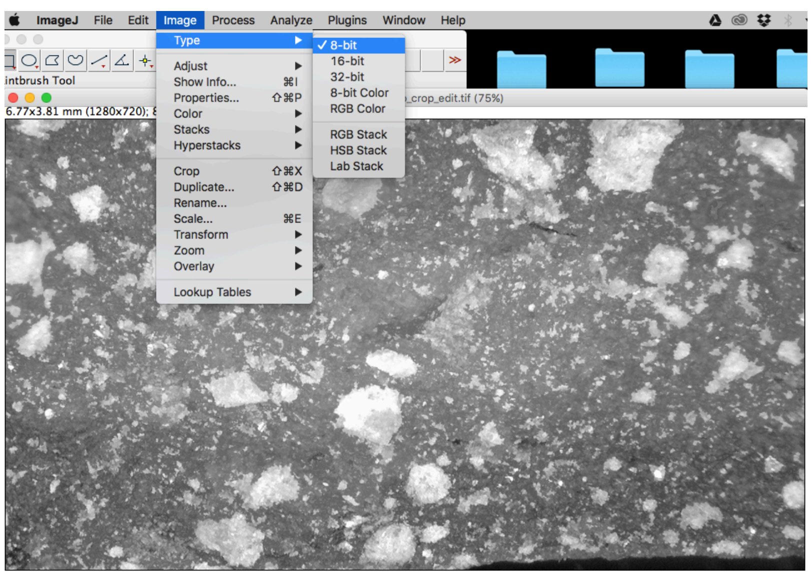


Figure B. 2 Converting image to grey scale 8-bit in the ImageJ program

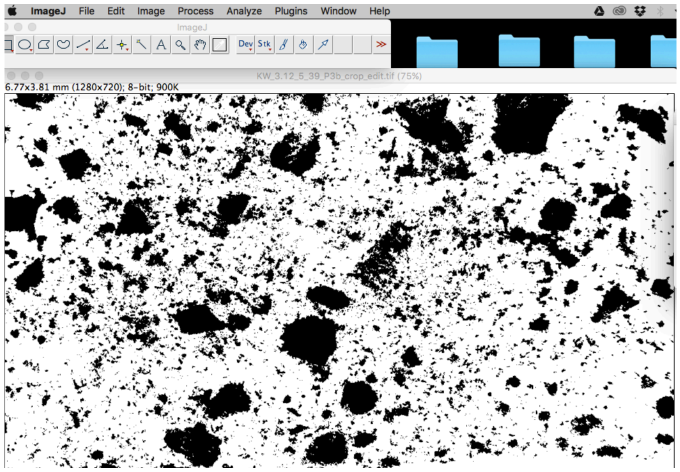


Figure B. 3 Using the threshold application in the ImageJ program.

I then used the "Finding Edges" setting to define inclusion edges (Figure B.4). Later I created a binary, with the Fill Holes, as well as the "Despeckle" setting, which removes the outliers. When using the "Remove Outliers" setting, I set the radius to 2.0.

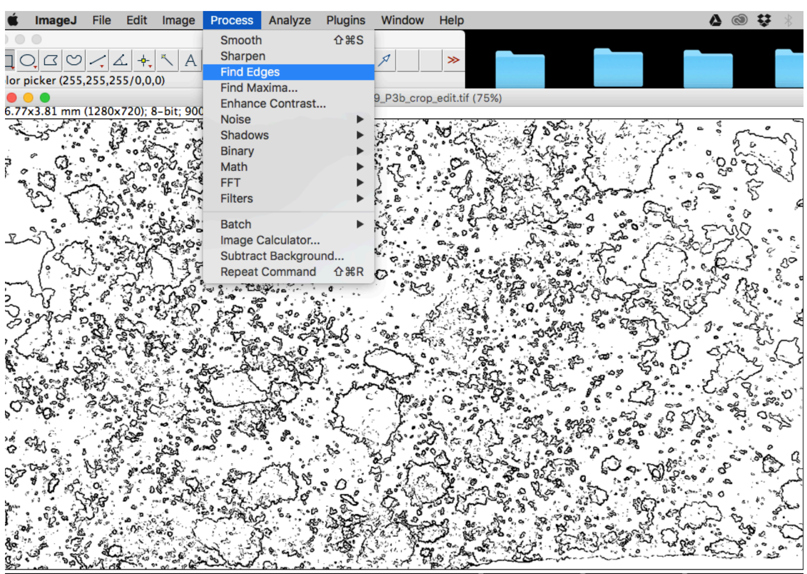


Figure B. 4 Using the "Finding Edges" in the ImageJ program.

I then selected the calculation factor (area, area factor, circularity). Finally, I selected the "Analyze Particles" setting and the program ran the measurements (Figure B.5). I saved the image with the labels, to identify the specific measurements of the inclusions. Image J allows you to export the results to excel.

Settings for Analyze Particles:

a. 0-infinity,
b. Show-masks (to see labels and what's being counted),
c. Include holes,
d. Display results
e. DO NOT Exclude Edges
f. Click Ok
g. Mask will pop up

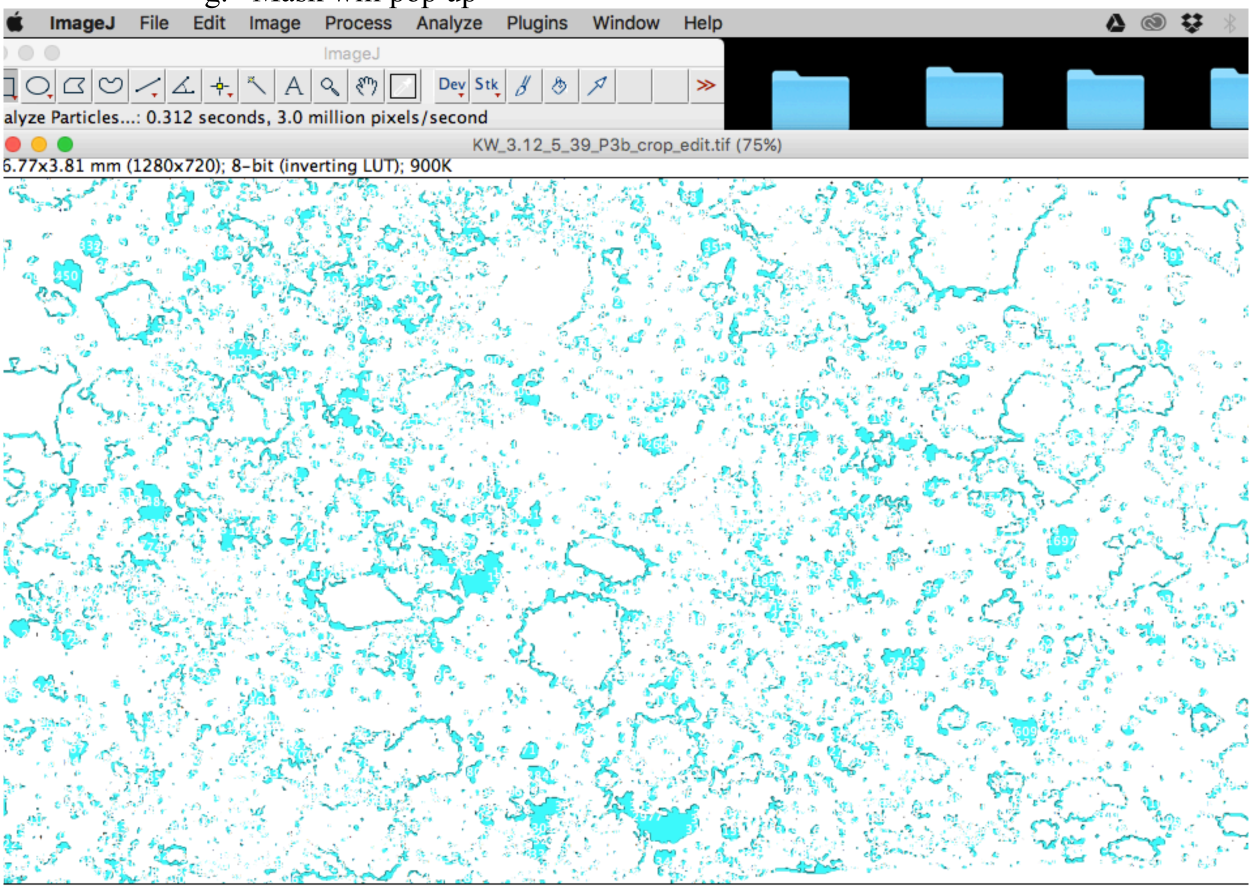


Figure B. 5 Image of isolated inclusions made in the ImageJ program.

Due to time restrictions and the scope of my thesis, I was not able to apply the information generated by the ImageJ program. However, I do feel this approach could be beneficial for future analysts. The program quickly identified the shape and size of inclusions, which could help determine the texture of a paste. De La Fuente and Vera (2015) have used images created by the ImageJ program to make “paste maps” where similar inclusions were filled in the same colour. These kind of maps could be helpful as a visual tool to see how inclusions were distributed in a paste. Due to the flexibility of the ImageJ program future researchers could find several applications of this digitial analysis software.

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