Chapter 5
Arcillas and *Alfareros*: Clay and Temper Mining Practices in the Lake Titicaca Basin

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Introduction

This chapter aims to integrate archaeological and ethnoarchaeological research on ceramic production in the Lake Titicaca Basin. Drawing on over 60 years of scholarship exploring the early stages of ceramic manufacture, we examine the acquisition of clays at quarries and the subsequent processing of these raw materials. Investigations into clay quarries have often focused on the availability of raw materials appropriate for pottery production. This research has included pedestrian survey for clays and sediments, and geochemical and mineralogical work on the quality of clays (Bishop et al. 1982; Neff et al. 1992). While such work is unquestionably useful (and unfortunately still rare in some regions), the dynamic nature of clays makes defining historic and prehistoric sources difficult. As a result, many archaeologists have considered these early technical stages through other means. For instance, research on prehistoric ceramics has long included careful analysis of ceramic pastes—the mixture of the aplastic inclusions and the plastic clay components of ceramics (for a good summary, see Arnold 2000). These findings have permitted for variability in local recipes to be correlated with regional and sometimes local deposits. In this work some have deployed sophisticated analytical tools in the laboratory to examine the techno-functional aspects of particular technological choices at quarry sites. This research has tended to focus on the relative performance of particular materials under a range of conditions (Bronitsky and Hamer 1986; Skibo et al. 1989; Summerhayes 1997).

Arcillas and *Alfareros*: Clays and potters

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Other researchers have conducted ethnoarchaeological studies of clay quarrying, tempering choices, and paste preparation within contemporary societies. Here scholars working in a range of contemporary cultural contexts are able to investigate the role of particular choices across wider cultural fields, including the relationship of clay and temper choices to linguistic, ethnic, or political affiliation, and to other types of quotidian practice (Gosselain 1992; Herbich 1987; Neupert 2000; Sillar 2000). A recent overview by Olivier Gosselain and Alexandre Livingstone Smith summarizes some of the social mechanisms that underlie the spatial and temporal variations in clay selection and processing. They note that patterns may be the result of "[a]ccidental discovery; competition over land use; competition between artisans; individual or collective conceptions regarding the quality of raw materials; habits and traditions in technical behaviour; and social interactions at a local or regional level" (Gosselain and Livingstone Smith 2005: 34). The authors stress that while environmental and technical *constraints* of raw materials are important, the vast *possibilities* in social practice are equally important.

This chapter focuses on some of these social mechanisms, drawing on insights from active ethnoarchaeological research to guide the interpretation of archaeological data. Careful ethnoarchaeology, such as that presented by Gosselain and Livingstone Smith and their colleagues of the "ceramics and society" project in sub-Saharan Africa (Corniquet 2011; Gosselain 1992, 1999, 2008, 2011; Livingstone Smith 2000; Wallaert-Pêtre 2001, 2008), challenges archaeologists to consider such social mechanisms involved in the initial steps of pottery production, including quarrying and paste preparation. They encourage a consideration of the cultural logics behind technical practice in their wider project of "decomposing traditions and their dynamics" (Gosselain and Livingstone Smith 2005: 45). Ongoing research in the South-Central Andes by the authors is guided by similar goals.

Investigations of cultural logics behind ceramic production are certainly not new to the Andes, and a number of prominent Andean ethnoarchaeologists and archaeologists have focused on such technical grammars (what some call "emic" perspectives) within wider social contexts (Hosler 1996; Lechtman 1977; K. Chávez 1992; Sillar 2000). However, the implications of both Andean and global ethnoarchaeology are not always considered in wider archaeological research. For instance, Gosselain and Livingstone Smith express frustration that while a wide range of patterns of quarrying and processing practices are repeatedly observed, archaeologists seldom consider them in interpreting variations in paste recipes. In fact, "variations in paste composition continue to be used mostly as chronotypological markers or interpreted in techno-functional terms" (Gosselain and Livingstone Smith 2000: 34).

Pastes are increasingly playing a key role in building regional chronologies in the Lake Titicaca Basin of the *altiplano* (high plains) of Bolivia and Peru (Fig. 5.1), yet few scholars have considered the processes that produce such variability. There are two main reasons for this particular, and somewhat limited study of ceramic pastes and raw materials. First, the assemblages that are characteristic of Titicaca Basin sites are highly fragmented. In the absence of clearly identifiable iconography or vessel forms in many collections, paste recipes have been key in the defining of periods and horizons, occasionally used for techno-functional interpretations, and

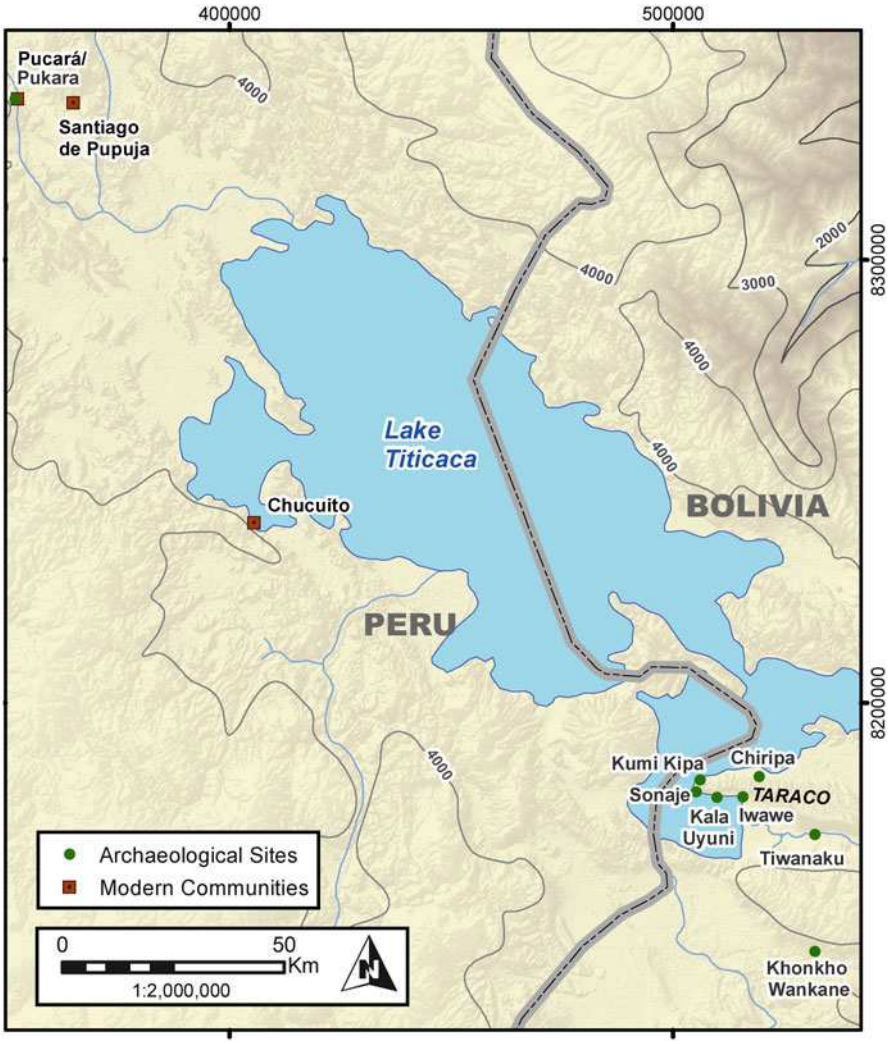

Fig. 5.1 Map of the Lake Titicaca Basin with relevant archaeological sites and modern communities

in some cases serve as the uncritical basis for delimiting ethnic or political identities and boundaries. The second reason may be methodological; there are few ceramicists in the region, and surveys for raw materials, with a few exceptions, have rarely been conducted. In other words, this lack of engagement with larger trends within the ethnoarchaeological literature is due to research orientation. So while Titicaca Basin archaeologists use varying paste recipes for chronological purposes, they rarely ask "why" questions concerning this variability.

This chapter represents an early effort by the authors to ask such questions of ceramics of the Late Formative Period and to consider the social dynamics of prehistoric quarrying, raw material choice, and paste preparation through ethnoarchaeological means. First, details of the paste types within the regional chronology are provided, which serve to frame the first author's work on Middle and Late Formative pottery production in the southern Titicaca Basin. Second, a brief summary of existing ethnoarchaeological research from the region is presented, which provides a context for the second author's preliminary research on the mining of raw materials in the traditional pottery producing community of Pucará in the northern Basin. In both the archaeological and ethnographic cases, specific "quarry quandaries" are examined, focusing in particular on the characteristic primary materials in these areas and the possibilities for distinguishing between "types" or boundaries of these sources. The relationship of particular quarries to technological choices is also briefly explored. In closing, the authors revisit the challenge proposed by Gosselain and Livingstone Smith in their work in sub-Saharan Africa and highlight the difficulties in studying source landscapes in both the present and the past. To this end, the authors attempt to bring together the results of recent ethnoarchaeological and archaeological research, drawing on wider Andean scholarship to consider the significance of shifting raw materials and sources, concepts of ownership, and technological choice.

Prehistoric Quarry Quandaries: The Late Formative Taraco Peninsula

The Lake Titicaca Basin is a high plateau approximately 80,000 km^2 in area and 4,000 m above sea level in the Central Andes of South America. Flanked by several mountain chains, it is an internal drainage basin centered on Lake Titicaca, but continuing south on the Desaguadero River. Twenty kilometers from the edge of Lake Titicaca is the Middle Horizon (AD 400–950) site of Tiwanaku. This large urban center located at high altitude has intrigued tourists and scholars alike with its remains of large cut stones, carved monoliths, beautiful pottery, and a diversity of long-distance trade items. Up until fairly recently, the understanding of the Formative Period was limited to the Middle Formative occupation of Chiripa located on the shores of the smaller, southern Lake Wiñamarka (Bennett 1948; Browman 1978; K. Chávez 1988; Hastorf 1999; Ponce Sanginés 1970), and the Late Formative site of Pukara in the northern Titicaca Basin (S. Chávez 1992; Kidder 1948; Klarich 2005; Stanish 2003; Tantaleán 2010; Wheeler and Mujica 1981).

The last 20 years, however, have seen an explosion of Formative Period research on both the Peruvian and Bolivian sides of the lake. Much of this research has been focusing on the Late Formative Period (200 BC–400 AD), a 600-year period before the emergence of the city and polity of Tiwanaku (see Hastorf 2005; Janusek 2004; Stanish 2003 for overviews). Unfortunately, chronological hiccups and a lack of excavation have forestalled much of this research. In some parts of the region, it has been particularly difficult to distinguish this long period from the earlier Middle

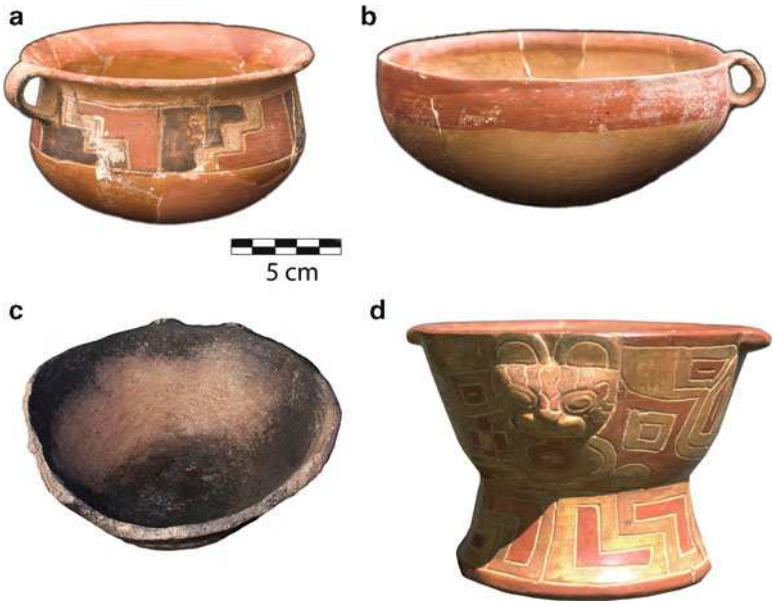

Fig. 5.2 Late Formative ceramics. Vessels made of fine-compact pastes (often with red hematite inclusions) from the southern Titicaca Basin: (**a**) Kalasasaya "zonally-incised" bowl from Tiwanaku; (**b**) Kalasasaya red rimmed bowl from Tiwanaku; and (**c**) a more typical coarse and micaceous tempered vessel from the site of Kala Uyuni, on the Taraco Peninsula. (**d**) Polychrome Pukara *incensario* from the northern Titicaca Basin, not to same scale as (**a**–**c**). Images compiled by Andrew Roddick

Formative (800 BC–200 AD) and later Tiwanaku (400 AD–950 AD) phases. There is some continuity in technology and production sequences resulting in subtle chronological boundaries. Defining these chronological boundaries has also been impacted by the predominance of survey projects and lack of systematic deep excavation in the region. Initially, Titicaca Basin cultural chronologies were constructed based on changes in surface decoration. For example, the Late Formative in the northern Basin was defined by the development of a new style of polychrome pottery with standardized iconography (S. Chávez 1992). Southern Basin decorated pottery includes red-banded and incised "Kalasasaya" vessels (some of which draw on styles from Pukara; Fig. 5.2) and a later Late Formative phase includes a rare polychrome style commonly known as Qeya (Janusek 2003; Ponce Sanginés 1971, 1993; Wallace 1957).

More recent research has focused on other attributes in Formative Period ceramic manufacturing sequences. In these highly fragmented assemblages, the paste recipes of nondecorated vessels have been particularly useful in creating chronological divisions in the Formative Period. In the northern Basin, Late Formative nondecorated pottery is distinguished from that of previous and subsequent periods by the presence of relatively large flakes of mica used as tempering material (Carlevato 1988; S. Chávez 1992; Klarich 2005; Oshige Adams 2010). In the southern Basin tempering

is also key to chronology building, where similar shifts have been observed (Janusek 2003; Lemuz Aguirre 2001; Mathews 1992; Steadman 1999, 2007).

Since 2005, the first author has been investigating issues of Late Formative ceramic production based on a large assemblage of sherds from three sites excavated by the Taraco Archaeological Project (Roddick 2009; Roddick and Hastorf 2010). While it appears that production was occurring on the Taraco Peninsula (a variety of tools of production have been recovered) few primary typical indicators of ceramic production (i.e., wasters, ash, burned clay) have been identified. As such, attention has been on technological choices in ceramic production (as seen in manufacturing attributes) across the three settlements through the Formative Period. The archaeological assemblage is defined by particular diachronic shifts. For instance, the Late Formative is defined by the appearance of a new decorated form—the red-banded Kalasasaya bowl discussed above—that is ubiquitous on Taraco sites. Other changes concern the use of raw materials, in particular related to clay and temper mixtures, or pastes. The interest in quarries and sources stems from questions surrounding these clay recipes.

A first step consisted of examining the "potential and limitations of available material and technology" (Shimada 1998a: 7, see also Arnold 2000). Over 40 years ago, Mohr (1966) called for a detailed survey of available resources on the Peninsula, and both she and Bandy (2001) have suggested that raw materials were quarried from the Taraco Hills. In 2007 a survey was conducted to investigate the possibility of ancient quarrying activities by testing the nature of locally available raw materials and their relationship to Late Formative ceramics. Unlike many other areas in the circum-Titicaca region, there are no active potters on the Peninsula today. Nevertheless, the ubiquitous clay deposits are still being used as a building and flooring material in many households (Goodman-Elgar 2008) and geophagy is a common practice.[1] The first author worked with a Tiwanaku potter in collecting the raw materials of the region, which were sampled from the surface, from areas dug by property owners, deep gallery-like deposits, and (most commonly) deep cuts through the *quebradas* of the Taraco hills (Fig. 5.3). A total of 112 clays, 14 possible temper sediments, and 5 colorful mineral pigments were collected.

A series of subjective tests similar to those used by a variety of contemporary potters were then deployed to gauge the plasticity and water retention of these local materials. These tests included a "coil test," a "loop test," and a "ball test," which allowed for plasticity, stiffness, and strength to be examined (McReynolds and Herbert 2004; Roddick 2009: 275–277). It was found that they are all high-quality potting clays that would have been well suited for pottery manufacture. X-ray diffraction supported these more subjective claims, as the clays were rich in smectites, illites, and kaolonite, making a particularly good potting mineralogical mix. The clays collected from the Taraco Formation included a range of colorful iron oxides, including white, light brown, red brown, orange, and yellow clays. These clays

[1] Like elsewhere in the Andes (including Pucará), Taraco villagers consume clay as a condiment during communal potato roasts called watiyas.

Fig. 5.3 Clay collection on the Taraco Peninsula, southern Titicaca Basin. Photo by Andrew Roddick

refired to colors in the same range as Late Formative ceramic samples. While detailed analysis is ongoing, petrographic and elemental analysis of Late Formative ceramics and the refired briquettes suggests Late Formative inhabitants on the Taraco Peninsula used local materials (Roddick 2009: 263–299).

Unsurprisingly, there is little direct evidence for clay quarrying 2,000 years ago on the Taraco Peninsula. However, there is plenty of evidence of sources that would have been ideal for mining clay and analysis has identified very little diversity among these sources. Clays from sources all along the Peninsula up to the site of Tiwanaku are quite similar, and true diversity in quality and geochemistry are not apparent until some distance away. There is significant color variability across otherwise similar (mineralogically, chemically, and subjectively) sources (Roddick 2009: 263–299). The ubiquity, but also homogeneity of possible sources in such a dynamic environment suggests that the entire peninsula could be defined as a potential prehistoric quarry.[2]

The recipes, or pastes, utilized during the Formative Period appear to have always included a temper mixing stage. If local Taraco materials were indeed being used in the Late Formative, tempering would have been essential for these fine clays to withstand the firing process. The paste mixing stage has proven to be vital for defining diachronic shifts. As noted briefly above, late Middle Formative pottery is defined by the presence of grass temper and often included large opaque quartz fragments. In contrast, Late Formative ceramics lack organic inclusions and are

[2] Dean Arnold noted deposits of clay and tempers that varied both vertically and over great horizontal distances in Quinua (Peru). His work in Ticul (Mexico) found raw materials that were much more homogenous, while not as widely distributed (Arnold 2000: 340). The Taraco case here appears to offer both homogeneity and fairly wide horizontal distribution.

defined by a high density of micaceous sands. Petrographically, grains of quartz, biotite, muscovite, plagioclase and sanidine feldspars, hornblende and both sedimentary and igneous rock fragments have been identified. The larger fragments are angular, yet unaltered, and clean looking compared to the smaller, nonclay minerals, suggesting the larger were temper elements (Roddick 2009: 310–314). There is also the appearance of several other paste recipes that were not present in earlier phases, including compact pastes. At magnification one group has characteristic hematite aggregates and another has high densities of volcanic ash (Roddick 2009: 314–316). The survey for tempering material did not find many sources of micaceous or ashy materials. So while ideal potting clay is ubiquitous in the deep rivers cuts on the current day Taraco Peninsula, the particular tempering material, used by generations of potters, is not as commonly available.

Nevertheless, researchers working in other regions of the southern Basin have noted similar shifts from fiber to micaceous sands in a number of pottery producing regions (e.g., Janusek 2003; Lemuz Aguirre 2001; Steadman 1995). Is this shift based on the constraints of raw materials and the intended purpose of the vessels? Do recipes change based on the regional variability of raw materials over time? Or are social decisions being made at quarry sites a key element? The rich tradition of ethnoarchaeological studies from the Andean region (e.g., Arnold 1984, 1993; Bowser 2000; Cleland and Shimada 1998; Donnan 1971; Druc 2001; Hagstrum 1988, 1989; Hosler 1996; O'Neale 1976; Ravines 1978; Ravines and Viller 1989; Shimada 1998a, b; Shimada and Wagner 2007) may offer some perspective on such prehistoric quarry quandaries. After a brief overview of studies focused in the circum-Titicaca Basin, contemporary clay quarrying and preparation practices in the community of Pucará, Peru are explored.

Modern Quarry Quandaries: Ethnography in Pucará, Peru

In order to frame the methods, data sets, and goals of recent ethnographic work in Pucará, it is important to first review the extant ethnoarchaeological literature from the Lake Titicaca Basin. Formal ethnoarchaeological research on ceramic production in the region began with Tschopik's (1950) "An Andean Ceramic Tradition in Historical Perspective." The article traces "the Aymara ceramic tradition" (Tschopik 1950: 196), which he argues remained relatively stable from the Inca period, through the colonial period, and into contemporary times (from 1940 to 1942) in three communities near the large town of Chucuito in the western Basin. He provides a detailed inventory of locally produced vessels, discusses regional specialization in various crafts, and includes a number of details on ceramic technology pertinent to the present discussion.

In terms of procuring raw materials, Tschopik describes one potter's process of creating *ñeq'e,* or paste, after moving from the countryside to Chucuito (ibid: 209). Because of a lack of suitable local materials in town, this potter returns to his home village and collects two types of clays (translated as red earth and purple earth) plus

tempering materials (white sand and "gold sand" with mica) from a dry riverbed. This potter's particular recipe involved combining an *olla* sized amount of purple earth, an *olla* of sand, and a bowl of red earth to create the paste used in the production of a wide variety of vessel forms. While Tschopik briefly mentions the well-known pottery centers of Pucará and neighboring Santiago de Pupuja (1950: 201) in the northern Basin, he focuses on workshop production contexts from this area, not the early stages of material procurement or processing as discussed for the Chucuito case study.

More detailed information about contemporary ceramic production in Pucará and neighboring potting communities appears several decades later in a series of publications written not by archaeologists or ethnographers, but by several scholars interested in documenting and promoting Andean folk or popular art traditions. Studies by Spahni (1966) and Litto (1976) provide valuable information on local clay sources and tempering materials, forming techniques, firing technology, and often exchange, which serve as a foundation for all subsequent ethnoarchaeological studies in the region (e.g., Chávez 1987 and Sillar 2000 citing Litto 1976).

The ethnoarchaeological studies most influential in framing the Pucará project are K. Chávez's (1987, 1992) work at Raqchi (Department of Cuzco, 150 km northwest of Pucará) and Sillar's (e.g., 1997, 2000) research in a number of Peruvian communities surrounding Cuzco (including Raqchi) and potting communities in Bolivia (in the southern Lake Titicaca Basin, Northern Potosi, and Cochabamba). At Raqchi, Chávez provides detailed descriptions of the stages of pottery production, consumption, and distribution, including valuable information on clay and temper procurement practices in the region. Her primary goal was to determine if the household- and community-level relationships concerning the organization of pottery production had "natural or artificial causes" (1987: 186). For example, did communities specialize in certain types of vessels because of limited access to appropriate materials (a technological constraint) or due to a shared interest in maintaining interdependency between those communities (a social constraint)?

This study is of particular interest because Pucará is noted as one of Raqchi's exchange partners (Chávez 1987: 186); Pucará offered the more reliable shale or slate-tempered *ollas* in contrast to vessels manufactured with volcanic temper in Raqchi. Raqchi potters provided Pucará potters with large *rakis*, a vessel type that would not be durable if produced in Pucará, according to local sources. While noting that her research was preliminary and limited to a single community, Chávez proposed that various patterns of complementarity—seen at the household level in the sexual division of labor and at the local level through community specialization—were maintained artificially for a variety of social and economic reasons. Clearly, this is a subject that merits further exploration through expanded interviews and analysis of raw materials used by potters producing for intercommunity exchange.

Lastly, Sillar's (2000) study of ceramic production, distribution, and consumption provides a wide range of information about the diversity of vessel types utilized in the processes of cooking, storing, serving, and celebrating in the region today. In all the potting communities Sillar visited, he observed production at the household level, making "the economics of pottery manufacture…inseparable from the

domestic economy" (Sillar 2000: 125). Unlike many ethnoarchaeologists, Sillar is not as concerned with using contemporary practices to model material signatures of ancient craft production, but instead focuses on "how the production, exchange and use of pottery is embedded in the wider activities and cultural values of Andean people" (ibid: 125). The work of Sillar not only provides excellent comparative data on the technical aspects of pottery production in the circum-Titicaca region (raw material procurement and processing for a variety of vessel types), but like Chávez offers insights into a range of social factors influencing decision making by contemporary potters.

Inspired by this rich tradition of ethnoarchaeological research in the region, the second author began to explore clay quarries in and around the town of Pucará in 2006. This work was associated with a full-coverage mobile-GIS survey of the archaeological site of Pukara (Klarich and Román 2012), where Klarich has been working since 2000. Casual surveys during multiple field seasons at Pukara and discussions with local potters suggested that there were numerous local and nonlocal clay sources that continued to be exploited for a variety of purposes. During the 2006 survey, which was conducted with a lifelong potter on the crew, clay samples were collected from four "defined" modern quarries and will be integrated into future studies of Late Formative pottery production.

The ethnographic data presented in this chapter were collected during the summer of 2010 as part of a multiyear project to develop a new *sala* (exhibition space) about modern craft production at the Museo Lítico Pukara, which opened in early 2011. As 80–90% of the few thousand residents of Pucará are part or full-time potters, there was quite a bit of interest in participating in the project. The co-directors of the Pukara Archaeological Project were able to conduct interviews in over 20 household-level ceramic workshops. Guided by both content needed for the new *sala* and previous ethnoarchaeological research in the region, the interviews primarily explored the organization of craft production, including the technological, economic, and social aspects of pottery production, consumption, and distribution.

Based on the interview responses, Pucará potters exploit a wide range of sedimentary and residual clays from meandering riverbank sources, deep galleries, and extensive surface deposits across a variety of settings (Fig. 5.4). When asked which clay sources are used to make their pots, potters responded using categories of color primarily, and then referred to location, or, less frequently, differentiated sources based on physical properties. In terms of color categories, there are two main local sources in Pucará: the *chocolate* sources about 2 km east of the town center near the river and the red source located on the northern edge of town. The other major clays used by Pucará potters (brown and red) come from sources approximately 7 km to the east in the district of Santiago de Pupuja. Minor sources include a yellow clay found along the margins of the river owned by the neighboring town of Choquehuanca; a blueish source that co-occurs with the *chocolate* source; a gray source; and an opaque white source located "in its place of origin" in the hills about 4 km south of Pucará.

Within color categories there are distinctions based on source location. For example, when discussing *chocolate* sources potters always distinguished between *relave*, which is mined along the river cut on the east edge of town or *hatun pampa*, mined from galleries several meters below the modern surface of the oxbow

Fig. 5.4 *Chocolate* clay sources on the edge of Pucará, northern Titicaca Basin: (**a**) *relave* and (**b**) *hatun pampa* (with David Oshige). Photos by Matthew Wilhelm

(see Fig. 5.4). As illustrated in Fig. 5.4, the *relave* sources are small, informal, and easily accessible pits along the river that fluctuate annually with shifts in water levels. In contrast, obtaining *chocolate* clays from galleries excavated into the *hatun pampa* requires entering deep, unstable pits that expand with use; the clays are typically removed by experienced men and often transported by the truck or tricycle load. The surface remains of previously used galleries are apparent across the pampa, which often fill with trash after the source has been exploited. These two sources of *chocolate* clays are only separated by a 5-minute walk, but were noted as distinct sources by potters interviewed.

Red is also a tricky category, as it includes both local and nonlocal clay sources used for distinctive productive activities. At the local level, Pucará red is a transported clay deposit that is mined from shallow, informal pits on the *pampa* (open plain) just north of town. The nonlocal red source is mined from transported surface deposits at Santiago de Pupuja, which is discussed below. The other named sources appear to be from either smaller deposits or ones not exploited with frequency. The consistent use of clay color categories across household workshops to define sources (potters always corrected interviewers who misspoke when referring to different clays) most likely reflects direct knowledge about the quarries from which potters select and/or buy their clays. Potters clearly know their landscape well; for example, they have no trouble differentiating between numerous clay sources located in the small, neighboring communities within the district of Santiago de Pupuja, which they would not actually visit with any regularity.

How do color categories correlate to the physical properties of the clay? Unlike the clays collected from the Taraco peninsula discussed above, the second author has yet to conduct formal analyses of the clays collected in and around Pucará. However, local potters were very clear and consistent about the properties (or "personalities") of these different sources, which are combined in a range of paste recipes for different vessel types. For example, *chocolate* is characterized as being very plastic, but with little "resistance to firing" (Interview #2). It is typically mixed with the red clay from Santiago de Pupuja, which is characterized as being resistant to higher temperatures, but with little plasticity and a tendency to dry too fast if used

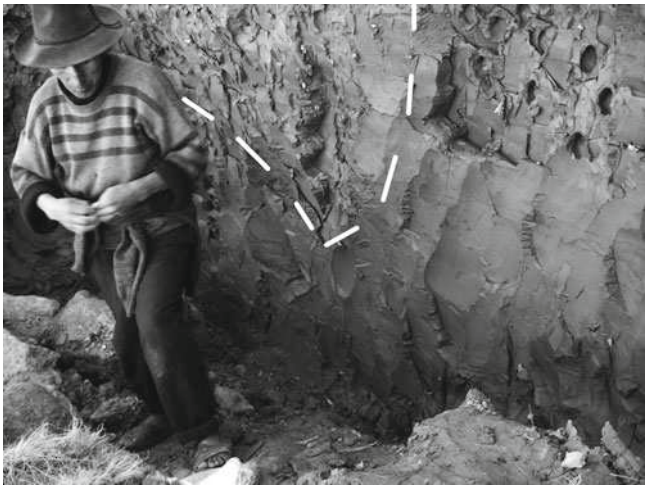

Fig. 5.5 Honorato Ttacca sampling clays at Santiago de Pupuja, a nonlocal clay source used regularly by Pucará potters. Clay to left of the white dashed line is bright red and to the right is a deep grey. Photo by Matthew Wilhelm

alone (#2). When discussing the main source in Santiago de Pupuja, local potters would refer interchangeably to "red" and "brown" or "light chocolate" clays, which initially confused the interviewers as to whether the interviewees were referring to one or multiple sources. However, after reviewing photos from the 2006 survey, it was clear that this particular clay deposit was quite variable in color (Fig. 5.5) and that potters were selecting from different areas within the same source. In terms of less common colors, yellow is sometimes added to make finished objects "more resistant to firing" and is described as being "like simple dirt…it doesn't have much plasticity" (#2). Gray, an "antiplastic," is described as "sandy" and is mixed with plastic clays to make them stronger and increase the range of possible firing temperatures (#14). The white clay is also mixed with other clays to "raise their firing temperatures" (#14). Blueish clay is never used for pottery as it sticks to molds and is hard to fire; however, it is used to paint houses.

Interesting to note is that the red clay from Pucará, which is mined from shallow pits on the *pampa* just north of town, was only mentioned in detail by a potter who continues to hand build low-fired, large utilitarian vessels like *ollas* (cook pots) and *phuos* for making *chicha* corn beer. He mixes this red clay with nonlocal clay from Azángaro (up to 30 km away) and the local yellow clay for these coil-built pots, which he constructs on a circular, ceramic or stone *molde* (disk), which rests on the floor (Fig. 5.6).[3] It is interesting to note that during the 2006 survey there were stacks of drying adobe bricks near the shallow, informal pit quarries for this red clay

[3] Similar stone or ceramic disks have not been recovered from prehistoric ceramic production areas at Pukara. However, large stone slabs may have been used as bases or platforms for producing coil-built pottery (e.g. Klarich 2005, Block 3 excavations).

Fig. 5.6 Photograph of semi-finished vessel on a *molde* (disk) used by Pucará potter. Photo by Elizabeth Klarich

on the *campo ferial* (market grounds) just north of town. During the interviews in 2010, some potters also referred to this clay as *sañu*, which means both "earth" and "roof tile" in Quechua, indicating a combination of color, location, texture, and even use in the varieties of names for this source.

Clearly, there remains much to do to tease apart the myriad categories of local and nonlocal clay sources based on the initial interviews of Pucará potters. While there are some trends across all workshops (e.g., every family uses some type of local clay), it is very difficult to generalize about clay recipes for a particular type of vessel (cooking pot or *olla* vs. a bowl) or for a certain production technique (mold vs. wheel vs. hand built). Most households use three to four different types of clays and, as summarized by one of the potters, for each type of pot "we have to prepare different materials—*ollas* are different, grotesque art is different and then there is the liquid form of clay used for mold-made" (#12) objects. Most potters did not offer specific information about their clay recipes; however, one potter (#2) explained that she made grotesque figurines by mixing 60% *chocolate* from Pucará, 30% red/brown from Santiago, and 10% yellow from Choquehuanca plus small amounts of "fine construction sand."

In general, few potters spoke of adding temper to their clays, even when asked directly if their ceramic recipes included anything besides "just clay." This was also noted in the work of Spahni (1966: 64), where he documented that Pucará potters used 75% "plastic clay" and 25% "antiplastic clay" in their paste recipes, but there was no mention of adding temper.[4] However, one potter (#14), a teacher at the local

[4] Although archaeologists continue to use standardized categories when examining raw materials, paste preparation often "does not conform nicely to immutable definitions of "clay" and "temper" as plastic and added non-plastic respectively. Rather potters are interested in modifying the paste so that they can successfully make pots with it" (Arnold 1998: 355).

school, had participated in a number of workshops sponsored by NGOs and was very familiar with the technical terminology surrounding both modern and ancient pottery production. For example, he explained that during ancient times the Pukara, Inca, and other cultures had used mica as an additive within their clay recipes, but that was no longer the practice. Today in Pucará, potters who make *ollas* use slate (*piedra pizarra*) temper, which comes from nonlocal, flat, soft stones of red, silver, and black, and is ground and added to clays to improve consistency and increase resistance to firing temperatures. The use of slate is a long-standing tradition in some parts of the central Andes (Druc 2001). Silica is also used as temper for strength and added to glazes to keep them from cracking. This is an interesting, if unfortunate, case of a source becoming "local"; it is commonly known that potters today acquire this material by knocking chunks off the vertically placed, worked stone slabs that line the Classic Pukara sunken courts on the Qalasaya complex. The original source has yet to be determined, but several people have mentioned the possibility that the slabs came from Asillo in the Province of Azángaro. It may be that in addition to the technological properties of these stones their position within the sunken court holds some significance for modern potters, which is a topic that merits further exploration.

A Social Orientation to Ceramic Raw Materials in the Lake Titicaca Basin?

We began this chapter noting that archaeological studies in the Lake Titicaca Basin are increasingly constructing cultural chronologies from the basis of variability of paste recipes. Contemporary studies of material culture in the Titicaca Basin (and perhaps the broader South-Central Andes) have been attempting to move beyond cultural historical models, prioritizing explanatory models to diachronic cultural patterns. Andeanists are enthusiastic about discussing the broad social, political, and economic processes that may correlate with shifts in productive practice. Yet there has been little engagement with the social aspects that lay behind minor ceramic variations, relations that may be key in explaining the subtle elements that are increasingly essential in fine-grained chronological frameworks. At this early stage the ethnographic data discussed above cannot speak to long-term trends directly (in the manner of Arnold's (2000) inspiring work), yet the ethnoarchaeology discussed above can reveal potential social practices behind paste recipes in the Lake Titicaca Basin. In this brief discussion, we focus on three aspects—material constraints and technological choice, social and technical boundaries, and raw materials on a dynamic landscape—all of which reveal future research questions and the need for engagement with larger issues of the social aspects of clay quarrying and paste preparation.

Material Constraints and Technological Choice

As stated in the introduction to this chapter, functional aspects are a key interpretive aspect to exploring manufacturing choice. On the Taraco Peninsula choices of raw materials do appear to correlate somewhat with the actual use of finished vessels. While compact pastes were used for decorated vessels, the more friable micaceous pastes have been identified for a variety of forms, including charred vessels used directly over the fire. While it certainly is possible that micaceous materials were employed to manufacture a better cooking pot (Roddick 2009; Steadman 1995), it is not clear how this explains the process of adoption. As Sillar (1996: 260) argues, functional interpretations should be made very cautiously, and efficiency models should be constantly evaluated within the framework of cultural choices and local representations. So while mica may have been deployed for functional use initially, it does not preclude a range of future uses, meanings, and landscape associations. In the case of Pucará, it is worth investigating whether the wide range of paste recipes used for different production techniques (wheel, mold made, or hand-built) are mutually exclusive as most potters note, or if they vary based on family traditions, access to nonlocal clay sources, or other factors.

Gosselain and Livingstone Smith (2005) observe that potters in sub-Saharan Africa are willing to use a wide range of clays, including low percentage clay mixtures, to produce their pots and that particular mixtures infrequently correlate with the intended functions of the vessels. They have found that the physical attributes of raw materials are rarely the key elements in deciding which clay deposits will be quarried (Gosselain and Livingstone Smith 2005: 39). Rather the *potters' perception* of what is considered proper materials are more important: "When discussing the matter with them, one gets the feeling that each clay used locally is thought to be so "appropriate" as to be non-substitutable" (ibid). This observation has also been made for the Andes, where potting clay is often widely available (Litto 1976). It is reflected in Chávez's (frustrated) observation about the "artificial" nature of potters' explanations of their inabilities to make particular forms (K. Chávez 1992: 82, discussed in Sillar 1997).

As the second author's research shows, the wide availability of high-quality raw materials does not preclude culturally meaningful categories for clay sources, which can in turn have real social and material consequences. For instance, at Pucará color, as a referent to particular quarries, is the main way of judging or naming clay qualities and clay ownership. These clay qualities may in fact communicate a wide range of contextual information about both the raw materials and the finished pots. Sillar (1997: 12, drawing substantially on K. Chávez 1992) has discussed how a good, or "reputable pot," may incorporate several interrelated contextual factors, including "serviceability, aesthetics and exchange value." Like "reputable pots," "reputable quarries," such as those found around modern day Pucará might carry significant weight, serving as a trademark, and creating a type of bond between producers and consumers.

A consideration of such reputable quarry sites could be revealing in both ethnographic and archaeological contexts. For example, one may ask how having a vessel

made from the famous "Pucará clay" mined from the various quarries around the town might enhance the prestige of the item; it has been documented that thieves from Puno, Cuzco, and Arequipa illegally mine community-owned clays from Pucará because of the fame of the source across the region. Such a perspective also introduces questions concerning similarities in manufacturing material in the Late Formative Period that go beyond performance requirements. Regardless of potential cooking advantages of micaceous pastes there may be broader social significance to particular technological choices in micaceous pastes, including the cultural value placed on the shiny particles by both producers and consumers (Arnold 1993; Lunt 1988; as discussed by Sillar 1996: 273). Wider regional survey for both clay and temper quarries and further detailed compositional research is necessary before such questions may be explored.

Social and Technical Boundaries

This relationship between "reputable quarries," producers and consumers also involves social boundaries, senses of place that can also create conflict and battles over property rights and use of clay (Arnold 2000: 357–359). Legal battles over ownership and access have been documented as early as the 1680s for nearby sources in the northern Lake Titicaca Basin (Spurling 1992: 244). At Pucará, different types of access impact the nature of boundaries, with some resources controlled by community members, and others purchased from private landowners in neighboring communities, while before land reform the local clay sources were owned by the *haciendas*. At this point it is unclear as to whether Pucará potters always pay for access to nonlocal clays (most responded that they did purchase nonlocal clays plus pay labor and transportation costs). Potters mentioned half a dozen sources they use from distinct communities within the nearby district of Santiago de Pupuja (e.g., Llallahua, Coqra, Checca) and it is unclear with the present data how the value of these sources vary both from a social and technological perspective.

This investigation of social boundaries around these quarries has introduced a number of questions to be investigated in the future: When potters exploit nonlocal sources owned by relatives or by communities in which they have close kin do they incur the same costs as other Pucará potters (clay, transportation, and labor)? Do the modern boundaries used today by potters (e.g., yellow clay is from Choquehuanca, the neighboring community, even though it is just on the other side of the riverbank) apply the same way across all families? How do intercommunity relationships and patterns of land ownership, for example, affect perceived physical and social boundaries of clay sources? Defining the range of boundaries for local and nonlocal clay sources clearly merits further attention in future interviews.

This work, along with other Andean ethnoarchaeology, suggests that raw material choice "may be heavily influenced by the particulars of local land ownership and/or political control" (Sillar 2000: 69). This relationship between technological choice and social boundaries would manifest itself in some subtle variability across

archaeological landscapes, which would create the patterns that archaeologists recognize as regional traditions (Livingstone Smith 2000: 27). The nuanced social boundaries that are being revealed through ethnoarchaeological research are evocative, and certainly require finesse to develop insight into archaeological research. An initial stage is to examine the technological boundaries that result from these social boundaries in both the ethnoarchaeological and archaeological contexts.

Roddick's (2009) dissertation work has clearly defined common technical practice on the Taraco Peninsula, with identical diachronic shifts occurring across the three sites. Although future publications will present the geochemical and mineralogical details of these technological styles, there are some brief trends to be noted. There was little statistically significant difference in the categories of paste recipes being deployed across these sites. Qualitative petrography on these pastes suggests that not only are similar quarries being used (likely located in the fairly homogeneous geological Taraco hills) but also that similar learned practices of processing are being deployed. All three sites had a consistent presence of the paste groups, including the micaceous sand subgroups, and the two compact paste groups characterized by the presence of either ash or red hematite inclusions. The micaceous pastes appear to be similarly ground up and prepared, while the fine compact pastes all appear to have either been accessed as fine, well-sorted material, or carefully prepared. In sum, there is no indication of a technological boundary associated with the quarrying and preparing of pastes. We still do not have a sense for Late Formative social boundaries in ceramic production on the regional scale. On the one hand, this is due to little baseline research on the geological diversity in the broader region. On the other, since pastes have predominantly been used to construct chronologies, the disjunctures in recipes are often explained away, rather than engaged with in greater detail. Recent findings suggest such questions surrounding technological choice and social boundaries merit further investigation. For instance, John Janusek (personal communication, 2009) has observed ceramic assemblages in the Tiwanaku Valley with red inclusions, descriptively comparable to the hematite aggregates found in both clay deposits and fired Late Formative ceramics of the Taraco Peninsula. Janusek notes that these ceramics are not evenly distributed across the landscape, and apparently some communities had differential access to either the finished products or the raw materials (Janusek 2003). One working hypothesis, based on the finding of clays with such hematite inclusions locally (discussed above), is that these materials were associated with a "reputable quarry" on the Taraco Peninsula. Ongoing work seeks to identify possible disjunctures in ceramic assemblages in the region, paying particular attention to the quarrying and processing stages of particular production sequences.

Raw Materials on a Dynamic Landscape

The final element to be considered in this discussion is the nature of clay quarries themselves. As briefly mentioned in the beginning of this chapter, the clay–water

system is particularly dynamic, both in a seasonal sense but also over the long term. In fact, "source locations of ceramic raw materials are not immutable and may change over time" (Arnold 2000: 346). As Arnold (2000: 348–351) points out, clay sources can come and go for a variety of reasons, including environmental processes, land ownership, and the exhaustion of sources. This contributes to the difficulty in clearly defining quarry sites; unlike many of the chapters in this volume, it is quite rare to find primary archaeological evidence for clay mining practices.[5] This is the elephant in the room, a troublesome issue within both the ethnographic and archaeological research projects outlined in this chapter that has concerned both of the authors.

While certainly a methodological concern, this dynamism is also a key element of the social practices surrounding raw materials. Like the Bariba potters that Gosselain and Livingstone Smith (2005) interviewed, the northern Andean potters of Las Animas (a pseudonym) stress that clay is alive, "it is sensitive, delicate and gets upset easily; it responds to the mood of the potter. Clay knows when the potter is ill or inexperienced, and becomes impossible to work. Clay changes state, formed and shaped by the potter's idea, but sometimes, they told me, clay has its own idea" (Hosler 1996: 83). While speaking directly to the materiality of clay, Hosler's observations also speak to the seemingly living nature of clay quarries themselves.[6] These sources are places with dynamic histories, which may include the mundane disappearance of a source through generations of use, to more dramatic and dangerous cave-ins (Arnold 2000: 348).

The shifting nature of such sites would have had a dramatic impact on the synchronic and historical processes seen at both the ethnographically visible time scales in contemporary potting communities and at archaeologically visible time scales in ancient potting assemblages of the Titicaca Basin. Such dynamism produces important questions for both research agendas. For instance, how might this impact naming conventions and debates over community ownership and access? One must imagine that named mines exploited over centuries (such as that of Santiago de Pupuja) must fluctuate across the landscape as they are exploited and erode.[7]

[5] Some historical archaeology projects have had some success. For instance, Stahl et al.'s (2008) compositional work in Ghana included raw materials from abandoned clay pits and galleries. These were likely accessed in the last 100 years and could not be accurately dated (Stahl, personal communication 2011). See also Arnold and Bohor (1977).

[6] This may draw comparison to the ethnographic work of Cruikshank (2005), who has written of the dynamic geological places associated with Northern Canadian communities. Cruikshank writes of First Nations' oral histories of "surging glaciers," shifting ice flows that are named animistic entities with cultural histories.

[7] It could also be expected that changes in larger scale sociopolitical organization (e.g. from hacienda-controlled to community-owned sources) would impact how sources are named, who accesses them, and their relationship to community (vs. individual) identity (also discussed in Sillar 1997). Clearly a much more dynamic understanding of larger political and environmental processes is required both in long-term archaeological and short-term historical processes.

From an archaeological perspective, how is it that particular quarrying practices could be maintained for many generations? In the Lake Titicaca Basin there are pastes that do not appear to change for over 200 years in a dynamic environment, which suggests potters are making an effort to maintain such stability. The transition from tempering with ubiquitous *ichu* grass during the Middle Formative to the Late Formative practice of tempering pots with more limited resources (volcanic ash and micaceous materials) suggests not only particular mining practices and potential trading relationships, but also a specific relationship to the landscape. While the lake levels of Lake Titicaca rose and fell, and while the Pucara River changed course, potters for several generations sought out (and likely named) particular sources. In the relatively geologically homogeneous Taraco Peninsula, this waxing and waning of sources may not impact the clay matrix of the pottery. More intriguing, perhaps, are the temper types that last across generations of practice. While not dynamic in the same sense as clays, particular temper deposits (such as the volcanic ash and mica discussed here) were important points on the broader Titicaca landscape, and likely were enmeshed in complex social histories of exploitation, much like other mineral extraction practices discussed in this volume.

Conclusions

This chapter represents an ongoing effort of two projects in the Lake Titicaca Basin to confront temporally disparate, but interconnected issues related to prehistoric and contemporary clay selection on the landscape. While these projects are different in scale and methodology, they find common ground in regards to perceptions of boundaries (both social and physical) and raw material qualities (or "appropriate" materials). There are two distinctive research trajectories as the authors continue to engage with "quarry quandaries." First, work on the Taraco Peninsula will continue to focus on the elemental variability of tempering materials, moving outward to a more regional approach to source materials. Second, continuing research in the northern Basin will examine the time depth of associations between Pucará and quality clays, taking a diachronic approach not typically employed in the ethnoarchaeology of pottery production (see Sillar 1997 and Arnold 2000 for a similar call for such archival research).

This chapter also speaks to the current state of ethnoarchaeology in the Andes, particularly the recent shifts to focus on consumptive practices, such as *chicha* (corn beer) production and consumption or feasting practices more generally.[8] These are welcome and much needed areas of study, and may impact our understanding of a range of technical sequences (e.g., Sillar's (2006: 274) discussion of large jars for

[8] E.g. Bray 2003 (editor); Hayashida 2008; Jennings and Bowser 2009 (editors); and Klarich 2010 (editor).

beer preparation being reused for clay processing). However, as this chapter demonstrates, a consideration of the processes behind patterns in raw materials reveals a rather astonishing number of potential research questions.

This leads to a final conclusion concerning the rich tradition of Andean ceramic ethnoarchaeology, which is fairly specialized scholarship rarely considered in wider archaeological practice in the region. As Andeanists continue to build local and regional cultural chronologies, a perspective on the social practices behind such elements would appear essential. Ethnoarchaeological perspectives offer important reminders of the complexities behind patterns in ceramic attributes, practices that occur at dynamic quarry sites as well as in potters' backyards.

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