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Smash: Ceremonial Intoxicants And Intentional Tool Destruction In The Northern Highlands Of Pre-Columbian Ecuador

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SMASHED: CEREMONIAL INTOXICANTS AND INTENTIONAL TOOL DESTRUCTION IN THE NORTHERN HIGHLANDS OF PRE-COLUMBIAN ECUADOR

by

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I. Introduction

This thesis explores ground stone tools from the late imperial Inca site of Caranqui located in the northern sector of Ecuador's Cordillera Oriental. Many pre-Columbian Andean societies used stone implements such as *manos* and *metates* or *batanes* to process food and for the production of the fermented beverage *chicha* (Hastorf & Johannessen 1993; Moore 1989; Moseley *et al.* 2005; Pearsall *et al.* 2004; Russell 1988; Shimada 1994; Valdez 2006; Valdez *et al.* 2010). Commonly made of maize, *chicha* was often consumed as an intoxicant of both secular and ceremonial importance to the Inca and other Andean peoples (Bauer 1998; Bray 2003, 2008; Classens 1993; Cobo [1653] 1990; Costin and Earle 1989; D'Altroy 2002; Dillahey 2003; Lau 2002; Moore 1989; Moseley 1992; Rowe 1946; Salomon 1978, 1986; Silverblatt 1987). Manos and metates are among one of the major artifact categories excavated at Inca-Caranqui, and they exhibit a pronounced range of variation. Curiously, nearly all of the metates and a large portion of the manos found at the site are broken. One contemporary approach to the study of archaeological remains proposes that some fragmented objects found in the archaeological record may have been broken intentionally in the ancient past (Adams 2008; Brück 2001, 2006; Chapman 2000; Chapman and Gaydarska 2009; Hull et. al 2013; Jones 2005; Pearson 1998; Verhoeven 2007; Walker 1995). This paper uses recent investigations of fragmented artifacts as a point of departure for the analysis of metates and manos from Inca-Caranqui.

Features within the archaeological site reveal that it was a ceremonial center for the Inca and perhaps also a sacred space for the indigenous Caranqui before Tawantinsuyu expanded into the region in the early sixteenth century AD. Within the Andes, food processing tools, like the manos and metates found at Inca-Caranqui, are most often associated with work performed by women during domestic activities and also to grind maize or other materials when making *chicha* (Bray 2003). To date, no obvious domestic contexts have been securely identified within the core of the Inca site; rather the imperial component contains an elaborate temple, various enclosure walls, and a number of hydraulic features (Bray and Echeverria 2014). The earlier, pre-Inca occupation of the site produced several burials and possible house floors. Broken manos and metates are associated with both Inca and pre-Inca occupation levels at the site, though a significant percentage of the assemblage was recovered in secondary contexts. The abundance of fragmented utilitarian tools found within the ritual precinct of Inca-Caranqui prompts the questions driving the research presented here, which primarily concerns the reasons for their presence at the site. The sum of the evidence suggests that many of these objects were purposefully broken. In the discussion section, I offer several possible explanations for this finding.

Manos are handheld apparatuses actively applied to process intermediate substances that are placed on top of metates. The latter are stationary, passive, lower base stones roughly equivalent to querns.[1] Working in tandem, these implements form a composite tool effectively used to process dietary resources. Therefore these tools are known as “food processors” and frequently referred to as “grinding tools” or “grinding stones” in archaeology and ethnography. In the Andes this equipment was integral in transforming sprouted maize to *jora*, a crushed, coarse flour-like meal made from geminated seed, which was the primary constituent of many *chicha* brews. *Chicha* was considered the beverage of luxury by the Inca (Bray 2003; Hastorf 2003). Ritual activities associated with Inca ceremonial spaces required copious amounts of *chicha,* which was controlled and requisitioned by the state. While manos and metates are

[1] Quern is a term used for ground stone food processing tools used in other parts of the world, for example in the Levant.

utilitarian tools, elites and administrators would have been indirectly linked to grinding stones at Inca imperial centers due to the roles these implements played during the production of *chicha* since the beer-like spirit was necessary to all ritual and stately proceedings.

In archaeology, grinding tools are typically understood in terms of intended utility and rarely as objects engaged in other realms of social life. In the Andes, metates and manos found in archaeological contexts are often reported in fragmented condition. These items are generally assumed to have broken accidentally or, once exhausted from use, via natural events either before or after entering the archaeological record. Although these scenarios of breakage may apply to some of the fragmented grinding tools found at Inca-Caranqui, I do not believe that this model holds for all of the fragmented specimens in the sample. At Inca-Caranqui, the frequency of broken specimens (n=415, 90% of the sample) found within the ritual sector of the site, as well as the appearance of scars adjacent to the broken edges found on many specimens, suggest that during their life-histories, a great number of these tools served as agents in activities beyond their originally intended utility. The ceremonial context of the site lifts these utilitarian items from the realm of the ordinary.

In this study, the life-histories of tools are considered through the analysis of interpretive data relating to design, use, wear and activity, with the intent of revealing the nature of the food processing assemblage from Inca-Caranqui. To better understand the possible significance of the grinding tools from the site, I analyzed them from technological and contextual perspectives. These approaches encompass the latter stages of tool production, as well as use and discard. From a technological standpoint, I include consideration of raw material selection, tool design and planned function; with respect to context, I am concerned primarily with tool use, curation and breakage. Coupling these strategies in ground stone analysis permits a consideration of implements beyond utility, and helps to situate them within their larger social and cultural contexts.

All of the known manos and metates collected to date from Inca-Caranqui comprise the sample presented here (*N*=464) and includes both complete and fragmented manos (*n*=169) and metate specimens (*n*=295). The goal of this study is to reconnect these artifacts to the environment in which they were made, used and ultimately broken. An expected outcome, sought through the systematic analysis of fragments, is the identification of distinctions between typical and atypical[2] breakage. An additional aim of this work is to construct a typological framework for the metates from Inca-Caranqui and to identify corresponding manos. These analyses are expected to contribute to discussion on intentional fragmentation and also to illuminate the relative degree of skill invested in ground stone craft production in the northern Andean highlands during the Late and Inca Periods as evidenced in the assemblage from the site of Inca-Caranqui.

This study incorporates archaeological data and historic references pertaining to the site and region, as well as ethnographic and experimental information concerning food processing tools and intentionally broken objects to better extrapolate the social significance of the artifacts comprising the sample from Inca-Caranqui. When reviewing previous research, added emphasis is extended to grinding stones from ritualized contexts and fragmented artifacts from ceremonial sites within the Andes, especially those found in Ecuador. An additional aim of this study is to heighten archaeological awareness and understanding of food processing implements by highlighting the variability of terminology used in Andean archaeology to address these tools.

[2] Typical breakage is defined here as incidental breaks (occurring through wear), accidental breaks (occurring through accidents), and breaks that occur from exposure to extremes in temperature or other environmental phenomenon. Atypical breaks are defined as occurring as the result of intentional action intended to render a tool of its utility.

When discussing previous research, I provide certain names and designations assigned by researchers or their informants used as analogs for grinding stones. The aim of underlining the diversity in terminology used for these implements is to stress the importance of normalizing ground stone analysis in Andean research and to promote awareness of the analytical potential of these often overlooked artifacts.

A. Research Problem and Methodology

This thesis will analyze the manos and metates found at Inca-Caranqui in order to ask questions pertaining to resources processed and the activities related to tools at the site. Namely, does the food processing assemblage from Inca-Caranqui indicate the intensive processing of maize? And too, were these tools engaged in a specialized economy, or was their use primarily restricted to domestic spheres of activity? Was the use of certain tool forms limited to ceremonial occasions? These analyses are intended to elicit information pertaining to pre-Columbian action and, potentially, ritual activities at the site.

Despite the central role of food processing tools to expanding sustenance and making *chicha* production possible, many details pertaining to these and other ground stone artifacts in the region have yet to be analytically addressed. As a result, our understanding of ground stone artifacts in Andean archaeology is skewed, in part, by an overreliance on research from outside the region, an issue further biased by the fact that ground stone examples from other areas only partially represents the diversity of features relating to assemblages within the Andes. This thesis is intended as an attempt to bridge the chasms between Andean archaeology and ground stone research by recognizing parameters for analyzing food processing tools in the northern highlands. Specifically, by examining the manos and metates from Inca-Caranqui, these analyses seek to illuminate stages in the life-histories of the food processing assemblage from the site.

Chicha production, and more generally food processing, was an obvious arena around which the Inca might assert control and create structured policy (Bray 2003, 2008; Hastorf 2003; Russell 1988:266; Silverblatt 1987). Inca policy measures included the manipulation of food-processing practices during imperial expansion (Russell 1988:266). To that end, it is reasonable to surmise that Inca administrators, when controlling maize resources, may have sought to ensure access to suitable tools since value was placed upon *chicha* and certain foods prepared with maize. Bray (2003, 2008) has noted that when comparing Inca ceramic assemblages to those of the Caranqui-Cayambe of the northern highlands, there is a lack in unrestricted vessel forms within the Inca assemblage in contrast to the relative abundance of these vessels forms within the Caranqui region. Bray suggests that these differences indicate variances in either the types of foods being consumed, the methods of preparation, or, perhaps the personnel employed in food preparation (ibid). Within the span of occupation at Inca-Caranqui, changes in population and culture would have expanded nutritional options, while at the same time cuisine likely became more refined and restricted –reflecting cultural values and requiring more, better, or different food processing implements intended to improve grinding efficiency.

While budget and time constraints precluded the molecular analysis of organic matter and possible residue traces, which offers the potential of revealing the intermediate substances processed by extracting phytoliths or starch grains from tool surfaces, the analyses of local ceramic vessels from other sites in the Pais Caranqui indicate that the peoples of the region brewed *chicha de maíz* (Bray 2003:128). Maize was located archaeologically at Inca-Caranqui and also at several neighboring sites in contexts containing manos and metates. Some regional archaeological studies have supposed that tools from other sites were used for processing maize during the production of *chicha* (see discussion in Cuéllar 2013; and critique in Lippi *et al.*

1984). Often these assumptions are based on the dominance of maize agriculture attributed to the Inca and other Andean polities and, moreover, the fertile context of the northern highlands. The approach presented here relies less on assumptions about the uses of these tools and instead focuses on discovering their potential functions by analyzing the range of use-wear traces and other activity indices that have become registered on the use surfaces of the implements comprising the sample.

Recent research derived from Ecuador and other areas in the Andes have proposed more nuanced approaches to the study of stone tools (see Freeman 2011; Downey 2010; Kornbacher 2010; Rumold 2010). Although these recent works bring fresh perspectives to lithic analysis in the region, they do not exactly align with the analysis of the sample presented here. The use-wear analysis presented in this study scarcely benefited from comparative models based on regional experimental data. In this paper, the methodological approaches used when analyzing tool forms, use-wear and respective functions were primarily derived from outside the Andes (for Andean exceptions see, Aldenderfer 1998:91-99; Mauldin 1993:319-322) and include the following key comparative sources: Adams (2002); Adams *et al.* (2009); Clark (1988); Ortman (2000); Schelberg (1997); Schlanger (1991) and Wright (1993). While not ideal, the lack of local literature necessitated relying on works from beyond the study region. A well-developed understanding of the relationship between food processing tools and function has been cultivated in ground stone research from the U.S. Southwest, Mesoamerica and other parts of Central America. Archaeological, ethnographic, and experimental research undertaken in these areas has found that while morphology alone is not a reliable indicator of what was processed with a tool, in some contexts, certain mano and metate forms were intentionally designed for the processing of maize and other forms were intended for the processing of other materials.

Similarly, fragmentation analysis was informed by archaeological and experimental data from outside the Andes to better recognize indications of certain modes of breakage and damage (primarily, Adams 2002; 2008; Gero 1978; Hamon 2008; Stroulia 2010). Additionally, I performed an experiment designed to help ascertain the manner in which stone breaks when struck in specific ways, and another, more, informal experiment aimed at recognizing exposure to fire for certain local rock varieties found around Caranqui.

From the data derived during the analysis of the ground stone tool assemblage found at Inca-Caranqui, especially those data pertaining to use and breakage, epistemological questions can be addressed for the site related to other aspects, specifically, resource use patterns, social organization and ritual.

B. Context of Study

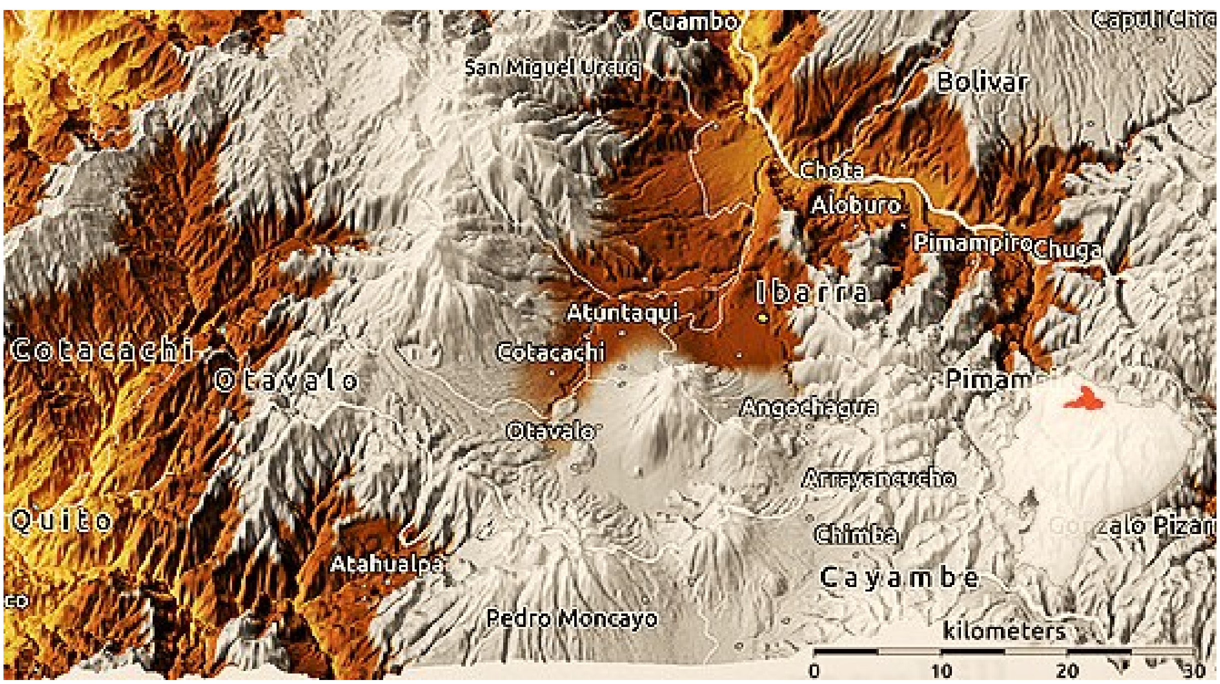

Figure 1.1. Ibarra, Imbabura Province, Ecuador

The site of Inca-Caranqui is located approximately 35 kilometers north of the Equator in an area of northern Ecuador known for massive volcanic mountains and fertile intermontane valleys (Fig. 1.1). Inca-Caranqui is situated in the parish of Caranqui on the outskirts of Ibarra, a colonial city with a population of 133,000 residents, located approximately 110 km north of the Ecuadorian capital Quito. Ibarra is centrally positioned within a large intermontane basin and serves as the provincial seat of the Imbabura Province, whose name is derived from the large inactive stratacone volcano, Mt. Imbabura, just outside of town. The neighborhood of Caranqui is positioned at approximately 2,306 meters above sea-level (masl), while Mt. Imbabura rises 4630 masl immediately to the south. Often partially shrouded in cloud cover, the northeast face of Imbabura is clearly visible from Ibarra all year. While covered with agriculture and grass *páramo,*[3] a large open crater exposed on the summit of Imbabura serves as a reminder that the lush-looking green mountain is indeed a volcano. Imbabura erupted earlier in the Holocene and also had several eruptions of ash and pyroclastic flows during the late Pleistocene which contributed to the fecund soils that are characteristic of the basin by providing rich alluvial deposits (Hall *et al.* 2008; Hall and Mothes 2008:346).

Imbabura is one of two volcanoes helping to define this portion of the large, productive inter-Andean zone. The other, situated to the west of Ibarra, and a bit further away, is Nevada Cotacachi (4935 masl). Snow-dusted Cotacachi is personified as female in local folklore and courts the male personified Imbabura, or *Taita Imbabura* ("father" Imbabura)*,* as the *apu* (mountain spirit) is locally referred by indigenous Quichua speakers (Parsons 1940:221; Parsons 1945:92; personal communication Alfonso Pupiales, July 2009).

This region represents the northern frontier of the Inca Empire and was the last to come under imperial control prior to the Spanish invasion (Bray 1992; Salomon 1986). The Inca

[3] High altitude steppe or grassland found throughout the northern Andes.

constructed a palatial site at Caranqui which was likely the last major Inca imperial construction built (Bray & Echeverría 2009). Recent investigations suggest the importance of the site to understanding the expansion of the Inca Empire (Bray & Echeverría 2008; 2010b). In 2006, a finely constructed sunken plaza was discovered at the site. The rectangular semi-subterranean structure has been interpreted as an Inca water temple (Bray 2013). This and other features at Caranqui suggest that the Inca designated the space for ceremonial purposes. Subsequent archaeological excavations established an earlier indigenous Caranqui occupation of the site, before the Inca conquered the region in the early16th century (Bray & Echeverría 2010b).

This earlier, Caranqui occupation, produced several burials and possible house floors. These and other pre-Inca components of site have been verified through radio carbon dates for the materials excavated from lower strata, with the oldest material dating between 342 BC-AD 40 calibrated ^{14}C (2101 ± 22 BP). The Late Period in northern Ecuador is defined through radio carbon dates from other sites in the region as lasting from approximately AD 1250-1525 (Athens 1992:203). With the antiquity of Inca-Caranqui clearly extending prior to the Late Period Caranqui, burials dating between 40 BC-AD 80 indicate that the site was likely used as a special location in a much earlier period. An example of one of these early burials contains an adult female resting in an upright seated position accompanied by a large ceramic vessel, a shell bead necklace and two thin folded gold discs (Bray and Echeverría 2009; 2010). The Inca venerated locations of historic significance (Bauer 1998; Bray *et al.* 2005:87) and perhaps considered the antiquity of a site when selecting the space for Imperial construction.

In 1869 a massive earthquake destroyed much of Ibarra and the local municipal road system was reconstructed primarily on a grid. The site of Inca-Caranqui encompasses a portion of a small rectangular city block within a neighborhood containing residential and commercial structures, a Catholic church and two city squares. The core of the site measures approximately 50 x 100 m^2 with the water temple situated on the northeastern edge of the central parcel. This feature measures approximately 1-2 meters in depth and contains a sunken plaza measuring 16 x 10 m^2. An elaborate system of canals, of two distinct types, services this semi-subterranean temple by directing water descending Imbabura to the plaza floor (Bray 2013). Bray and Echeverría (2010) believe the hydrological features associated with the temple indicate that it could be drained and filled, transforming the recessed feature into a pool. The authors find that the complex hydrological system servicing the temple built at the site represent a considerable investment in engineering, design and skilled labor by the Inca (Bray and Echeverría 2014).

The focal emphasis of the water temple is unquestionably its impressive plaza floor; composed of fine cut-stone ashlar masonry in the classic Cuzco Inca style. The floor is accessible via impeccably crafted steps at each of the four corners of the temple. Today, a large hole interrupts the plaza floor at the north end of the pool. Archaeological evidence indicates that this section of the plaza was likely destroyed during the early Colonial period as Spaniards tore through the mosaic of andesite blocks in pursuit of gold believed buried beneath the temple (Bray and Echeverría 2008). Likely eluding the conquistadores at the time, their haphazard excavation revealed an aspect of the temple, perhaps as precious as gold –a secret hidden beneath the plaza floor –another floor. Different in appearance to the already exposed upper floor, the lower is also a superb example of Inca stone masonry, composed of finely cut andesite tiles. This unusual feature –one floor purposefully concealing another –represents two distinct architectural episodes and is interpreted by Bray and Echeverría (2010) to indicate two separate Inca occupations at the site, perhaps that of father Huayna Capac and, subsequently, his son, Atahualpa.

A privately-owned residential lot immediately across the street to the southwest of the core of the site contains the remnants of two large Inca stone walls of *pirca* construction (fieldstone set with pebble and earthen mortar), one almost 40 meters in length and the other over 50 meters. Once finished in painted plastered with trapezoidal niches, these enclosures likely formed two sides of an Inca great hall (Bray and Echeverría 2008). This rectangular architectural feature likely served as a space for feasting and potentially as lodgings for imperial subjects (Bray and Echeverría 2010). The proximity of the two imperial architectural features, the great hall and the water temple (less than 100 meters apart), suggests that these structures comprised part of a larger palatial Inca complex constructed within an area estimated to be approximately 10 hectares (Romero and Bray 2014:28).

In addition to historically derived dates for the arrival of the Spanish in highland Ecuador, the advent of the European invaders in the region may also be indirectly evidenced archaeologically at the site. The duration of Inca occupation at Caranqui was cut short by the Spanish invasion and thus may have resulted in a lower than expected frequency of Inca imperial ceramic vessels excavated archaeologically at the site (personal communication Tamara Bray 2012; Bray and Echeverría 2010; see regional comparative frequencies for Caranqui and Inca imperial vessels Bray 2003; 2005).

While an abundance of imperial vessels associated with *chicha* storage and service were not archaeologically located at the site, charred maize (*Zea mays*) kernels were recovered from archaeological contexts within two features and three other respective test units[4] at Inca-Caranqui. All maize specimens were found below the level of Inca occupation at the site (Bray and Echeverría 2010). Radio carbon dates confirm that these samples are associated with a time

[4] Test Unit 20, Level 9, Feature 6; TU 20, L8 (80-90 cm below datum); TU 76, L8, Feature 13 (79 cm bd); TU 29, L8 (85-95cm bd); and TU 74, L8 (66 cm bd).

earlier than the Inca or Late Caranqui, possibly signifying an early agricultural occupation associated at the site. Analysis revealed that the respective maize specimens, collected in 2010, share the characteristic of being fused together when wet. This finding suggests that kernels were charred when wet (Hastorf 2011: lab report #71). Wet kernels may reflect *chicha* production; often the brewing of *chicha de maize* would begin with the sprouting of kernels that occurs through dampening of the seeds (Hastorf 2011: lab report #71).

C. Ground Stone Tool Assemblage

The tools comprising the sample presented here includes complete manos (*n*=41), fragmented manos (*n*=128) fragmented metate (*n*=294), and one complete metate (Table 1.1). The sample includes three special metates, two of which are miniatures and the other is likely a fragment of palette perhaps intended to resemble a metate. There are also multifunctional tools (*n*=11) in the ground stone assemblage from the site which functioned as either a manos or metates but were also secondarily or concomitantly used for other purposes. Some of the more aesthetically pleasing tools were clearly crafted to achieve symmetry. Most all of the specimens in the sample, with few exceptions, were made of sturdy yet malleable raw material.

Table 1.1. Frequencies of Whole vs. Broken Manos and Metates

Artifact Class	Quantity	Percent of sample	Whole	Broken
Manos	169	36.4%	41	128
Metates	292	~63%	1	291
Multifunctional grinding tools*	11*	2.4%*	5	6
Special metates (miniatures and palette)	3	<1%	1	2

*Multifunctional tools were included in the table as a discrete unit and also in counts for both manos and metates

Manos and metates form a composite tool. Consequently, the contact surface of each reflects that of the other. These tools operate kinetically during contact through the buffer of an intermediate substance, such as grain. While holding the mano, one generally applies pressure through the upper body to impose force through the handheld tool upon the intermediate substances placed atop the contact surface of the metate (Fig. 1.2). Matter is ground by repeated applications of pressure and motion. The motion, referred to as *stroke*[5], is applied with the mano. The stroke is dependent primarily upon the grinding surface configuration of each element of the composite tool, as well as the material being processed, the desired consistency of that material once ground, and the ability or skill of the individual operating the equipment. For example, with a *reciprocal stroke*, or a back and forth motion, matter (often seeds) is processed and pushed off the *distal end* of the metate (the end furthest from the body of the user) into some form of catchment –usually a container or a cloth (as depicted in Figure 1.2).

For the majority of the metate specimens in the sample presented here, a downward motion of the body starting at the *proximal end* (the end closest to the body of the user) would follow the *longitudinal axis* (length) of the metate. In other parts of the Andes, *half-moon shaped rocker manos*[6] were relatively common and required a different motion to operate than that required when operating manos like those found at Inca-Caranqui. Presently, archaeological and ethnographic data does not suggest that the characteristically, half-moon shaped rocker manos of the southern and central Andes were part of the food processing toolkit in the northern highlands.

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[5] Mano stroke direction and motion has been analyzed by Adams (2002:100-114) on the basis of the tool morphology the use-wear traces. There are several different strokes that were utilized in the sample analyzed from Inca-Caranqui.

[6] Cutler and Cardenas (1947) refer to the half-moon-shaped stone rocker mano of the southern Andes as *maran uña,* and corresponding metates as flat stones or *maran.*

Figure 1.2. Mano and metate toolkit

The posture most associated with activity performed on toolkits similar to those found at Inca-Caranqui, is a kneeling position, with the metate pressed-up against the knees, thighs, or pelvis of the user, depending on the height of the metate (Fig. 1.2). With ones feet positioned under the sit-bones, it is necessary to lean-over some metates to effectively perform the work required. In many ethnographic contexts, metates are used on the floor or ground and are sometimes propped on an intermediary, such as a stone, so that the contact surface of the metate is at a vertical angle. An angle may be manufactured into the design of a tool or one may develop as a result of use-wear. Some specimens in the food processing assemblage from Inca-Caranqui evince being propped on an intermediary object, while others appear to have been placed directly on a relatively level surface such as the ground or floor directly. Activity with the toolkit could also have taken place with the metate positioned on an elevated surface such as a table or large rock, thus allowing the user to stand.

The *use intensity* of tools is defined as the amount of time spent at each grinding task (Adams 1993; 2000:118). Metates can be understood in terms of the manner in which they were used; *extensively* used metates are those used for more frequent but shorter duration tasks, while *intensively* used metates are those used for protracted, time-consuming, grinding tasks. (Adams 2002:271). Tool *curation*[7] is the practice of caring for tools in such a way as to maximize their utility (Shott 1989). Adams (2002) suggests that the behavior of tool curation can be evidenced through the addition of *comfort features* and *wear management strategies.* The former are small indentations chipped, ground, or etched into manos for the purpose of aiding the grip of the user. Wear management strategies encompass a range of maintenance activities that may include: the flipping and rotating of manos during use to balance the effects of wear; the sharpening of tool surfaces which become dulled through use; and the widening of metate troughs that become narrowed from the reduction of the mano. The employment of wear management strategies have been interpreted in some archaeological context as indicators of the intensive rather than extensive use of manos and metates (Adams 2002:118). This means that in some contexts, manos and metates used often for short duration tasks (extensive use) are less likely to contain evidence of wear management strategies than are equipment used for prolonged durations of time (intensive use).

Specific attributes associated with the modification of lithic materials establish whether tools were manufactured purposively, or whether items became "tools" through opportunistic

[7] Binford's (1973:242-251) original and, later, revised concept of stone tool "curation," has been argued and elaborated upon by lithic researchers. I find that perhaps a best definition of curation as it pertains to the ground stone assemblage from Inca-Caranqui is that presented by Shott (1989:24), "{Tool curation is} *the degree of use or utility extracted, expressed as a relationship between how much utility a tool starts with –its maximum utility –and how much of that utility is realized before discard."*

Curation is understood here as a tool-using behavior and as a continuous, not nominal, variable that is a characteristic of individual tools rather than an assemblage as a whole (Shott 1996).

usage by exploiting a rock's natural form. *Expedient*[8] objects are defined by Adams (2002:21) as those in which the natural shape of rock is altered only through use, while those of *strategic design* are defined as objects purposively modified to create a specific shape or form. Under this definition, the metates and most all of the manos from Inca-Caranqui would be considered strategically designed, despite many differences in the degrees of modification present among these tools. Here, I have expanded the category of expedient objects to include items exhibiting minimal modification. My alteration is at odds with the original definition presented by Adams but is perhaps not overly problematic in relation to the sample considered here. Because I believe it is important to distinguish between the more and less crafted appearance of tools in the assemblage, I retain Adams' terminology under her original rubric with the slight noted modification. For example, many of the apparent less crafted manos in the assemblage analyzed here, exhibit no signs of manufacture, yet these objects evidence the of presence of comfort features, such as *finger grips* or *groves*, these modifications offered more efficient performance and comfort during usage. Such features also may indicate the likelihood that a tool was curated.

The typologies constructed in this study used to describe tool types are based on activity (sensu Adams 2002:14-16). Technological aspects relating to design, manufacture, and use are emphasized, when drawing on functional typologies constructed in previous ground stone research. Since manos and metates form a composite tool and their contact surfaces reflect each other, the classification of manos, within a technological framework, is contingent on corresponding metates in an assemblage rather than the shape of manos (see Adams 2002:100). This manner of classifying tools is intended to facilitate meaningful comparisons among assemblages in future research.

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[8] The concept of an "expedient tool" was presented by Binford (1973:243). Dubreil and Savage (2014:139) refer to expedient ground stone tools as those of "*non-manufacture*."

A brief summary of metates and manos follows, with more thorough descriptions presented in the analysis section of this paper. While many specimens are large, heavy, and cumbersome, all of the artifacts in the sample are portable and many exhibit *post-manufacture modifications* that result from wear management strategies such as the addition of comfort features for better gripping manos and the undertaking of use-surface maintenance to sharpen and widen the trough of certain metates. The metates from Inca-Caranqui are undecorated and do not contains feet or legs. The apparent curation of many of these tools indicates a level of caretaking as investment in the viability of a tool during its use life (Aldenderfer 1998:98), and may also indicate the meaningfulness of these objects to their users. A small percentage of specimens appear to have served as multifunctional implements and contain *secondary use-wear* associated with *recycling*, *re-use*, or the *re-purposing* of tools.

1. Metate Designs

Metate specimens were divided into morphological designs based on attributes related to manufacture, use surface configuration, and use-wear patterns (Fig. 1.3). Additionally, undifferentiated metate fragments (*n*=34) were catalogued as those too fragmentary to assign type. Metates fragments consist of the following types: *basin metates* (*n*=11); *flat metates* (*n*=46); *flat/concave metates* (*n*=21); and *trough metates* (*n*=180). In general, troughs are relatively more crafted in appearance than other metate designs in the sample.

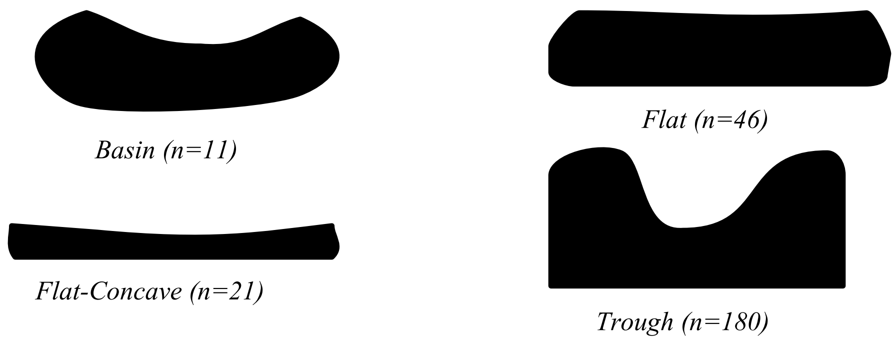

Figure 1.3. The relative appearance of metate types in cross-section

Troughs were further sub-divided into three sub-types based on attributes related to varietal and stylistics distinctions. In addition, a portion of the trough metate fragments (*n*=74) are consistent with trough designs but are too small to accurately subtype. *Open-trough metates* (*n*=50), contain open, unrestricted proximal end and distal ends. The sample from Inca-Caranqui contains only one complete metate from a functional category and it is a small-sized open trough. Using the morphological attributes of this complete specimen, I was able to surmise the relative original size of other, fragmented, specimens in the sample. This particular artifact is much smaller than other open-trough metates, and is more consistent in size with certain shaped *morteros* found in the region. The wear on this tool resulted from reciprocal strokes with a compatible-sized mano. *Three-quarter trough metates* (*n*=56), contain restricted margin walls and an open distal end similar to open troughs but also contain a restrictive back wall at the proximal end.

Finally, there is a category designated as, *special metates* (*n*=3). These items were likely not created to functions as a food processor. Two of the three special metate specimens are not fragmented.

2. Manos

In previous research, particularly studies from the Southwest, manos are often characterized as "one-handed" or "two-handed" (e.g. Ortman 2000). As these names suggest, one-handed manos are smaller in size when compared with those characterized as two-handed. The term one-handed manos generally implies that these tools were employed using a circular stroke, or to crush and pound, or possibly using a flat stoke or even a rocking stroke. The term two-handed implies a reciprocal (back and forth), a rocking stoke, flat stroke, or to crush and pound matter. The latter, two-handed manos, in many contexts, have been associated with the intensive processing of maize.

In this study, rather than using the designation of "one-handed" or "two-handed", the manos from Inca-Caranqui are characterized by the metate designs that they are compatible with. For analytical purposes, manos were also separated in categories based on the respective shape of their transverse cross-sections (Figure 1.4). When sorting manos in this manner, distinctions in tool shapes became apparent and manos of similar shapes were grouped together. From contexts in the Southwest, Adams (1993; 2002) has found that mano shape is not a result of manufacture but is rather an effect of use-wear. This too appears to be true for some of the manos in the assemblage from Inca-Caranqui, while others exhibit morphological aspects clearly related to manufacture. Ortman (2000) suggests that there are four potential sources of variation in large mano cross-sections: *manufactured shape*, *grinding stoke*, *wear management*, and the *reductive sequence* for the use-life of manos. Analysis of manos from Inca-Caranqui suggests that all four sources may have affected the variation of mano based on the cross-section.

Manos of strategic design that exhibit shaping through manufacture include many of the: *plano-convex* (*n*=40); *bi-convex* (*n*=46); *sub-circular* (*n*=16) varieties, which are generally

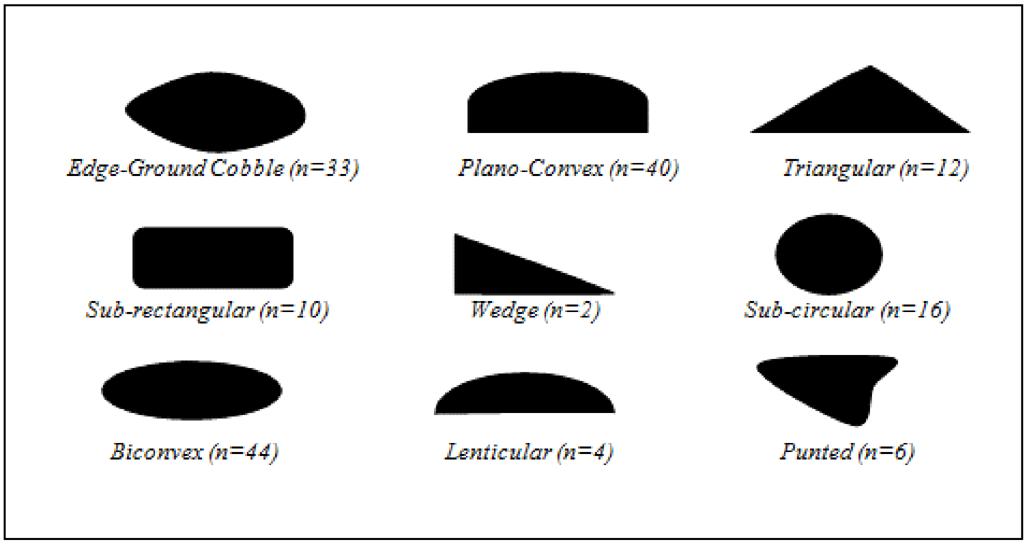

Figure. 1.4. Mano transverse cross-sections

circular in cross-section and conical in form. *Punted* manos (*n*=6) may also be included here insofar as all contain one special, rounded inverse thumb or finger indentation resembling a divot referred to here as a "punt" that are located in the same location for each specimen. With the exception of punted manos, the category just listed are large and exhibit wear that is consistent with a reciprocal or flat stroke during use. Some sub-circular specimens suggest that they were operated using a rolling motion similar to that involved in the use of a rolling pin. Other sub-circular manos in the assemblage contain rounded bands of use-wear, while several also exhibit distinct use-facets that number between one and four. Punted mano specimens each contain two use facets. Most plano-convex manos contain only one use-facet that contacts the surface of the metate when processing foodstuffs during use.

The bio-convex specimens that exhibit high levels of use each contain four use facets and share similar, if not exact, metric dimensions. Depending on the level of use and the employment of wear management, bi-convex manos contain two or four use facets. Among those bi-convex specimens with four use facets, it is difficult to determine if shape derives solely from wear management employed to balance the effects of the reductive sequence, or if the manufactured design contributed to the cross-sectional bi-convex shape of the well-worn specimens of this type in the assemblage.

The assemblage contains manos with cross-sectional shapes that may have resulted from a combination of the grinding stroke used, wear management, or the process of manufacturing. These include: *triangular* manos (*n*=12), and also *sub-rectangular* manos (*n*=10), which are relatively rectangular in profile, yet some contain rounded corners. Triangular manos were operated through a particular reciprocal stroke that is referred to as a *rocking stroke*, wherein users apply pressure to the proximal end of the mano on the downward stroke while keeping the distal end of the mano a little above the metate use surface. On the up-stoke the distal end of the mano contacts the metate and the proximal end is kept slightly above the metate (Adams 2002:114). This repeated action creates a rocking motion. The triangular manos in the assemblage contain three use-facets. Sub-rectangular manos are large, heavy and were operated with a flat, reciprocal stroke. Sub-rectangular specimens contain between one and four.

Also included in the Inca-Caranqui assemblage are *wedge-shaped* manos (*n*=2), which likely derive their form from a reductive sequence. Both of the wedge-shaped mano specimens contain two use-facets. The assemblage also contains *lenticular* manos (*n*=4). The shape of these manos derives from circular grinding strokes during use.

The final form of mano recognized in the Inca-Caranqui assemblage are referred to here as *edge-ground cobble* (*n*=33). These mano specimens are expedient tools modified only through use and the installment of comfort features such as finger grips. Most edge-ground cobble manos in the assemblage are relatively large and heavy and although they contain grinding surfaces, many lack the striations that result from use-wear which many other large manos exhibit. Instead, many of these tools contain relatively uniform and shallow impact fractures and many use-facets appear dented instead of abrasively worn. Adams (2002:42) describes *crushing* as a stroke which uses the weight of the tool (stone) to reduce the matter being processed and *pounding* as, "a more forceful stroke." Edge-ground cobble manos contain between one and four use facets and the ends of some specimens exhibit use-wear as well. The smaller specimens containing use-wear traces that are consistent with a circular use stroke

With the exception of punted manos and the smaller edge-ground cobble (n=3 complete specimens that measure ≤ 10 cm in length), all of the manos in the assemblage are (prior to becoming broken for fragmented specimens) relatively large. The variability found in mano shape may suggest that a range of somewhat different food-processing techniques may have been used related to the site.

3. General Observations

The most frequent ground stone artifacts excavated from Inca-Caranqui are metates and manos, yet the assemblage contains several other portable utilitarian and aesthetic ground stone items manufactured from an extensive variety of raw materials, and some of which exhibit high levels of technical skill. These artifacts represent a wide range of activities associated with Inca-Caranqui. However ethnographic analogies in the region do not provide insight into the functions of some items. Ground stone artifacts included in the site assemblage include: hammerstones, ground discs (figure 1.5a), maces, spherical stones (figure 1.5b), shaped mortar fragments, a Caranqui anthropomorphic effigy (figure 1.5c), small ornamental amorphous polished stones, canal sections and drain plugs, *tulpas* ("fire dogs" used to prop pots near a hearth), several preforms, presumed preforms and blanks, and various other artifacts potentially including tools and objects of unknown function, for example, a small conical pumice object.

Notable, are three massive, shallow, rounded, discoidal *morteros* (mortars) (figure 1.5d). These large morteros are composed of hard granular material, each weighing in excess of 65 kg and standing approximately 40 cm in height. Of the abundance of other ground stone artifacts from the site, only manos and metates appear fragmented with such frequency. The tools used to manufacture these implements as well as the other ground stone examples in the assemblage, were not recognized at the site, nor was there debitage recognized resembling flakes created during tool production. However, various sizes of blanks and preforms, many resembling rectangular blocks, were found at the site.

Five preforms or shaped stones that contain archaeological provenience[9] were found at levels lower than what is associated with Inca occupation. Four of the five preforms or shaped

[9] Test unit 55, level 7; TU 56, level 5; TU 70, level 5; and Feature 12, test units 55 & 70, levels 9 & 10.

stones are composed of a similar heavy, dense, fine-grained, non-vesicular, blue material. This raw material type appears unique to these items, since no other ground stone artifacts found at the site are comprised of this material. The other preform or shaped stone are composed of coarse-grained vesicular material unlike the types of vesicular materials used to make manos and metates found at the site.

Figure 1.5. Ground stone from Inca-Caranqui**:** *a*. ground disc; *b*. spherical stones; *c.* Caranqui effigy; *d*. large morteros (with shaped blocks in the background)

4. Provenience Information

In 2006, the local bureau of cultural patrimony (FONSALCI) acquired the land on which the central core of the Inca site is located and began preliminary investigations. Many of the specimens in the sample were recovered during the initial clearing of the site before systematic archaeological excavations began in 2008. As a consequence, the precise location of these objects was not recorded. Additionally, some artifacts were casually collected as surface finds and again, their proveniences not systematically documented.

When FONSALCI first reconnoitered Inca-Caranqui, the now defunct bureau created a map recording the vertical locations for some ground stone artifacts found during their initial investigation of the site. The map contains an alphanumeric grid comprised of an *x* and *y* axis. A corresponding *x-y* coordinate was included on the identification tags of some artifacts, although depth, or more precise horizontal location, was not also recorded for these artifacts. Based on the locations recorded, I was able to surmise that most all of the grinding stones mapped in this manner were collected within the water temple feature and immediately to the north and west of this feature (n=28: 13 metate fragments and 15 mano fragments). It is not known whether these items were found on the surface, or within the fill that covered the temple, or if they resting directly on the plaza floor. From the early map, it also appears that these artifacts were found within close proximity to each other, perhaps even in concentrations. Other manos and metates in the assemblage also may have derived from the same or nearby contexts but had no assigned coordinates associated.

Provenience was determined archaeologically for each artifact excavated from 2008-2010 and includes information on associated features, test units, and levels. As mentioned previously, the site contains two phases of pre-Columbian occupation represented in an Inca period and a pre-Inca period, which includes the Caranqui and an earlier phase of occupation prior to the Caranqui. For purposes of analysis, the occupations were treated as two homogeneous units with *Levels 1-3* assigned to the Inca occupation, referred to as *Level I*, and *Levels 4-12* assigned to the pre-Inca period, referred to as *Level II* (Table 1.2).

Table 1.2. Distribution of specimens with provenience by occupation level

Specimens	Total	*Level I*, Inca	*Level II*, Pre-Inca
Manos	169	4	23
Metates	295	16	27
Totals	464	20	54

Unfortunately, only 16 percent of the site sample has precise provenience, thus limiting the scope of statistical comparison of items by time periods. For the portion of manos and metates containing adequate provenience information (*N*=74), those associated with the Inca level of occupation (*n*=20) comprise little more than four percent (4.3%) of the entire sample, and those from the pre-Inca occupation level (*n*=54) comprise nearly 12 percent (11.6%) (Table 1.2).

From *Level I*, the upper, Inca levels of occupation, four mano fragments were excavated with each exhibiting strategic design. Also from *Level I*, 16 metates fragments were excavated; (*n*=14) exhibit strategic design and (*n*=2) of expedient design. From *Level II*, the lower, pre-Inca levels of strata, 23 manos (*n*=8 whole and *n*=15 fragments) were excavated. Of those manos fragmented, *n*=14 exhibit strategic design. *Level II* also yielded 28 metate fragments. Of these fragmented specimens containing provenience, there is only one example of adjoining fragments found *in situ* together. In this instance, the two metate fragments[10] were excavated during the

[10] Items is possibly a palette

Figure 1.6. Metate fragment re-fits found *in situ* together

2008 field season and only comprise a portion of a much larger original tool. No other fragments containing provenience, whether adjoining *re-fits* from or from separate areas of the same original object, were found within the same context (e.g. level, unit, or feature). *Re-fitting* is the activity of 'matching-up' the fragments of an original tool, with a *match* as the rejoining of two or more fragments (Schelberg 1997:1017).

The archaeologically excavated specimens were found in a variety of contexts at the site. For instance, metate and mano fragments were included in the small rock pile capping one of the pre-Inca burials dating 39 BC-AD 82, and were found in association with other burials contexts at the site. They were also found in association with a hearth feature, adjacent to canals, and in the overburden covering the semi-subterranean water Inca temple. As *in situ* elements, they were found in contexts with ceramics, other lithics, faunal remains, carbonized maize, human remains and disarticulated human remains.

During the latter part of the twentieth century, the property that the site of Inca-Caranqui is situated on was exploited by a small-scale brick making operation. In 1998, the Instituto Nacional de Patrimonio Cultural (INPC) conducted test excavations at the lot. At that time, some sections of the canals were exposed but the semi-subterranean water temple was not discovered. The manos and metates found within the lower levels of strata during archaeological excavations at the site, e.g., Level II, are similar to those recovered by FONSALCI in 2006-2007. Based on these similarities between the tools collected by FONSALCI, and those collected by the Inca-Caranqui Archaeological Project team between 2008-2010, I have surmised that the artifacts comprising the food processing assemblage from the site were manufactured before the arrival of the Spanish in the region.

5. Lithic Raw Material

Characteristics of the raw materials used to make ground stone tools from Inca-Caranqui were considered for their potential importance in understanding typological, functional, and conditional aspects of the artifacts in the assemblage. Most all specimens in the sample were manufactured from igneous lithic materials that are andesitic[11] or dacitic in composition and presumably of local origin. With noted exceptions in this report, the lithic materials are not categorized by common geological names (e.g. rhyolite, gabbro, or scoria) but rather by the characteristics and specific qualities pertaining to texture and grain. Approaching lithic material in this manner emphasizes that material selection was a significant technological choice in the

[11] Different types of andesite comprise the most prevalent raw material in the assemblage of manos and metates from the site. In archaeology, procurement of materials can depend on the availability of materials locally, as well as the on the quality and quantity of materials.

Although a typology of raw materials was not developed during this study, I did recognize basic rock types. The rock types used to make these tools vary widely in mineral composition and structure even though many of these materials may have originated from the same or adjacent locations. There are three major rock types present in the sample andesite, dacite, and granite. Basalt and rhyolite may also be represented in the sample.

Most of the andesite varieties found in the sample are generally medium gray to a pinkish-gray and slightly porphyritic. The phenocrysts in these andesites are white to light gray, also present is black hornblende, or augite crystals and white to light gray crystals plagioclase set against the fine-grained gray or pinkish-gray groundmass. Other andesite varieties found in the food processing assemblage from the site are reddish in color and some are vesicular. The vesicular rock varieties found in the sample may be andesite or basalt. Many of the vesicular specimens are fine-grained. Some contain amygdaloids, vesicles that became filled with secondary material after the initial formation of the rock.

production process. For instances, basaltic andesite and basalt are often quite similar in terms of texture, grain, and density. The processing of crystallization differentiates certain andesites from certain basalts. When comparing a particular sample of basaltic andesite with one of basalt, it can be difficult to determine the differences between the two since andesitic and basaltic (as well as dacitic) materials are similar in chemistry and composition. Additionally, Ogburn (2008:48-49) advises to use specific rock names cautiously in archaeological analysis unless derived from recent geological analysis, noting that for the Inca, construction materials were not always derived from the closest or most convenient quarry to a particular project. Therefore, for purposes of this study, lithic material is divided into two overall categories referred by general surface texture, as *vesicular* and *non-vesicular* (*granular*) material. The latter ranges from fine to medium-coarse in grain (most aphanitic, porphyritic, or phaneritic), with these specimens being relatively smooth in texture when compared to the former. Vesicular rock contains small vesicles or cavities formed by expanding gas or steam during solidification causing the surface to become relatively rough in texture (Bates and Jackson 1984:55). These two general categories will be further elaborated when defining specific characteristics relating to the texture of respective specimens.

While the scope of this study did not include the sourcing of the lithic materials, the local landscape contains an abundance of readily accessible volcanic rock suitable for food processing tools. Over the course of several field seasons, I had the opportunity to explore two intermittently dry stream beds at the bottom of two separate *quebradas* (ravines) within the foothills of Mount Imbabura, just a few kilometers south of the site, near the indigenous village of San Clemente. The bottoms of these quebradas are veritable cobble quarries that run continuously for kilometers, as are many of the other local streams flowing from the nearby volcano. These quebradas would have offered a ready source of suitable grades of stone for both construction and tool manufacture. Many water-worn cobbles contained in these stream beds possess seeming symmetry, making many ideal to employ as certain tools in which proportional evenness is desired.

II. Regional Context and Previous Research

A. Pais Caranqui

The highland portions of Imbabura Province and the northern portion of neighboring Pichincha Province once comprised the homeland of the ethnic Caranqui, a socially stratified group containing many distinct polities (Bray 1991; 1992; 2005). The Caranqui are sometimes referred to archaeologically and historically as the Cara (e.g. Athens 1992; Cobo 1990 [1635]; Murra 1946). The most prominent polities of this ethnic group were the Caranqui proper, and also the Cayambe, Cochasqui, and Otavalo (Bray 2005). Bray explains that each polity contained communities with "semi-urbanized centers," in which smaller satellite sites were also incorporated (Bray 2005:120). In ethnohistoric reference, the Caranqui have been portrayed as skilled craftspeople, weavers, and tanners who wore cotton, wool, and hide (Murra 1946:763 and 794; Juan de Velasco as cited in Parsons 1945:2). Caranqui ceramic vessel assemblages indicate that this cultural group, like many others in the Andes, brewed chicha (Bray 2003:128).

The social hierarchy of the Caranqui is demonstrated in the region by the large number of artificial earthen constructions or sacred mounds, referred to as *tolas,* that once numbered in the thousands (Athens 1980; Bray 2003; 2005; Jijón y Caamaño 1914). Many of these special constructions date to the Late Period (AD 1200-1500), before the appearance of the Inca in the area (Athens 1980; Bray 2003). Several *tolas* are scattered throughout the modern villages of the region, yet sadly nowhere near the profusion which the landscape hosted in the recent past. Within just blocks of Inca-Caranqui, and elsewhere around the region, *tolas* are being demolished for the fabrication of adobe bricks, ironically purposed for new constructions. Local cultural resource managers report that the destruction of these *huacas* (sacred places and things or shrines) is occurring at an alarming rate throughout the area. The community of San Clemente contains small *tolas* that are communally viewed as representations of the group's ancestral past.

The most prominent *tola* sites in the region are those of Cochasqui and Zuleta. These sites contain impressive complexes of large truncated, ramped pyramidal-like mounds accompanied by numerous smaller earthen constructions.

Other prominent regional archaeological features include *pucarás* or hilltop fortresses. These pre-Columbian constructions are dispersed around the Pais Caranqui, strategically placed atop selected hills. For the Inca, *pucarás* were constructed defensively as fortifications built in provincial regions. Examples of these fortresses constructions dot hilltops throughout the region, most notably Rumicucho and Pambamarca. The latter is a fortress complex constructed in the homeland of the Cayambe (ethnically Caranqui). The largest Inca construction at Pambamarca is Quitoloma, a massive architectural compound containing high, outer, concentric walls with more than 100 inner structures.

Yaguarcocha or "blood lake" is located approximately 3km from central Ibarra and figures prominently in regional history. The lake is depicted as the site of a massacre perpetrated by the Inca army of Huayna Capac at the expense of the local Caranqui male population in approximately AD 1500 (Salomon 1986a:145-146, 1987:67). The Caranqui banded together with other local ethnic polities in attempts to stave-off Inca invaders, who had, for several years, sought control of the region. A resistance likely comprised of a Caranqui-Cayambe-Cochasqui-Otavalo coalition was defensively successful for at least a decade or more, yet eventually succumbed to the Inca (Murra 1946:808; Salomon 1986b:91). At the conclusion of the long military engagement, the Inca allegedly slaughtered a large portion of the region's indigenous male population, designating Yaguarcocha as the place of execution (Echeverría 2007). Local legend contends that the water turned red from the blood of the men who perished, their bodies allegedly jettisoned into the lake (Cobo [1653]1979:155-159). Bray and Echeverría postulate the construction of the subterranean water temple feature at Inca-Caranqui may have commemorated Inca triumph over the Caranqui and the events that occurred at Yaguarcocha as a result of that victory (personal communication Bray and Echeverría April 2012).

Pre-Columbian *camellones,* or raised fields, have been located archaeologically in the region, many dating to the Late Period (Athens 1992:207; Echeverría 2004; Bray 1991; 2008b:534). *Camellones* are artificially mounded beds, generally constructed in a series, separated by lower-lying irrigation ditches intended to control excesses and deficiencies in water. Those found in archaeological contexts in the region are generally a few meters high and wide and several meters long with adjacent ditches mirroring these dimensions in adjacent ditches. In addition to normalizing influxes in water supplies, *camellones* regulate soil temperatures and reduce the likelihood of frost for crops while facilitating year-round cultivation (Knapp 1991:158-159). The moist organic matter stewing in *camellones* ditches can be used to fertilize and reinforce planting beds. Some *camellones* in the region are associated with *tolas* (e.g. at Cayambe and on the San Pablo plain) (Athens 1980; Bray 1991; Knapp 1991:154-157). Knapp (1991) believes that a large flat land area on the southeastern side of Ibarra, near Caranqui, likely contained raised fields. He explains that this plane contains soils similar to the raised fields nearby in Otavalo, San Pablo and Cayambe (Knapp 1991:156). Additionally, the author explains that *camellones* were mentioned in a historic Spanish land annexation dispute document dating to 1635 from Ibarra, and also from a 1595 Spanish document that refers to *camellones* in the Caranqui area of Ibarra (Caillivet 1983:13; Knapp 1991).

By Spanish arrival in Ecuador, many varieties of maize could be found throughout the Andean realm, in several areas the cereal has been used as food since pre-ceramic time (Bonavia 2013:222). Demographic information collected by Paz Ponce de León, Spanish *corregidor* (a colonial administrative and judicial position) of Otavalo in 1582, concurs that maize was one of the main crops cultivated in the region before and during the time of Inca rule (Newson 1995:34). At some sites in the northern highlands it appears that maize was simultaneously cultivated both as a sacred crop and for subsistence purposes (Cuéllar 2012; Lippi *et al.* 1994).

The maize specimens excavated at Inca-Caranqui date to much earlier than the Late Period, indicating an early agricultural component associated with the site. Nearby, early and extensive maize agriculture has been identified in sediment cores extracted from Lago San Pablo (Athens 1992; 2008) located outside of the modern city of Otavalo, on the south side of Mount Imbabura opposite Caranqui. Maize pollen and maize charcoal found in the lake were dated to ca.4200 years ago (~2200 BC) (Athens 1999:161).

Archaeologically, maize has also been recovered throughout the region during to the Late Period (Athens 1978:116). Athens (1978) notes the common occurrence of various kinds of grinding stones, including trough metates, at Late Period sites in northern Ecuador and remarks that they are suggestive of the importance of seed processing—most likely maize, but also perhaps quinoa (*Chenopodium*) (Athens 1978:118). Salomon (1986:73-75) posits that maize was among the prime cultigens in the northern Andes economy and was grown in all inter-Andean *llajta* (respective native group lands). He describes the northern highlands as a rich "maize land" and reports that during the Inca Period, maize was one of many foods comprising a broad pantry of vegetables, tubers, legumes, fish, and quinoa in the region (Salomon 1986:110-115, 1987). Social factors led the region to heavily cultivate the grass and Salomon draws on historic references to explain that, invariably, maize played an important role in production of the intoxicant *chicha* in the northern highlands, as it was used for rituals of the region (Atienza [1575?] 1931:52 as cited in Salomon 1986:76). Salomon refers to the northern highlands as the "maize Andes" in contrast to the Central Andes of Peru which he refers to as the "potato Andes" (Salomon 1986:74).

In addition to the cultural implications that led maize to become heavily cultivated in the region during the Late Period, warm days and cool nights on the region's vast expansive humid flats contain arable land that were well-suited for growing the grass (Mothes and Knapp 2008:140). The lower elevations of the north afford an environment that is wetter and more temperate compared with other areas of the Andes. The intermontane basins of the region enjoy a relatively mild, humid equatorial climate, experiencing few extremes in temperature. Although consistent humidity persists year-round, the region experiences separate and prolonged wet and dry seasons with pocketed precipitation occurring in higher altitudes during the dry months. These seasonal variations in the volume and regularity of rainfall necessitated the implementation of horticultural irrigation systems, such as the *camellones* described above (Fresco 2003:249).

If present climate conditions approximate those of the past, Caranqui could have hosted abundant and diverse wild plants and domesticates. Athens (1992) aptly refers to the northern highlands as a, "mosaic of closely juxtaposed microenvironments" (Athens 1992:195). The region is a heterogeneous biome containing closely-positioned, broad ecological zones; many vertically oriented and defined by elevation. Within this landscape, encompassing high altitude pastures and lower flat agricultural lands, altitudinal variation is punctuated by snowy peaks located within close proximity to tropical forests and the temperate level plains ideal for the cultivation of maize.

B. Ground Stone Tool Research

1. Terminology

Prior to presenting more detailed data for the sample, it is important to first address certain aspects pertaining to ground stone craft production, *chicha*, and intentional fragmentation. For purposes of the present discussion, I will first present a general overview of tool design, manufacture and utility within prehistoric practice follows, and too, terminology and the contexts with which food processing tools have been associated within Andean archaeology.

The most common referent for metates and manos is food. In archaeology, food processing tools generally have been perceived as indicating the emergence and importance of cultivated plants within diet and, in many contexts, the creation of domesticated landscapes. The catalytic nature of this toolkit, used to transform resources to a more useful or desirable state, is understood in terms of expanding nutritive options, not only for cultigens, but also for wild foods and animals-based foods (Stahl 1989). More dynamic models emphasize the importance of these tools when addressing the expansion of complex human cognition and the escalation of symbolic behavior. Further, food processing tools have been interpreted in some contexts as contributing indicators of diachronic social change. For example, Hastorf and Johannessen (1993) found that increases in maize cultivation were linked to political changes over a thousand year period (from AD 500-1500) in the Mantaro Valley, Peru. Maize, once a crop cultivated for food in the region, became produced almost entirely for the production of *chicha*, thus paralleling the trajectory of political changes and the emergence of the Inca within region (Hastorf and Johannessen 1993). The authors found that as isotopic and archaeo-botanical evidence for the intensification of maize cultivation increased, so did grindingstones (Hastorf and Johannessen 1993:124-126).

In many Andean contexts these implements have been interpreted to evidence *chicha* production. In some cases it seems that there is little basis for this conclusion besides the presence of grinding stones. In other instances, these tools have been interpreted as material contributors in the signaling of *chicha* production when found in association with other materials and specific contexts (e.g. Moore 1989; Morris 1979; Prieto 2011).

As grinding tools, food processors constitute a form of technology; the incorporation of knowledge and behaviors associated with the crafting and use of implements (Adams 2002; Schiffer 1992). Within this framework, tool design is understood as a characteristic of respective technological traditions, reflecting modes of social or economic organization. Adams (2002, 2011:294) recognizes distinctions in similar tools categories for respective cultural groups based on the analysis of specific attributes relating to design and explains that some technological attributes are temporally and contextually specific. Examining the life history of tools permit analyses that look at whether variations in morphology result from differences respective trajectories of tool use or whether morphological distinctions derive from specific tool designs (see Adams 2002:18,144).

General-processing tools have been used as food processors but were not specifically designed as such in the same way that metates and manos are (see Adams 2012:313). Metates and manos are distinguished from other somewhat similar ground stone artifacts, such as mortars and pestles, on the basis of function; metates and manos are primarily associated with food processing (Adams 1996, 1999:480, 2002:99, 2011:297; Russell 1988). Like mortars, the metate and mano toolkit can be used to make medicine and to process bone, clay and minerals,[12] as well

[12] Clay and minerals in this example refer to those used outside of food production, for example, clay for ceramic production or building. In many instances clay and minerals have been processed as food or dietary supplement, as in the case of geophagic clay as a dietary aid (see Stahl 1989:174).

as paint, pigments, plaster, shell, temper, or fiber. However, the most common association of metates and manos is with food. Many archaeological and ethnographic contexts relate these tools with grain grinding yet also with the processing of other plants and organic matter including insects, fish and animals. An example of the latter, from Andean contexts, is reported by Shimada (1994) who associates a "*batan"* and a "cobble pounder" with the removal of marrow from the long bones of fragmented llamas remains found within the same context at the Intermediate Moche site of Pampa Grande on the north coast of Perú (Shimada 1994:191).

In other Andean archaeological, ethnohistoric, and ethnographic contexts, food processing tools have been referred to by a variety of names including *chungo, chungas, manizuela, tonay, tunay, tunan, tunaukuna* for the upper handheld stone, and *k'iaña, kutana rumi, malay*, *maran*, and also *mealing stone* for the lower stone (Cobo [1653]1990:195; Cutler and Cárdenas 1981:251; Garcilaso de la Vega [1609] 2006:74; Russell 1989:271; Salomon 1978:110; Saville 1910; Shimada 1994:222; Marcus 2009:318; Valdez 2006:68; Weismantel 1988:21). The chroniclers Garcilaso de la Vega and Cobo report that the Spanish referred to the toolkit as *batàn,* likening them to fulling mills[13]. The local name, *maray*[14] has also been recorded for the toolkit, with the bottom stone called a *callacha* and the top stone a *tanay* (Cobo [1653]1990:195). In English, these implements have been referred to as grinding or "milling" stones/tools[15] due to their association with the processing of cereals and other seeds into flour. I chose to use the terms *manos* (Spanish) and *metates* (15th -century Spanish from Nahuatl, *metatl*) as this is a common referent used in the archaeological literature by local archaeologists working

[13] Fulling was a process of cleaning wool to remove insects, dirt, and oil that involved pounding.

[14] Based on Cobo's description, *maray* seems to refer to the toolkit as a whole: "We have given this implement the name *batàn* because it grinds like a fulling mill. The Indians call it *maray*; the bottom stone is called *callacha* and the top stone *tanay*" (Cobo [1535]1990:196).

[15] Some ground stone researchers reserve the term "milling" for the mechanized processing of grain.

in highland Ecuador (e.g. Echeverría 1977:207; Porras 1980:197,267; personal communication José Echeverría July 2009).

Manos and metates are commonly thought to derive from the object category 'ground stone,' which is also referred to by the synonymous term, 'macro-lithic tools'. This category, encompasses an extensive range of objects that have been broadly defined by some researchers to include: stone utilitarian and nonutilitarian objects used to abrade, crush, drill, grind, impact, polish or smooth; and also objects created or modified through any or all of these mechanisms (Adams 2002; 2013; Adams *et al.* 2009; Clark 1988:83; Dubreuil and Savage 2014; Rowan and Ebeling 2008:2; Schneider 1996; Semenov 1981; Zurro *et al.* 2005). An alternative characterization of food processing tools such as metates and manos, positions them outside the category of ground stone, defining these tools as 'grindingstones' (Dubreuil 2001). Differentiating grindingstones from other stone objects, this perspective choses to view items such as metates, manos and mortars as representing specific action; intended to reduce material into particles by crushing, pulverizing, and grinding (Dubreuil 2001:73).

As many ground stone researchers have appositely pointed-out, in contrast to other artifact classes, there is a relatively small array of works published on ground stone tools, with even fewer still based on assemblages from Andean contexts. General perceptions of these tools position them within the realms of the mundane. Ground stone is not obvious and can be relatively easily overlooked during excavation due, in part, to modifications that may only be minimal (Banning 2000:151; Kraybill 1977; Schneider 1993; Shelley 1983) and also, arguably, the seeming banality of many objects lends them to be overlooked. As mentioned earlier, the lack of local literature necessitated relying on works from other areas for interpreting the food processing assemblage from Inca-Caranqui. Yet even outside the Andes, the field of ground stone research has struggled to assert a distinctive identity within realms of lithic research. This issue is exemplified by a lack of a systematic terminology and an over-reliance on terms borrowed from chipped stone tools (an issue further complicated by the fact that many ground stone tools can also be chipped) (Rowan and Ebeling 2008; Schneider 1996:64). Further, the differentiation between ground and flaked tools can become obscured since stone is often ground in preparation before being effectively flaked in later stages of manufacture (Rowan and Ebeling 2008; Schneider 1996:69).

Many ground stone researchers advocate for unified approaches to identification, terminology and analysis (Adams 1997; 2010; 2013; Adams *et al.* 2009; Clark 1988:83; Rowan and Ebeling 2008; Wright 1992). Normalized terminology is intended to better facilitate future research and to highlight distinctions between ground stone and other lithic categories. However, even among researchers advocating a more standardized approach, there is still terminological ambiguity (Dubreuil 2001; Schelberg 1997:1018). For instance, manos and metates are most commonly interpreted as a food preparation toolkit (Adams 1996), but some researchers have also noted the use of these tools in other activities outside of food. The inherent flexibility of these tools lends them to be secondarily utilized outside of food once they are perceived as obsolete, or they break, or they become exhausted of effective food processing utility. Some archaeologists have also exploited this characteristic flexibility to ascribe function to these tools outside of food-processing. Other tools may appear similar but functioned outside of food, for example as hide processors, hence illuminating the importance of wear analysis (e.g. see Adams 1988:313-314; Aldenderfer 1998:97-98). Tribology is the study of wear mechanics of contacting surfaces. Adams (2013:1) defines wear through a tribological frame, in which wear is understood as the "progressive loss of substance from the surface as a result of the relative motion between it and another contact surface."

In the Andes, terminological ambiguity arises in archaeological reporting as some researchers use the same terms for food-processing implements as they also use for tools associated with other activities, such as metallurgy. For instance, in the previous example of grinding tools used to process animal parts for food, Shimada (1994:191) uses the term *batan* for the tool likely used to aid in the extraction of marrow from llama bones. The same term, *batan,* is used by Shimada *et al.* (1982) to describe a tool used to process slag created in copper processing during the Inca Period at Batan Grande, the Sicán complex within the La Leche valley on the north coast in Peru:

> The grinding of slag and the recovery of copper prills may have been done by other labor units distinct from those in charge of the furnaces. Slag grinding with *batan* and *chunga* is not a particularly physically taxing or time-consuming task. The recovery of prills is a tedious task that requires time and patience but no special skills or strength. This task could have been performed by women, elders, or children. The Inca state allocated work quotas to heads of households who were assisted in fulfilling these obligations by any able-bodied members of the household [1982:957].

In another section of the same text quoted above, the authors offer a more thorough description of the implement referred,*"…batanes* (large, tabular mortar-like stones used in conjunction with *chungas* or rocking stones)" (Shimada *et al.* 1982:954). In an ethnographic example, from the same area in the north coast, Hayashida (2008) refers to wooden *batanes* and stone *chungas* that were used during an experiment which the author conducted to approximate aspects of pre-Columbian *chicha* production:

> A few of the Lambayeque households still have large, wooden *batanes* or grinding troughs with their corresponding ovoid rocker stones, or *chungas*…The millers were two women using the same *batán* and *chunga* set (one that has been in their

> household for many years), and one man using a *batán* and *chunga* from the ethnographic collections of the Sicán Museum [2008:168-169].

From the three examples quoted above, and also from other sections of Shimada (1994), Shimada (1982), Shimada *et al.* (1982), and also Shimada (1981),[16] one would reasonably assume that the respective authors are referring to the same tools since the examples occur within the same area, and also since there is shared authorship in Shimada (1981, 1982, 1994) and Shimada *et al.* (1982). Additionally, the tools used to perform Hayashida's (2008) experiment came from the Sicán Museum –an institution which Shimada, Epstein and Craig likely contributed to the interpretations of collections. Moreover, Shimada (1982) uses the terms *batanes* and *chungas* interchangeably to describe tools used at Pampa Grande in the north coast for metallurgical activities and also those used in maize processing, even though the author found evidence indicating that *chicha* production and metallurgy were occurring within the same complex (Shimada 1982:159, figure 10).

2. Maize Processing Tools

In many Andean contexts, manos and metates have been found in contexts interpreted as reflecting increased agricultural production which is often the result of a shift to maize reliance

[16] "*Batan* is an anvil with a circular concave depression used in conjunction with a *chunga*, rocking stone, to pulverize various materials" [Shimada 1981:433].

In describing an area within the site containing dense concentrations of materials related to metallurgy, Shimada *et al.* explain :
"The area also contains the heaviest concentration of *batanes* at the site. Within an area with a radius of 25 meters, 12 *batanes* are visible on the surface, most measuring about a meter in diameter and deeply worn and polished from use. Numerous *batanes* have been removed from the site within the past 50 years. Those present at the site probably represent only a small portion of the original number" [Shimada *et al.* 1982: 955].

Shimada (1994) found ground stone tools in association with *chicha* production, metallurgical activities, and ceramic craft during the Middle Horizon, Moche V Phase at Pampa Grande. The author uses *batanes* and *chungos* to describe tools used to grind maize in the preparation of *chicha* (Shimada 1994:221-222) and also for tools used to grind slag (Shimada1994:203). He describes *batanes* as "anvil stones" and believes that *chicha* was likely made in two areas of the Pampa Grande complex based on contexts containing specific ceramic vessels, carbonized maize, a *batànes*, and a "*batàn-chungo*" (Shimada 1994:144).

(Coleman Goldstein 2008; Lippi *et al.* 1984; Pearsall *et al.* 2004). Eliciting functional parallels to desired conclusions (i.e manos and metates equal *chicha*), some archaeologists have interpreted metates as indicators of maize agriculture and the production of *chicha* when there is may be little evidence to support the claim. Many sites in the U.S. Southwest and Central America contain large numbers of relatively finely manufactured metates in contexts relating to the processing of maize (e.g., Schneider 1996; Shelley 1983). The trough type metate, in particular, has been identified as the preferred form for the grinding of maize in various ethnographic and archaeological contexts (Adams 2002; Hayden 1987; Hayden and Nelson 1988; Odell 2004; Schlanger 1991; Searcy 2011; VanPool and Leonard 2002). In the U.S. Southwest, Adams (1999:491) has found that maize was prepared through parching, roasting, popping or stewing, therefore the cereal did not necessarily need to be processed with mano and metate, thus negating the need for the effective design of these tools.

Changes in mano and metate morphology have also been linked with increased food production, greater reliance on maize and specialized craft production. In some cases these inferences are substantiated (see Clark 1988; Mauldin1993) yet often, morphological differences do not necessarily reflect functional or food-related differences or increased levels of production (Horsfall 1987; Schneider 1996:94). A general critique of analyses related to ground stone tools, suggests that functional inferences are often based on the size and shape of tools (Adams 1993; 1999; 2002; Kornbacher 2010). In archaeology, the morphology of tools is often connected to intended longevity of use rather than function (Kraybill 1977). In the context of La Libertad, Mexico, Clark (1988:93) found links between the overall size of metates and their function; larger metates were used for maize grinding and smaller metates were assigned to miscellaneous grinding tasks.

Research has supported the association between trough metates and maize processing within many contexts but there is also evidence for a different model in which flat metates were preferred for grain processing in some contexts (Adams 1993). Adams (1993:331) believes that morphological variation in manos and metates was not entirely based on changes in the production of food but rather may also have social and behavioral implications. Through experimental studies, Adams (1993) found a relationship between grain processing and metate morphology. She analyzed technological aspects of grinding maize on metates using three common metates types found in the U.S. Southwest: *basin, trough* and *flat*. Her goal was to determine which metate offered the best grinding *efficiency* (the economy of energy and time exerted while grinding) and *intensity* (the quantity of time spent during a single grinding episode) (Adams 1993:334). Ideally, one would want to spend the least amount of time possible to grind the largest quantity of maize possible.

The results of Adams' experiment revealed that basin metates were the least energy efficient but their surface configuration allowed users the opportunity to reduce muscle fatigue by changing mano stroke direction during use (Adams 1993:338). Work performed using trough metates allowed users to more quickly crush larger amounts of kernels in comparison to with basin and flat metates (Adams 1993:338-339). Both hands can be applied to a trough mano, which produces greater force by engagement of the user's shoulders and back (Adams 1993:339). The drawback to using the trough is that stroke direction cannot be altered during use (Adams 1993:338). Work performed on flat metates allowed users to change stroke direction, even when using both hands, these metates lack restrictive borders so grain spillage is inevitable (Adams 1993:339). A catchment system is necessary when using flat metates to collect the spilled grain and Adams remarks that walled bins, a somewhat common feature in the U.S.

Southwest, were erected around flat metate for this purpose (Adams 1993:339). The results of the experiment led Adams to propose a more dynamic model of changes or variations in metates in the some Southwest contexts, wherein differences in grinding tool configurations were affected by different grinding techniques, personal preferences, available lithic materials, and learned behaviors (e.g. increased efficiency and managing the use-life of a tool) (Adams 1993:340,342).

In a more recent study, Adams (2011) suggests that broader social changes may have been the impetuous for changes in metate morphology and finds evidence that design attributes were characteristics of specific technologies at different times. In an example of the Hohokam in Arizona, she found that metates and manos changed after A.D. 450. Prior to that time basins and flat/concave metates were used with manos shorter than the width of the metates (Adams 2011:294). After A.D. 450, open-trough metates were manufactured and were used with compatible manos (Adams 2011:294). She found that grinding tools became more formalized, making them distinct from earlier designs, and links these morphological transformations to changes in food processing strategies (Adams 2011:294). Similarly, Vanpool and Leonard (2002) also found parallel changes in metates with intensifications of social complexity at the local and regional level. The authors found that the morphological standardization of metate forms were both an indicator of social differentiation and regional hierarchical-ranking (Vanpool and Leonard 2002). Adams (1999) suggests that, in many contexts, trough metates and compatible manos were designed to be more efficient in grinding dried seeds than other technology formerly used by certain cultural groups, such as basin and flat/concave metates.

Within the Andes, an experiment on grain processing rates in Bolivia, reported by Mauldin (1993:318-319), tested different sizes of manos and metates in order to determine which ground more effectively and to substantiate arguments made in previous research from the Southwest which posit mano size as an indicator of increased levels of agricultural intensity. Mauldin conducted twenty-four timed grinding experiments with four different sizes of equipment to process equal weights of wheat, *Chenopodium*, and four varieties of maize (Mauldin 1993:319). The goal of the experiment was to measure which size toolkit performed the tasks quickest in order to establish and compare rates of grinding for varying-sized tools. The results of the experiment found a correlation between tool surface size and the time required to process grain (Mauldin 1993:319). As the grinding surface increased, the time required to complete a task drastically decreased (Mauldin 1993:319). Mauldin asserts that mano area is the most reliable predictor of the time required to complete grinding tasks (1993:319). An obvious drawback to larger tools, as Mauldin (1993) points-out, is that as the weight of the toolkit increases, so does the energy required to operate the mano. The author speculates that perhaps the cost of acquisition and transportation may have propelled the usage and adoption of smaller tools.

In addition to style and surface configuration, intensity and efficiency are affected by lithic raw material, especially for metates (Horsfall 1987:340; Searcy 2011). *Metateros*, metate makers, in the modern Southwest and Central America commonly select stone types based on specific physical characteristics such as vesicularity and the hardness of material (Adams 1993; Hayden 1987b:14; Horsfall 1987; Mauldin 1991; Searcy 2011). Lithic material must be soft enough to work during tool manufacture but not too soft or tiny rock particles will release from the metate and contaminate the food (Clark 1988:84). Less durable stone may be easier to work during manufacture but tools made of softer stone have a shorter use life (Hayden 1987b:14-17). Likewise, durable stone tools are more difficult to make, therefore greater skill is needed for making effective tools from better-quality materials (Hayden 1987b:14-17). The durability of tools often depends on the lithic raw material, which can be an important consideration within social contexts requiring large quantities of a grain or other resource to be processed for prolonged durations of time (Stahl 1989; Wright 1991).

Tougher stones are also preferred for ground stone tools because they are more resistant to fracture (Cotterell and Kamminga 1990:129). Hardness is a desired attribute for ground stone tools but it can come at the expense of brittleness (Cotterell and Kamminga 1990:129). It has been suggested, that in areas lacking more desirable stone for metates, the implements used to process harder non-food materials, such as clay and pigment, are composed of local stone, and more desirable stone is reserved for the maize-grinding toolkit.

During ethnography, Horsfall (1987) found that individuals not making their own metates nonetheless had input into the making of their tools. Ethnographic studies suggest that basalt is the favored material for modern metate consumers. Hayden (1987b:15) reports that higher quality, intensively used basalt metates can last at least 30 years and Horsfall (1987) reports that manos of basalt can function for 10 years. Hayden (1987b) also reports that the preferred basalt for metates contains very small vesicles.[17] Metates are often resurfaced to expose vesicles or cavities when sharpening the work surface (Adams 2002; Hayden 1987; Searcy 2011:96). Tools made of certain vesicular material types may not need to be refurbished since new vesicles are waiting below once those atop become dull and worn. Manufacture and maintenance techniques can be employed to compensate for lithic material not possessing the exact desired texture. For instance, a coarse surface can be made smooth and, likewise, a smooth surface can be made coarse through pecking (Adams 2011:295). Adams (2002:118) points-out that the users of more

[17] Small vesicles may have been preferred, in part due, to the possibility that food particles may become trapped in larger vesicles.

effective tools have more available time (and arguably energy) to participate in activities outside of grinding. Similarly, in ethnographic contexts, Clark (1988:93) found that large manos were often preferred to economize time, effort, and the duration of physical exertion.

In an experiment testing wear rates for sandstone grinding tools to grind maize, Wright (1990) found that large, "two-handed" manos became worn-out eight times faster than trough metates. Mano use-life is also considered by Ortman (2000:109) who explains that members of the Crow Canyon Native American Advisory Group (with participants from Pueblo communities in the Four Corners region of the US which encompasses parts of New Mexico, Arizona, Colorado and Utah) rotate their manos to keep the grinding surface from getting too hot and melting into the flour. Ortman also explains that in addition to rotating the mano used for purposes of keeping the grinding surface cool, sometimes users will periodically switch manos. He explains that they begin processing corn by heavily crushing the matter with a manos made of coarse-grained raw material and then move on to a mano made of a finer-grained rock for performing the grinding that reduces maize to a finer state (Ortman 2000:109-110). Although some modern users employ this technique of changing the manos, Ortman believes that millers in the distant past may have employed similar techniques. He bases this believe on the presence pf multiple manos that have often been found by archaeologists in the context of individual metate bins within grinding areas of ancient Puebloan Colorado (AD 750-1150) (Ortman 2000:109). Ortman suggests that using multiple manos to perform a grinding task may have negated the necessity of managing wear on manos. He proposes that the shape of manos in cross-section may have resulted from the reduction sequence that occurs through use (2000:109-110).

3. Metates and Craft Production

Archaeologically, standardization in the manufacture of objects has often been used to measure craft specialization. Within this model it is understood that items manufactured by specialized producers tend to be more standardized and exhibit less variation than those made by non-specialized producers who are assumed to possess less skill (Blackman *et al.*1993:60 and also Diepenbroek 1992; Saragusti *et al.* 1998, 2005). As opposed to a binary model of specialists and non-specialist, specialization can be viewed on a continuum, ranging from non-specialized producers (whom often consume what they make) to specialists, capable of producing specific goods for target consumers (sensu Costin 1991:7-10; VanPool and Leonard 2002). The continuum of production is defined by the relative degrees of homogeneity of characteristics exhibited within an artifact assemblage (Costin 1991; Rice 1991:268). Homogeneity, in this sense, would be both an incidental and intentional outcome of standardization; therefore with standardization one would expect to find a reduction in variation relative to an assemblage for one type of artifact. A benefit of homogeneity, with regard to mano and metate forms, is that standardized styles insure that component parts are compatible and swappable (Clark 1988:86). For instance, a trough mano needs to fit with the trough of the metate it is used with.

Specialization in archaeology is commonly defined in social-economic terms, and it is taken to indicate differential participation in certain activities within an economy (Costin 1991:43; Russell 1988). Costin (1991:93) argues that it can be identified archaeologically by differences in the distribution of types of artifacts and contexts associated with craft production. Moreover, Russell (1988) adds that specialization implies that households do not produce all of the items consumed by their members. The presence of multiple types of the same tool used to perform the same tasks, differentiated only by morphology and degree of finish, have been suggested to represent differing degrees of specialized production within a local economy

(VanPool and Leonard 2002). Increased skill and the need for increased efficiency can be viewed as factors contributing to standardization, resulting in a decreased number of producers (Costin 1991:34; VanPool and Leonard 2002:714). Distinctions in production or decoration of an assemblage are subject to fewer idiosyncratic variations when more limited specialists are involved in manufacturing (VanPool and Leonard 2002:714). In contrast to generalized production, the presence of specialists implies that fewer individuals are producing the same products (Costin 1991:33-34).

Specialized design and evidence of skill in manufacture have been argued for metates from a few archaeological contexts in the Southwest and also Central America. For example, it has been argued that metates found at Hohokam sites in Arizona (AD 200-1400) were produced by specialists (Bostwick and Burton 1993). Most trough metates and rectangular-shaped manos at Hohokam sites are composed of vesicular basalt and the authors suggest that the prevalence of this lithic material type demonstrates it was favored for food processing implements (Bostwick and Burton 1993). The authors base their argument on local and regional basalt sources and evidence of a regional trade in ground stone tools (Bostwick and Burton 1993:359). They contend that vesicular basalt was likely the most valuable resource in the area (Bostwick and Burton, 1993:359). A variety of ground stone tools were used at Hohokam sites, yet the authors make an important distinction between the manos and metates used to grind maize and other similar food processing equipment used to grind of other edible, wild plant resources (Bostwick and Burton 1993:358). The authors categorize these two different sets of manos and metates as complementary tool systems (Bostwick and Burton 1993:359). The maize grinding equipment consists of a rectangular-shaped mano and a trough metate that was usually manufactured of vesicular igneous materials, while the other, non-maize grinding mano and metate set, was made of non-vesicular material and the manos were oval or round (Bostwick and Burton, 1993:359). Bostwick and Burton (1993:368) further report that maize grinding tools had economic value and were exchanged for ceramics from within the region.

Metates from Chaco Canyon, New Mexico (AD 850-1250) are argued by Shelley (1983) to have been produced by specialists. Shelley also characterizes the users of these tools as specialized millers (Shelley 1983). The author identified a specialized production area used for the manufacture and maintenance of metates and believes that those tools were only maintained by a few skilled individuals (Shelley 1983). Shelley notes that Chacoan metates appear to have been used by large task groups rather than by individual households (Shelley 1983). He found that the size of the use surface of metates increased through time at Chaco and believes that the increase is an indicator of the relative intensity of Chacon maize grinding activities (Shelley 1983). He argues that changes in milling technology (e.g. configurations with metates and catchments for group milling) may evidence changes in the degree of specialization in the manufacture, maintenance, and use of metates (Shelley 1983:93).

Huckell (1986) argues that some metates found along the Colorado River in the Mohave Desert exhibit specialization in manufacture and explains that specialized expertise was required to make these tools as relating to both technological knowledge and physical skill (Huckell 1986). He highlights the technological aspects involved in the processes related to the manufacture of metates through archaeological investigation of a quarry site, arguing that technological knowledge, as well as physical savvy, was required to produce the metate preforms extracted from the quarry (Huckell 1986:42). Huckell argues that skill would have been requisite to an investment made in quarrying stone.

The specialized production of metates is also argued by Van Pool and Leonard (2002) at the site of Paquime in Chihuahua, Mexico in the Casas Grandes region during the Medio period (A.D. 1200-1475). Within the frame of the standardization hypothesis[18], the authors analyzed two functionally equivalent metates types (trough and non-trough) from the food processing assemblage of the site and compared these with trough metates from another site. They contend that specific performance characteristics (e.g. trough length/width and total metate length/width; back-rim thickness and total metate thickness) indicate that troughs from Paquime were created by specialized producers (VanPool and Leonard 2002:72).

C. Ground Stone in the Andes

Manos and metates can be found in the Andes in both the archaeological record and in modern contexts. For instance, present day usages of such tools are found within a few kilometers of Caranqui in the indigenous community of San Clemente by women who are engaged in small-scale family agriculture. While working in the northern highlands, I observed the toolkit in a variety of contexts. Despite the ubiquity of grindingstones in Andean contexts, this category of objects has only relatively recently become a focal point of archaeological attention in the region (e.g., Coleman-Goldstein 2008; Freeman 2011; Klink 2007; Kornbacher 2010; Mauldin 1993; Meddens *et al.* 2010; Rumold 2010; Russell 1988; Valdez *et al.* 2010). While there is ample archaeological interest in the Andes as a case study for the socio-economics of complex polities, the mechanisms through which pre-Columbian groups produced and distributed food processing implements and other ground stone tools remain poorly understood. To date, there have been relatively few attempts to analyze ground stone production in the

[18] VanPool and Leonard used the corrected coefficient of variation (corrected CV) to analyze two functionally equivalent trough metates types excavated Paquime and compared them with metates from another site. They calculated the mean values for chosen performance characteristics and results of their calculations suggest standardization of morphology for metates from the site (VanPool and Leonard 2002:72).

Andes. Was production of these implements specialized or were they made by individual users? This remains an open question that is likely to vary by specific local contexts. This lack of attention seems somewhat ironic given the heuristic potential that stone tools offer researchers and the emphasis placed on stone by both pre-Columbian and modern Andean cultures. Stone is emblematic of the Inca as evidenced through imperial architecture, fine cut-stone ashlar masonry, and the imperial showcasing of megaliths and other stone *huacas* within Inca landscapes. Although stone was perceived as special by the Inca, even animate in some contexts, Dean (2010:6) points-out that the Inca did not see all stone as extraordinary. Analysis of craft production in the Andes has tended to focus on ceramics, textiles or sumptuary items but rarely on ground stone objects, with a few exceptions. Unfortunately for food processing tools, our current ethnographic and archaeological understanding of metates or manos does not suggest that they were exchanged as valuables, or that strikingly large or uniquely crafted metates were used for ceremonial purposes similar to the decorative metates documented in Central America. As archaeologists, we need to look a little harder at utilitarian ground stone artifacts to see their significance, since they too are valued pieces of the past.

1. Ritual Contexts

Ritual implies participant understanding of an order of events undertaken to best suit the fulfillment of a goal with defined intention impelling the performance of ceremonious acts. The breakage of objects within ritualized contexts elevates even the mundane to the ethereal. Despite the utilitarian nature of grinding tools, there are several examples of manos and metates recorded in non-utilitarian archaeological contexts in the Andes, many deriving from ritual and funerary contexts. For example, at the Archaic period site of Aspero in Peru, Feldman (1980) found a metate in a special burial context within a ceremonial platform mound (Huaca de los Sacrificios) containing the remains of an infant (c.a.5000-3000 B.C). The child was wrapped in textiles and had been interred with an unusual hat, hundreds of beads, a separate bundle of textiles, and a single finely-worked inverted “food-grinding stone” containing traces of red pigment (Feldman 1980:114-117; 1985:81, as cited in Benson 2001:2). Within a special Moche burial, Quilter (2013:74) details two men in an embrace buried with quartz crystals, a split mano, and a long staff. He thinks, perhaps, the elder of the pair was a shaman (Quilter 2013:74). Quilter believes the fact that these items were taken to the grave underscores the importance (ibid).

Formative Ecuador has produced an abundance of manos and metates from funerary contexts. In one example, Lathrap *et al.* (1977) documented an elite burial associated with Valdivia culture (ca. 3300–1500 B.C.) at Real Alto containing an individual female that had been carefully placed upon a floor covered with manos. The authors’ report that the side walls of the burial chamber were “lined with halved metates (querns) and the entire tomb was partially covered in metates” (Lathrap *et al.*1977:9-10). Also at Real Alto, manos and metate fragments were found in a mound with over 100 small pebbles (Stothert 2003:376; Marcos 1988:64). Guayaquil Phase burials contain, among other things, mano and metate fragments found along with other discoidal stone artifacts (Parducci Z. and Parducci I. 1975, as cited in Stothert 2003). It’s thought that perhaps manos and metates may have been used as shamanic aids at the Ecuadorian site of Las Vegas (Strothert 2003:380). Late Period burials throughout the Pais Caranqui are described by Bray (2008:535) to contain a mano or metate among the limited grave goods associated with typical Caranqui burials.

Other regional stone objects, somewhat similar to metates, of note, are presented by Valdez (2008:883) who describes fine polished stone wares (mortars, plates and bowls) that were uniquely characteristic of the Mayo-Chinchipe complex dating to the Formative. It is posited that these items were used in communal and individual rituals that spread throughout the coastal and highland Ecuador and Peru (E. Peterson 1984, as cited in Valdez 2008). From later periods, at the Inca-Cañari site of Ingapirca in central Ecuador, manos, metates, and morteros were found in Inca and pre-Inca burial contexts (Fresco 1984). Of the four burials from Ingapirca reported to contain food processing tools, one of the individuals was an adult female, another was an adult male, and there was also a juvenile of unknown gender.[19]

Saville (1910) suggests similarities between metates and other ritualized stone artifacts from the coastal Ecuadorian pre-Columbian tradition of carved U-shaped stone seats, known archaeologically as Manteño seats, in Cerro Jaboncillo and other sites in the province of Manabí dating to AD 800-1530. Saville compares the iconic U-shaped seats with ornamental footed (or legged) metates that were made and used for ritual purposes in Central America, Columbia and other parts of South America, as well as the Caribbean. With many exhibiting zoomorphic forms, these elaborate metates overtly functioned as ritual objects (Saville 1910:103-105). Citing their lack of structural durability for grinding, and explaining that most only exhibit slight evidence of wear, Saville believes that these "metates" were only used to grind matter ceremonially and that they were likely also intended to serve as, or at least resemble, a ritual seat (Saville 1910:103-104). One example of ritual use of grinding tools in an ethnographic context is found in Isbell (1978). She offers an account of grinding tools used before rituals that served to maintain social

[19] Tumba VI (adult female approximately 30 years old): "Un machacador o pequeño martillo de piedra verdosa, de forma ovalada y con un extremo aplanado por el uso" (Fresco 1984:99).

Tumba XX (juvenile, gender unknown): "Aparecieron dos manos de metates, una sobre el abdomen del individual y otra detrás de su nuca, que pueden haber constituido una especie de pequeña tapa de la tumba" (Fresco 1984:105).

Tumba XXII: "Un metate y dos manos que aparecieron mezclados entre piedras de la tapa de la tumba" (Fresco 1984:106). Ceramics were also found within this same burial context containing an adult male.

Tumba XXIV: "Dos pequeños morteros globulares de piedra…Un fragmento de metate de piedra porosa de unos 90 cm de diámetro…Tres manos de metate de piedra, muy pulidas en una cara" (Fresco 1984:107-108). Two copper rings, deer antlers and ceramics were also found in this same burial context containing and individual of unknown sex and age.

structure in the Quechua-speaking community of Chuschi, Peru during the 1960s. Here specialists would ritually prepare a concoction containing ground maize called *llampu* that was used for other ritual offerings. Isbell was told that to prepare the concoction, specially selected maize had to be carefully ground; any maize escaping the grinding stone would cause animals to perish (Isbell 1978:156). The ritual specialist would bring in a flat rock and cobble to perform the task, explaining to Isbell that he could not use the grinding stone utilized for daily food preparation when making *llampu* (ibid.). Before grinding the maize, his mother wrapped a blanket around the edge of the grinding stone to prevent grains from falling to the floor (ibid.). She then played a small ceremonial drum while her son ground the maize for the concoction (ibid).

2. Utilitarian Usage

Pearsall *et al.* (2004) off an example of archaeological research in the region benefiting from the study of ground stone implements. The authors used residue analysis of micro-botanical phytolithic material extracted from metate fragments to prove that specific species of maize were cultivated at Real Alto during the Early Formative Period –earlier than previously believed (Pearsall *et al.* 2004). In other research, Kornbacher (2010) offers a re-analysis of T-shaped ground stone hand-axes from collections previously excavated at sites throughout the Andes, including many from Ecuador. Kornbacher challenges preconceived assumptions of homogeneity with regard to the functionality of these “wedge tools.” Through experimentation, the analysis of use wear, and material types, Kornbacher finds that the function of these tools varied temporarily and regionally in the Andes. The author finds that tools were used for a variety of purposes and suggests the need to re-think previous assumptions about the function of these implements. Her re-analysis of lithics draws attention to just how pervasively understudied and misunderstood ground stone traditionally has been in Andean archaeology.

In other research, Freeman (2011) addresses the social implications of ground stone production within the household and community economy during the Late Period for the Quijos and Cosanga valleys in the eastern montaña of Ecuador. He approaches craft production in the Quijos River valleys by comparing distribution patterns and the manufacture of ground stone implements, including manos and metates, to assemblages from other Andean sites. He argues that lithic production was a part-time, individual household venture for Quijos chiefdoms, in which the identities of individuals, households and communities was intermeshed with ground stone craft production (Freeman 2011). He finds that households in the Quijos region appear to have had relatively equal access to raw materials. He thinks perhaps that the manos and metates in his study sample may reflect household economy and he questions whether there is a typical northern Andean ground stone assemblage (Freeman 2011:195).

The differentiation of grinding stones (i.e. metate/mano verses mortar) for specific activities is supported ethnohistorically and ethnographically in the northern highlands. Bernabé Cobo reported that to grind small things, the indigenous people of the Andes used a mortar-like concave tool and a small elongated pestle and reports that this instrument was in every home (Cobo 1990 [1653]:195). Bray (2003) drawing from Cobo, elaborates that *aji*, a red pepper table condiment, was made by first grinding peppers (Cobo 1964 [1653]: Bk.4, Ch.25:172-173, as cited in Bray 2003:100). *Aji* is a staple in the contemporary cuisine of the northern highlands of Ecuador. It is prepared today by some indigenous women on an *uchurumis* or chili pepper grindstone (Colloredo-Mansfeld 1999:108, illustration 15). Colloredo-Mansfeld (1999:178) explains that "*aji stones*" are differentiated from other grindstones among the indigenous of

Otavalo. Similarly, Parsons (1946), reported that in Peguche, a community adjacent to Otavalo (approximately 25km from Ibarra), *aji* stones were differentiated from other food preparation stones. The metate belonging to one of Parsons' informants was kept in a corridor and carefully covered with cloth when not being used (Parsons 1946:22).[20]

Food processing tools in rural Bolivia were addressed ethnographically by Mauldin (1993) when analyzing how the size of the grinding surface area of tools relates to settlement type. Mauldin conducted a study in three types of agro-pastoralist settlements: main villages containing houses occupied year-round; agricultural field camps used by large groups during intensive farming activities and by a few individuals for short periods throughout the growing season; and pastoral camps hosting a few individuals for extended stays (Mauldin 1993). The author explains that subsistence during occupation varies and that at times groups would bring flour to the camps and at other times grinding took place within the camps. For those few individuals who stayed in camps for several months, grain was ground as needed (Mauldin 1993:320).

Mano sizes were compared for houses in the main village with those in the two respective camps (Mauldin 2003). Mauldin found that the differences in the frequency of processing grain at the three settlements affected respective mano size (Mauldin 2003). On average, mano size was bigger in the main villages, where grain preparation was a frequent and more intensive activity (Mauldin 1993:320). Grain was infrequently process in the pastoral camps, and Mauldin

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[20] Parsons (1946:22) found that the *metates* and "*grindingstones"* used by Otavaleño women in Peguche were cut from a quarry in a quebrada by non-indigenous locales. She describes the metate of her informant as a footless oblong block, 18 x 10 inches (~46 x10 cm), and about a foot high (~30.5 cm), with a narrow rim on three sides (Parsons 1946:22). The mano was round and oblong, and the author notes that these are not the half-moon found in the Central Andes (Parsons 1946:22).

Parsons also observed clay for ceramics was ground by local potters on a mat "with a large unworked boulder, naturally convex on one side so that it could be readily rolled from side to side (Parsons 1946:24).

found that mano size areas were on average much smaller than those found in the main villages (Mauldin 1993:320). He found the highest coefficient of variation from the agricultural camps where processing was varied (Mauldin 1993:320). Mauldin divides manos into types based on whether or not manos were used in the processing of agricultural grains. He found an association between the larger manos and the exclusive processing of agricultural grains (Mauldin 1993:320). He explains that smaller manos are used to process chilies, dried meat, salt and other materials (Mauldin 1993:320, Table 1).

D. Chicha Production and Use in the Andes

1. Imperial Elixir

Long before the Inca regulated the production of *chicha* for state purposes, the beverage was already ancient in the Andes (Dillahey 2003), emerging in some areas as early as the Initial Period (1800-500 BC) (Burger 1992:108). An example from the Formative Period (800-250 BC) Titicaca Basin, finds that *chicha* starts to be produced almost simultaneously with the introduction of maize (Logan et. al 2012). Archaeological evidence supports the premise that *chicha* was produced and consumed by many Andean cultures including: Chavin (Burger 1992) Moche (Shimada 1994), Recauy (Gero 1990), Lima (Llanos 2001), Tiwanaku (Goldstein 2003), Wari (Cook and Glowacki 2003; Isbell 1988; Williams *et al.* 2005; Valdez 2002), Chimu (Moore 1989; Pierto 2011), and the Inca (Bauer 1998; Bray 2003; D'Altroy 1992; Dillahey 2003; Morris 1979; Rowe 1946).

The importance of *chicha* is apparent through the state-managed production of the drink during the Inca Period in most every settlement within the expansive empire (Morris and Thompson 1985:70; Valdez 2006:58). When shared, the beverage provided social cohesion for the Inca and other groups during public ritual. It was used to venerate gods and ancestors during religious ceremonies, to cement political relations, and as a form of reciprocity for laborers at state-sponsored feasting events (Bauer 1998; Bray 2003; Costin 1998; Garcilaso de la Vega [1961 bk.6:178-179; Hastorf 2003; Morris 1979; Salomon 1995).

Brewing, storage, transport, service and consumption of the beverage have been evidenced archaeologically, typically through associated materials given that precisely identifying *chicha* production has proven somewhat difficult. Morris (1979) comments that indicators of production are often reduced to broken ceramic vessels and abandoned equipment, making production and consumption difficult to substantiate for archaeologists. An example of an exception is the Inca administrative site of Huánuco Pampa in the central highlands of Peru. The site contains concentrations of ceramic sherds belonging to large vessels in contexts containing grinding equipment (Morris 1979:27). Morris reports finding, "large rocker flattening stones" that he believes were used to process maize (1979:28). The author discovered a large scale *chicha* production operation at the site, which he specualtes, may have been an *acllawasi,* or house of the chosen women (Morris 1979:28). As an Inca institution, the *acllawasi* was comprised of *acllakuna*; specially chosen females charged with the tasks of making *chicha*, textile production, and serving the Sun god (Silverblatt 1987). In sequestration, these girls and women, whom were allegedly selected for their physical attractiveness and the social rank of their fathers, brewed the most revered *chicha de maize* for service to the Inca, his military, others of privilege, and also for daily ritual offering to the sun (Silverblatt 1987).

The arid coastal desert of Peru also provides examples of *chicha* brewing. Excavated materials from the Late Intermediate Period Chimú site of Manchán, located in the Casma Valley, include grinding stones, charred maize, storage vessels and other materials linked to brewing *chicha* (Moore 1989). Moore conceives Manchán as a large-scale *chicha* production site and argues that *chicha* may have served similar purposes for the Chimú that it served for the Inca; a stabilizing return for the workforce while symbolically affirmed the hierarchical position of the state (Moore 1989). Similarly at another Chimú site, San José de Moro in the Jequetepeque Valley, Prieto (2011) found a large-scale *chicha* brewing operation. The specialized brewing facility of San José de Moro benefits from conditions which preserved this immaculate example of a *chicha* brewery on the coast. Prieto, like Moore, argues that *chicha* was utilized strategically and employed by the Chimú to maintain of authority in the region (Prieto 2011).

2. Chicha Brewing

> *"Drunkenness, anger and madness go together; only the first two are voluntary and to be removed, while the last is perpetual"* (attributed to Inca Pachacutec in Garcilaso de la Vega 2006 [1609] II: 208)

The preparation of *chicha* is described by Bray (2003:143-144) as one of the most elaborate culinary tasks undertaken in Andean cuisine. The beer-like beverage can be made from a variety of foodstuffs such as berries, fruit, quinoa and also molle (Rowe 1946:292; Cutler and Cardenas 1947:39; Goldstein et. al 2009; Gómez Huamán 1966:33; Valdez *et al.* 2010:30), plantains (Cutler and Cardenas 1947:34), peanuts and manioc (Cutler and Cardenas 1947; Cutler and Cardenas 1947; Morris 1979: 22) and other plant foods. Contemporary *chicha* makers provide some insight into preparation; however modern contexts cannot be taken as exact replicas for pre-Columbian brewing (Hayashida 2008).

The flavor and alcohol content of *chicha* relies on the conversion of starch to sugar. This transformational process occurs by creating a diastase that constructs enzymes which act as a catalyst to breakdown starch into maltose (Cutler and Cardenas 1947:34). For *chicha de maize,* diastase can be introduced via malting, which involves the controlled germination of seeds

(Morris 1979: 22). Kernels are soaked in water, allowing the seeds to germinate, then dried and ground. Alternatively, diastase can be introduced via saliva (through salivation or mastication)[21] (Cutler and Cardenas 1947:34, 39; Morris 1979: 22). Once kernels are soaked, the sprouted grains are dried and toasted before being ground to a medium-to-fine grain flour, which is referred to as *jora*, (also called *quinapo* and *huinapu*) (Cutler and Cardenas 1947:45; Hayashidia 2008).

3. Chicha-makers

A common archaeological assumption associates the work of women with grinding tools and other culinary equipment, while the actual archaeological data to support this idea is limited (Conkey and Gero 1991; Gero 1991; Searcy 2011:75). In an example presented previously, Shimada *et al.* (1994) posit that easier metallurgical tasks, those not requiring skill or knowledge, may have been performed by women, children and older household members. The authors explain that the state required worked to be performed and extracted from each household unit. Similarly, archaeological and also ethnohistoric examples from other Andean contexts, especially from Inca contexts, describe work extracted from household units. Whether it was ceramic production or agriculture, it wasn't necessarily women's work or men's work, but rather just work and it needed to be done (sensu Gero 1992). Rowe (1946:252) explains that women shared in the agricultural duties. The Andean concept of the *ayllu*, or community kin group, is generally perceived to be composed of individual household units that participate in work activities together (Coleman Goldstein 2008).

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[21] Cutler and Cardenas (1947:41) report that chicha makers on haciendas in Punata, Bolivia would slightly moistened ground maize flour with water and worked with the tongue until well mixed with saliva, then pressed against the roof of the mouth to form a single mass. Salivating maize flour was referred to as *mukeando* and salivated morsels were sun dried and referred to as *muko*, which commanded a higher price than un-salivated flour (Cutler and Cardenas 1947:36-41).

Ethnohistoric references from highland Andean contexts portray *chicha* brewing and food preparation as labor primarily associated with women in both domestic and state contexts (Cobo 1990 [1653]:174; Bray 2003:131-132; Costin 1998; Rowe 1946:269,299; Silverblatt 1987). Cobo reports that the indigenous people of the Andes knew how to make "their own beverages" (Bernabé Cobo [1653] 1990:240). Women played an integral role in Inca state craft in the laborious of preparing the food and *chicha* for immense state-sponsored feasts (Bray 2003; Costin 1998; Jennings 2004; Silverblatt 1987). Costin (1998) finds that commoner women, who contributed to the Inca state through texile and *chicha* production, were not compensated, or even recognized, for their roles in the maintenance of the state (Costin 1998:133).

Colonial descriptions have portrayed the use of grindingstones in domestic contexts as involving great amounts of physical effort on the part of women during the processing of maize[22] (Anónimo [1573] 1965:212, translated in Salomon 1986a:76; Garcilaso de la Vega [1609] 2006:74; Cobo [1653]1990:195). Rowe (1946) offers an example derived from Cobo, during the Inca maturation ceremony of *waracikoy,* boys entering pubescence were made to help in the task of chewing maize for the production of *chicha* (Cobo,1890-95,bk.13,ch.30 as cited in Rowe 1946:283). One may questions whether this activity was intended to evoke reverence for *chicha,* the labor of women, the state, or if the *waracikoy* initiates were being hazed with an effective

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[22] Garcilaso de la Vega and Cobo offer similar descriptions of maize ground on flat broad stones by half-moon shaped rocker stones (Garcilaso [1609] 2006:74; Cobo [1653]1990:195-196).

Garcilaso notes that:

> "{Distinguishing between mortar & metate} Grinding in a mortar is done by the force of blows, but the moon-shaped stone grinders whatever comes under it by its own weight and the Indian women can easily handle it because of its shape, rocking it to and fro {a different action than what is found in U.S. Southwest and Inca-Caranqui on flat metates}and occasionally heaping the grounds in the middle of the flat stone with one hand so as to grind them over again, while the other hand is left free to hold the grindstone, which we might reasonably describe as a *batàn* from the strokes given alternately by the two hands" [Garcilaso [1609] 2006:74].

reminder that they were not yet men, therefore the boys were made to do as the women do and chew maize.

In modern ethnographic contexts, a household or community system of gender complementarity has been reported by Colloredo-Mansfield (1999:108) for the indigenous people of Otavalo living traditionally, with the women of households being responsible for the grinding of grain and food preparation (also Hamilton 1998; Parsons 1947). Colloredo-Mansfield observed that food preparation was the primary work of women, and what distinguished them from men, while men's work concentrated on weaving cloth (1999:103-106). The author reports that modern appliances facilitate gender crossover for domestic tasks but in households dependent on older technologies (e.g. grindstones, open hearths or backstrap looms) he did not observe men cooking or women weaving (ibid:106). He also notes, however, that objects associated with a particular gender do not preclude the use by the other gender (also Allen 1988; Weismantel 1988).

III. Fragmentation Theory

A. Archaeological Perspectives

Much of the material record of the ancient past comprises broken artifacts; as archaeologists we expect to find broken things. This is a generally accepted and unremarked upon fact. But when intentional, fragmentation can easily be viewed as the physical manifestation of deliberate acts. Breakage prohibits items from functioning as originally designed. From an archaeological perspective, artifacts bearing evidence of intentional fragmentation index premeditated action and can suggest the ways in which objects may have been perceived at different moments in the past. In the Andes, intentional fragmentation has been recorded with most frequency for ceramics in association with funerary contexts. From outside the region intentional fragmentation has also been reported in association with: burials, mourning rituals, place abandonment, resistance, ritual healing, sacrifice, ancestor veneration and deity appeasement (Brück 2001, 2006; Chapman 2000; Chapman and Gaydarska 2007; Grinsell 1961, 1973; Hoffman 1999; Hull et. al 2013).

The action of breakage is viewed by Chapman (2000) as a catalyst in relationship building social practices via material means; deliberately broken objects become symbolically loaded with mnemonic and metaphorical value by those who perform the breakage and those collecting the fragments. Chapman (2000) analyzed deliberate fragmentation in a variety of artifacts, including querns (analogous to metates) and other stone tools, from southeastern Balkan Neolithic and Copper Age sites. He posits that some objects in prehistoric societies were not as distinct from people as objects may now appear to be for us today (Chapman 2000). Relying in part on ethnographically constructed models of Melanesian gift economies, Chapman views the identities of individuals in prehistory as constructed through objects in somewhat the same way that objects are constructed through their producers and also their users and owners.

Objects and individuals or groups become connected in a process that Chapman (2000) refers to as *enchainment.* Individuals wishing to establish a social relation or to solidify a transaction would break an object, each party keeping a part as tokens of their formed association, thus becoming enchained (Chapman 2000; Chapman and Gaydarska 2007). With this transaction, as the symbolic part of the respective individuals or groups involved is passed down with the object(s), part of the maker of the object is imparted as well (Chapman 2000). The broken parts of a single object represent the means to create and maintain associations between members of the same community or different groups. In some contexts enchainment via material means is valid for both living and dead individuals (Chapman 2000; Chapman and Gaydarska 2007).

Fragments that are further fragmented and passed down to third parties, created what are referred to as *fragmentation chains* (Chapman and Gaydarska 2007:138). Chapman (2000) uses the refits of fragments located at different sites within the same region to demonstrate enchainment as a transaction among distinct individuals or groups living in different places. This model has been used to explain fragments of the same original object that are not found together in the archaeological contexts. Yet, critiques of this perspective question the relationship of historical eventuality to contexts, and also the universality of applying enchainment archaeologically (see Britian and Harris 2010:582).

The fragmented objects found in burials at Early Bronze Age sites in Ireland and Britain are believed to be the result of deliberate breakage (Brück 2006). Brück (2006:297) posits that intentional fragmentation was not purely a symbolic activity; rather it was viewed by participants as a way of easing the transformation from one state to another. The broken object symbolized death but also were intended to facilitate the regeneration of life (Brück 2006). In Brück's view, individual Early Bronze Age identities were formed more through relationships with other people rather than things, and the contents of a burial are reflections of the relational characteristics of identity; items were chosen by those related to the deceased and reflect their relationship with the deceased rather than the deceased relationship with the object (Brück 2006). Brück (2001) has also examined the correlation between humans and ceramics during the Bronze Age, and suggests that pottery was perceived to have qualities similar to human qualities, in the sense that the life-cycles of these objects were also perceived as cyclical. Similar to the cyclical nature of human life, the author explains that ceramics were conceived through intentionality and manifest through creation (Brück 2001). She finds that after their use-life expired they were either buried or they were intentionally fragmented and added to temper to become "reincarnated" in the creation of new ceramics (Brück 2001).

B. Breaking Rocks

For archaeologists it is often impossible to discern accidental from intentional breaks since not all artifacts and contexts retain indices of breakage. The notion of intentional breakage is perhaps more problematic when considered in relation to ground stone artifacts. Compared with other artifacts categories, greater time, energy, and considerable force must be invested to break the types of ground stone items like those found at Inca-Caranqui. A sustained methodical approach is generally required to break certain stone objects, which may include, among other things, repetitive striking to weaken structural composition in an area of the object (Adams 2008). Knowledge of the effects of force and mechanics are required for the destruction of some objects, similar to the requisite skills needed for the production of objects (Chapman 2000; Hoffman 1999). For metates, in some contexts, Adams (2002:120) believes that it is conceivable to determine the intentional termination of a tools intended use.

In other lithic research, one approach to fragmentation uses 'point of impact' fracture to analyze breaks on projectile tools and other objects (Andrefsky 2005; Odell 1981). This method employs macro and microscopic examination of the immediate area of breaks present on tools. Intentionally broken stone is indexed through scars that are registered during the action involved in breakage, whether through a single strike, percussive hammering, flaking, or as in the case with some fragmented projectile points, trampling (Odell 1981). Forcible strikes leave behind signatures or scars registered on stone artifacts as indices of impact.

Stone can also break from various environmental, climatic, and cultural conditions. Adams (2008) provides a framework for distinguishing ground stone artifacts that were purposely broken or perforated in archaeological contexts from those accidentally broken in the ancient past. She identified four potential types of breaks for stone: *natural breaks, manufacturing breaks, intentional breaks,* and *mechanical breaks* (Adams 2008). *Natural breaks* are caused by seasonal freezing and thawing, diurnal heating and cooling, or one-time exposure to intense heat, such as fire (Adams 2008: Cotterell and Kamminga 1990). *Manufacturing breaks* are intentional breaks that occur through the crafting of stone for specific purposes (Cotterell and Kamminga 1990). *Intentional breaks* are categorized as planned breaks, potentially rendering an object non-functional (Adams 2008; Cotterell and Kamminga 1990). *Mechanical breaks* are stress fractures that occur during use for manos, which can possibly derive from imperfections present in stone (Adams 2008:217).

A systematic approach was applied to re-fitting fragmented ground stone tools by Stroulia and Chondrou (2013). The authors believe that artifacts were intentionally broken at a late Neolithic Greek site. Their assumption is based on three unexpected break patterns found on specimens in the sample they analyzed (Stroulia and Chondrou 2013). *Flake removal pattern,* was defined by the authors as conchoidal-shaped fractures, with surfaces containing a flake scar, or the fragment itself is the resulting spall from breakage of an original tool (Stroulia and Chondrou 2013:114). *Midsection breakage patterns* are characterized by Stroulia and Chondrou (2013:117) as occurring through more than one stage of fragmentation and can be thought of as an incremental approach to fragmentation. *Multiple axe breakage patterns* are considered by the authors as a more extreme version of Chapman and Gaydarska's (2007) *fragmentation chain*, wherein a single object is broken into multiple pieces, with some fragments containing two broken surfaces at right angles to each other (Stroulia and Chondrou 2013:118).

For intentional breaks that render a tool of its utility, Adams (2008) describes metates from archaeological contexts that exhibit a well-worn round hole (perforation) in the center of the use surface that penetrates through the base of the object. She explains that in archaeology, metates bearing this strange feature often have been misinterpreted as worn through by attrition (Adams 2002). Through experimentation, she found that the chances of a hole developing all the way through a metate by means of wear is very unlikely (Adams 2002; 2008). Rather, she finds that the holes were created by methodical, intentional pecking at the center point of these tools. She suggests that metates containing a hole may have been destroyed because they were perceived as worn-out or of obsolete design, or possibly to keep others from using them (Adams 2008). This type of destruction has also been noted ethnographically in the Southwest, revealing that objects associated with the lives of individuals were subsequently broken (referred to in many archaeological contexts as "killed") to mark the death of the individual (Adams 2002:43; 2008; 2009; Schelberg 1997:1016). Metates were also found to have been destroyed during important events associated with specific sites (see Schelberg 1997:1016). Adams (2008) reports that in some contexts in the Southwest, objects deliberately broken upon an individual's death were often discarded as domestic debris rather than interred with the person. In another example, she explains that cooking stones used by the Hopi were considered to be alive (Adams 2008). She remarks that the metates containing the holes were possibly destroyed so that their essence could return to the cosmos (Adams 2008). Adams found that broken tools without signs of wear were accidentally broken during manufacture, while those with signs of abundant wear had been purposefully "killed" since they no longer performed adequately or their design was perceived as obsolete (Adams 2008).

C. Fragmentation in Andean Contexts

As discussed previously, fragmented manos and metates have been recorded from several different Andean archaeological contexts, some of which were funerary. The presumed intentional fragmentation of objects in Andean contexts has been described for ceramics and has often been interpreted to have ritual connotations. For example, at the Middle Horizon Wari site of Conchopata, Isbell and Cook (2002) excavated several large ceramic vessels that were smashed in burial contexts (2002:259-269). Shimada (1994) details the presence of smashed Wari ceramics from late Moche V at Huaca del Sol within the Moche site complex (1994:250). The painted vessels depict Wari religious themes and Shimada argues that they were smashed as ritualized offerings (Shimada 1994). Three ritually smashed Wari ceramic cups were also excavated from a cached offering context at Sausal, a site within the Chicama Valley near Pampa Grande (Shimada 1994:250). During conservation of Diaguita ceramics from northern Chile, once sherds were cross-mended, it was discovered that many vessels contained a single perforation in the base (Roman and Cantarutti 1998:90). Through experimentation, the holes were found to have been intentionally created, occurring through indirect percussive strikes with a small handheld oblong chisel stone struck by another larger stone (Roman and Cantarutti

1998:96-98). In another example, one of four *capacocha* burials found on Mt. Ampato in southern Peru was capped with six deliberately broken Inca ceramic vessels (Reinhard 1996; 1997 as cited in Bray *et al.* 2005:90).

Fragmentation in the Andes has also been noted in the form of dismembering bodies for the Moche culture (Hill 2003). Bioarchaeological information and mortuary contexts from the Andes demonstrates that fragmentation of humans, often via trophies heads and other body parts, often occurred during warfare. Human bodies were found to be dismembered at Huaca de la Luna in a methodical way (Bourget 1997, 2001 as sited in Arkush and Stanish 2005:15).

D. Metate Fragment Re-cycling

The re-use or re-cycling of metate fragments has been documented in the Andes. For instance, Nash (2002) found metate fragments used as fill in the construction of a building feature from the Wari settlement of Cerro Mejia (AD 600-1000). In northern Peru, at least one fragment of a concave metate was found to have been re-used in the north wall of the Inca compound at the site of Huamachuco (Topic *et al.* 2002).

Outside of the Andes, the potential usability of fragmented metates and mano has been address by Clark (1988) during ethnography in Mexico. He observed that they are rarely discarded; rather they become repurposed, serving in some cases as hammerstones or other expedient tools (Clark 1988:93-94: and also Schlanger 1991:463). The accidental breakage of these tools generally has been found to result from wear, dropping or, in some cases, throwing (Clark 1988:94; Hayden 1987b). Modern metates users in Mexico employ different storage practices for complete metates verses fragmented ones (Clark 1988; Hayden 1987b). Clark reports that fragments are kept for potential future re-purposed use in a readily accessible, yet out-of-the-way place, while complete metates are stored in, or close to, the kitchen (1988:94).

Clark also found that less usable fragments were deliberately left behind or discarded (1988:94). In modern Guatemala, Searcy (2011) was aware of only one broken metate still used to grind maize. The metate in question was footed and Searcy reports that only one of the feet had been broken-off, therefore the entire use surface was unaffected by the break (Searcy 2011). In another instance, he found that a broken mano and metate set were being used by the family to grind coffee and chili (Searcy 2011).

Broken manos and metates have also been recorded in Mexico to grind herbs, salt, sugar and temper (Hayden 1987b:191; Clark 1988:103). These items have also been repurposed as hearthstones (Clark 1988:103). Clark explains that there is ethnographic and archaeological examples of grinding clay, temper, and pigment on broken or much worn metates instead of the principal metates of domestic units that were used to grind maize (Clark 1988:93). These more abrasive grinding tasks involving clays or minerals are considered secondary activities (Hayden1987b; Horsfall 1987). The use life of metates can vary considerably, depending on intensity of use and the age of the tool (Adams 2002; Clark 1988:93). Maize is processed by reciprocal strokes of the mano, while other materials require different strokes. This results in distinctive wear patterns (Adams 2002; Clark 1988:93). In some contexts, researchers have found similarities in the methods used to grind maize and the methods used in the re-purposed activities of grinding clay, pigment, or temper for ceramics, although the rate of wear for grinding implements is faster for these materials compared with maize grinding (Clark 1988: 93).

In other research, focusing on intentionally fragmented ground stone tools, Stroulia (2010) found that after systematic intentional breakage, some fragments were recycled. She characterizes the re-used tools from the Neolithic site as multifunctional and believes that the character of multi-functionality was a conscious choice that reflects a flexible attitude of tool makers and users toward tools and lithic material (Stroulia 2010).

IV. Methodology: Analytical Techniques and Justifications

A. Attributes Used in Analysis

This study evaluated manos and metates found at Inca-Caranqui between 2006 and 2010. Most of these artifacts were first made available to me for preliminary study in 2009, with a more extensive examination conducted in 2010. Manos and metates excavated from 2006-2007 were analyzed at a laboratory located in the city center of Ibarra. Preliminary information was collected in the field by the Inca-Caranqui archaeological team for manos and metates excavated in 2008. Those implements excavated during the 2009 and 2010 field seasons were cleaned in the field by rinsing with cold water and very lightly brushing away dirt before being rinsed again and analyzed at my lodgings in San Clemente.

The goal of evaluating the manos and metates from Inca-Caranqui was to obtain information pertaining to pre-Columbian activities, cultural variation and, potentially, ritual activity at the site. To achieve this goal, the methods described below aimed to: determine modes of breakage for fragmented specimens; establish a typology for the food processing assemblage; and to explore tool functions. The research design included an attribute-level data collection project. By correlating the data collection methods, it was possible to ask questions that provided pertinent information concomitantly for breakage, typology and tool use. For example, I expected the attribute *lithic material* type to have a significant correlation to variables associated with *condition* (broken or whole), as well as those related to tool *design*, and those associated with *function.*

Descriptive statistics were used to test specific mano attributes compared against criterion relating condition, design, and function respectively. Similar variables were analyzed statistically for metates with the exception of condition since all metate specimens are fragments. These analyses were performed using Pearson Chi-Squared procedure in SPSS program package. Statistical significance is indicated at the 0.05 level (95 percent confidence interval). What follows is the list of attributes that pertain to condition, form, and function. Subsequent segments within the *Methods* section of this report focus on other attributes related to condition, design, and function respectively.

1. Lithic Raw Material

The classifications used to describe lithic material are primarily derived from Bates and Jackson (1984) and Thorpe and Brown (1993). The attributes used to analyze lithic material included *grain size*, *structure*, and the *distribution of inclusions*, such as crystalline and phenocrysts. As mentioned previously, raw material type is described here as *vesicular* and *non-vesicular* (*granular*), with a few noted exceptions discussed in the analysis section. Variable data pertaining to vesiculation was collected with the following range in values: *vesicular* (structure has gas cavities that comprise ≤50%); *scoriaceous* (structures are generally darkly colored with > 50% vesicles); *pumiceous* (structures are light in color and contain > 50% vesicles); *amygdaloidal structure* (vesicles are filled with younger minerals). *Vesicle size* was determined relationally with possible values for this variable including: *small, medium, large*, and *atypical vesicularity.*

Texture, as used here, is an analytical construct that refers to the attributes that make-up the physical components of a rock. These attributes include the size and shape of the components comprising rock and their relationship to one another. Analysis of texture on broken speciemns was performed by examining broken surfaces where rock was not altered by wear.[23] For unbroken specimens, un-used or less-used surfaces were examined. The following range in values applies when analyzing *grain size* to describe texture: *fine grained* (<1 mm, groundmass contains few or no crystals boundaries when magnified 10X); *medium grained* (1-5mm, apparent crystal boundaries when magnified 10X); and *coarse grained* (5mm-3cm, apparent crystal boundaries visible without magnifying). *Grain distribution* is considered as either *uniform* or *uneven*. *Solid inclusions* found in rock affect grain size and are distinct from the groundmass of rock. The distribution of solid inclusions was recorded when apparent and the possible range of variables for this attribute includes: *random* (distribution is irregular and therefore lacks discernible pattern); *structured* (distribution is patterned or isolated to a single area); and *uniform* (no variation in distribution). The *appearance of inclusions,* such as phenocrysts, was a subjective evaluation with values that includes: *black linear flecks, shiny black linear flecks*, *bloom-shapes*, *white crystalline rectangular masses*, *round black inclusions*, and *white amygdules*. The distribution of *voids*, which are generally characterized as naturally occurring crevasses in rock, were recorded and includes the following range in values: random, structured, or uniform. *Color* was determined using *Geological Rock-Color Chart* on dry specimens (Munsell 2009).

2. Morphological Features

a. Metates

Metate fragments were each weighed with a digital scale to the second decimal and measured using a variety of devices. Dimensions were taken from the same location on respective specimens when possible. Specific attributes pertaining to basic metate morphological

[23] For some fragmented specimens that exhibit secondary use, traces of use-wear extend over the broken surfaces of these items. The broken edges of these tools are not as sharp and rounded. For these items texture was also examined on the broken surface of the tool in an area that appears least altered by secondary use.

characteristics are provided in figure 4.1. A schematic drawing of the dorsal side (use surface side as opposed to the base) of a complete three-quarter trough metate with a compatible mano resting atop the metate use surface at the proximal end (the end closest to the body during use) is given in figure 4.2 and indicates the locations at which measurement were taken. The morphological features depicted in figure 4.2 are relevant to most trough and basin metate fragments, as well as many other metate specimens in the sample.

Length was measured from the existing proximal end to the existing distal end (*1* in figure 4.2). *Width* was measured from one exterior side wall to the other, perpendicular to length (*2* in Figure 4.2). *Height* was measured as the distance from the rim or margin (located on the dorsal surface) to the ventral surface (*3* in Figure 4.2). *Trough* and *basin thickness* was taken from the center of the proximal to the center of the ventral surface (*4* in Figure 4.2). Thickness and height were measured with calipers, with measurements rounded to the second decimal. Additionally, the length and width of the *existing use surface* or working surface of the metate fragments was measured.

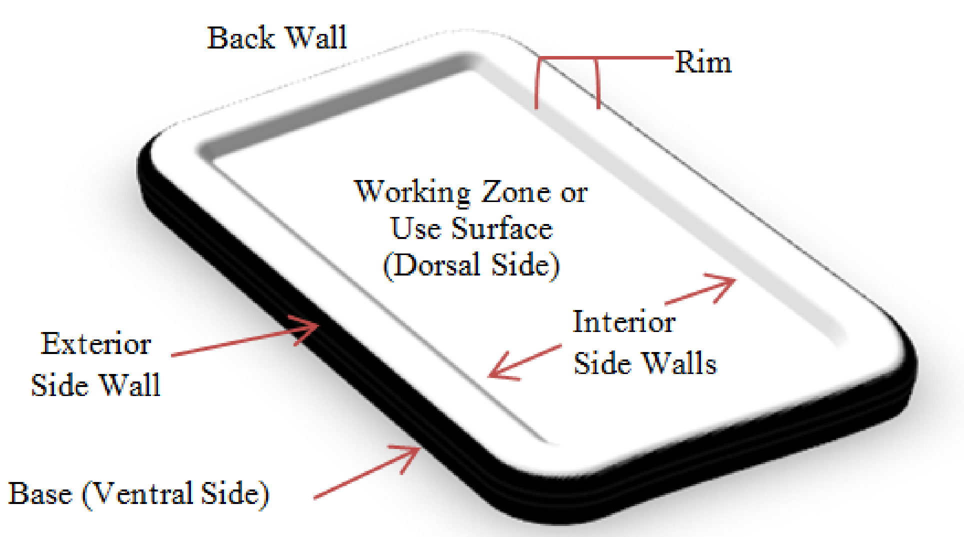

Figure 4.1. Metate morphology

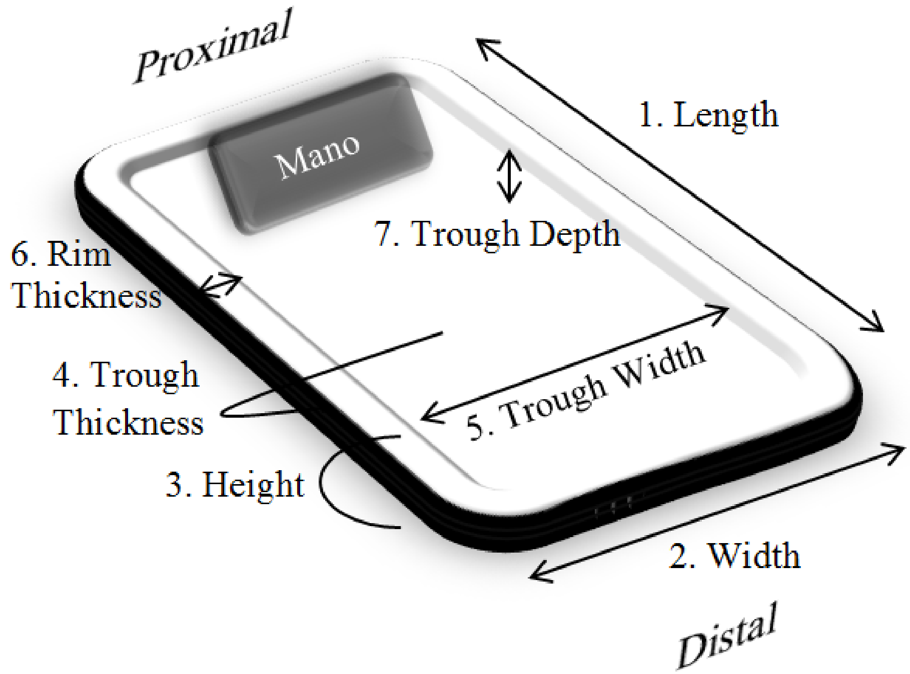

Figure 4.2. Metate measurements

For trough and basin metates, *trough width* (or basin width) was measured from the inside of the trough (or basin) (*5* in Figure 4.2). *Rim thickness* was measured with calipers (this metate feature is also sometimes referred to as the lip, margin, border or ridge and is located on the lateral sides of trough metates) (*6* in Figure 4.2). *Trough* and *basin depth* is the amount of concavity present for the use surface of specimens (*7* in Figure 4.2). The technique used to measure trough depth is depicted in figure 4.3. Also with regard to depth, the use surfaces of many metates are angled or sloped from proximal to the distal end (see figure 4.4*)*. When this was the case the measurement was taken in the same manner as depicted in figure 4.3 and an additional measure measurement was taken from the top of the back to the start of the grinding surface at the proximal end.

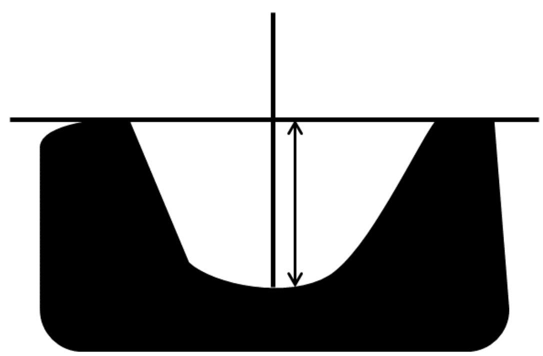

Figure 4.3. Cross-section of a trough metate, measuring trough depth

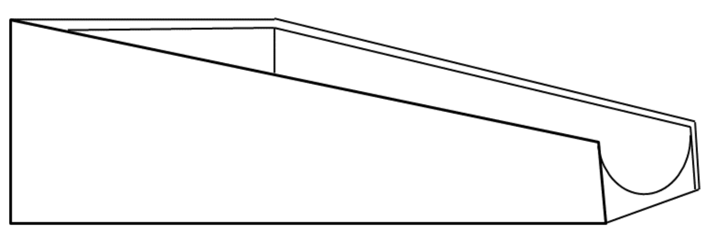

Figure 4.4. Outline of vertical orientation for a trough metate

Metate *shape* was determined by estimating the original form of the respective tools. The range of variable for shape included: *amorphous, ovoid, rectangular* and *trapezoidal*. Apparent *plan view symmetry* and *symmetry in cross-section* was noted for artifacts possessing these characteristics. *Exterior corner angles* were measured in degrees with an angle finder for those specimens containing corners. The *appearance of corners* was also noted as *rounded* or *square.* The *configuration of exterior side walls* was a relational attribute with specimens determined to be *finished* or *unfinished*. Finish is characterized here as either *ground, ground and chipped,* or *ground and polished.* If finished, exterior side walls can exhibit one of the following attributes: *apparent horizontal symmetry, apparent vertical symmetry*, or *both horizontal and vertical symmetry*. The *relative shape of exterior side walls* was recorded from a range that includes: *rounded, squared, vertically angled out from the base*, or *vertically angled out from surface*.

After collecting the metric data, an approximation of the original length and width was relationally established for most metate fragments based on a visual estimate. *Artifact completeness* was a relational construct that was recorded as: *less than one-quarter*, *between one-quarter and one-half*, *one-half,* or *greater than one-half*. It was not possible to make these assessments for the smaller specimens.

Wear affects the surface configuration of metates, often altering the apparent shape of the use surface. Therefore the respective *base shape* of specimens was noted with the possible range of variables including: *amorphous, ovoid, rectangular* and *trapezoidal.* Additional notes were collected concerning the configuration of metate bases including the horizontal levelness of the base plane, corner shaping, or the appearance of scars or indentations registered on this ventral surface.

b. Manos

Complete and fragmented manos were weighed and measured. Length was measured from end to end. Width was measured from one side to the other, perpendicular to length. Area and diameter was calculated for some manos when relevant. As discussed when introducing the food processing assemblage, profile shape was determined for most all mano specimens in the food processing assemblage. As discussed previously, when introducing the sample, mano shape was derived from the transverse cross-sectional shape with a range of values that includes: biconvex, lenticular, plano-convex, triangular, sub-rectangular, wedge, sub-circular, edge-ground cobble, and punted manos. For many strategic designed mano fragments, an assumption of bilateral symmetry enabled me to estimate the original size of many specimens.

3. Breakage Features

The preceding archaeological, ethnographic and experimental discussion demonstrates that breaks may occur from activities related to accidents, attrition (incidental breakage from exhaustive use) intentional action, and prolonged exposure to extreme variations in temperature or other natural phenomena. The methods used to diagnostically assess and categorically interpret specimens were informed by Adams (2008), Hamon (2008) and Stroulia (2011). Additionally, I consulted the work of Gero (1978), who illuminates the need to determine which scars or indices found on stone artifacts were made in prehistory and which were created during and after excavation. Gero conducted a micro-wear analysis experiment on flint flakes to determine the appearance of indirect and incidental damage that can occur during excavation, transport, storage, and analysis of artifacts once removed from archaeological contexts (1978:34). She found screening, cleaning, and storage to result in scars on the surfaces of the specimens in her experiment, yet she notes that this damage was limited in severity (Gero

1978:34). I utilized the suggestion made by Gero and determined which indices (scars or marks) registered on the specimens in the sample from Inca-Caranqui resulted from excavation, transport or storage (fig. 4.5).

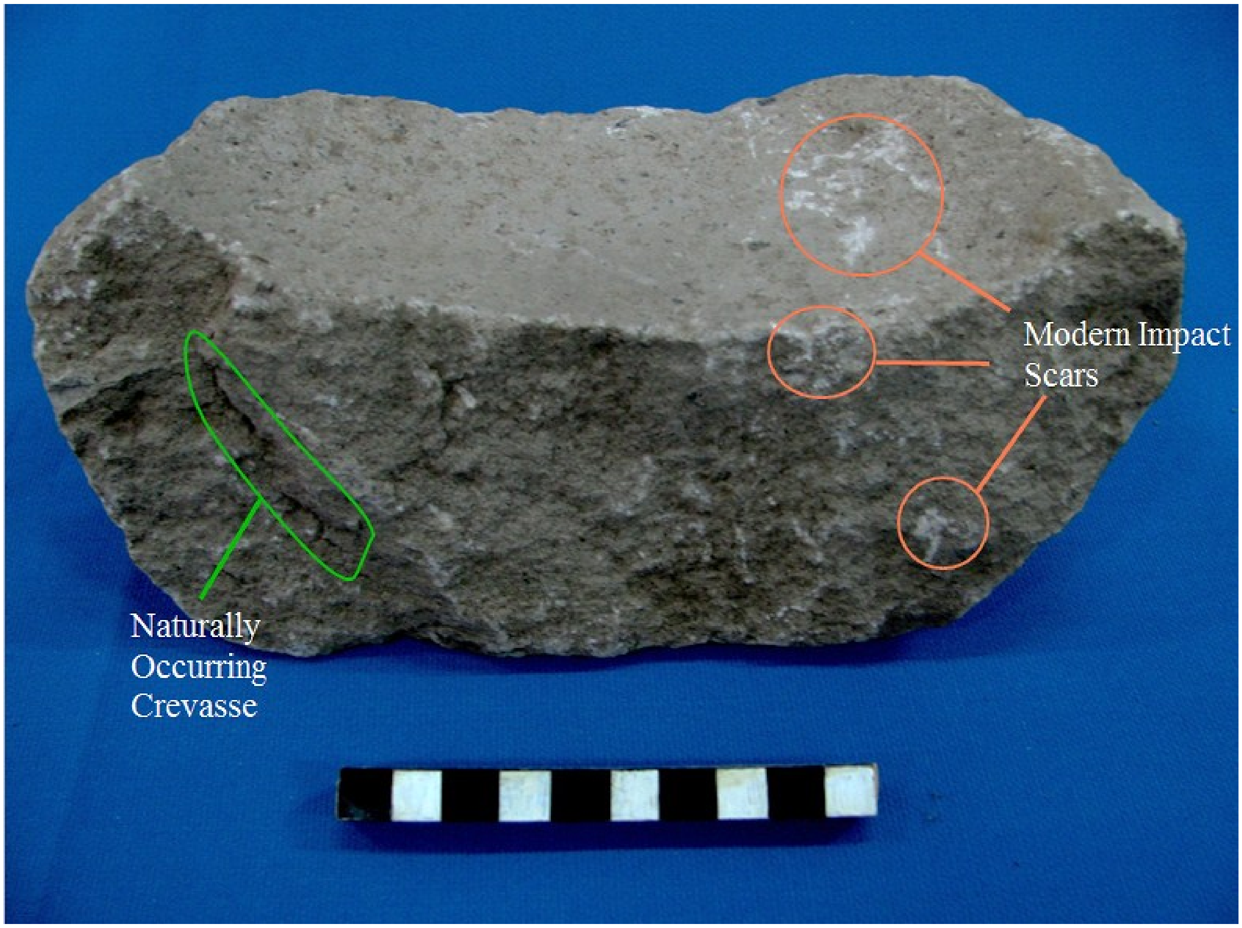

Figure 4.5. Metate with modern scars and natural imperfection

Analysis of breaks was performed on broken specimens in the sample by both macroscopically and microscopically examining the configuration of broken edges and scars present adjacent to break precipices. Additionally re-fits were attempted for fragments, and also the *degree of use* was determined relationally for most items. What follows is the list of attributes that pertain to the analysis of fragmentation.

a. Condition

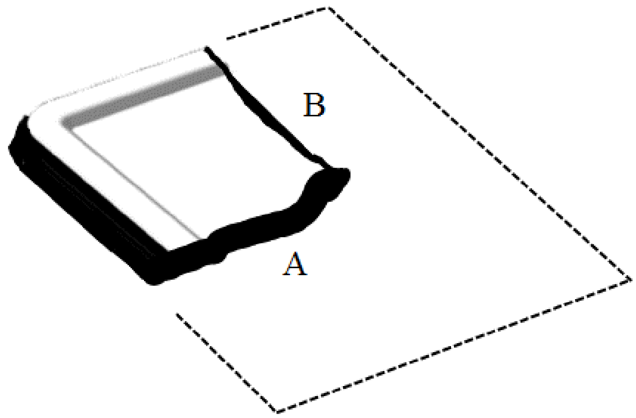

Figure 4.6. Corner fragment from a three-quarter trough metate

The *condition* of specimens was identified as either *broken* or *whole*. Mano and metate fragments were further characterized as *exterior fragments* or *interior fragments* (or *mid-section)*, depending on the section of tool that the respective fragments represented. The former refers to specimens containing at least one unbroken edge. For example, Figure 4.6 depicts a corner fragment of a metate with two broken edges labeled *A* and *B* and also two unbroken edges that form a corner. The number of *broken edges* was counted for specimen containing an exterior edge (see Figure 4.6). The range in values for this attribute is from one to three broken edges. For metates, interior fragments are those that do not exhibit an exterior edge but rather have only exhibit a portion of the dorsal side and the base (Figure 4.7a). With manos, interior fragments refer to the mid-section of a tool, since both ends of the mano are broken (Figure 4.7b). The dotted lines depicted in Figure 4.7b*,* suggest the potential shape of the original complete tool and illuminate the area of the tool that the fragment represents.

Figure 4.7. Broken edges: *a*. metate interior fragment; *b*. mano mid-section fragment; *c.* metate corner fragment with one vertically broken edge; *d*. metate proximal end fragment with two broken edges.

When possible, the section of the tool that the fragment represents was also recorded (e.g. figure 4.6 depicts a corner fragment from the proximal end of the trough). The range of possibilities for this attribute includes: *proximal corner*, *proximal half*, *distal half*, *lateral half*, *interior* or *mid-section*, and *proximal end without corner*. Figure 4.6c depicts a metate fragment with one vertically broken edge, and Figure 4.7d depicts a proximal end metate fragment with two broken edges. *Break appearance* was a relational construct identified as *jagged*, *even* (straight) or a combination of jagged and even.

b. Impact Damage

The examination of broken areas of specimens included the macroscopic and microscopic inspection of the immediate and surrounding areas of breaks. Relational comparisons within the sample were made with respect to the presence or absence of *scratches* (fig. 4.8), pecks (fig. 4.9) *indentations* (figures 4.10 and 4.11), and other scars noted on the use surface of tools. Other observations were also collected regarding the appearance of breaks and break patterning.

Figure 4.8. Scratches: small edge-ground cobble mano

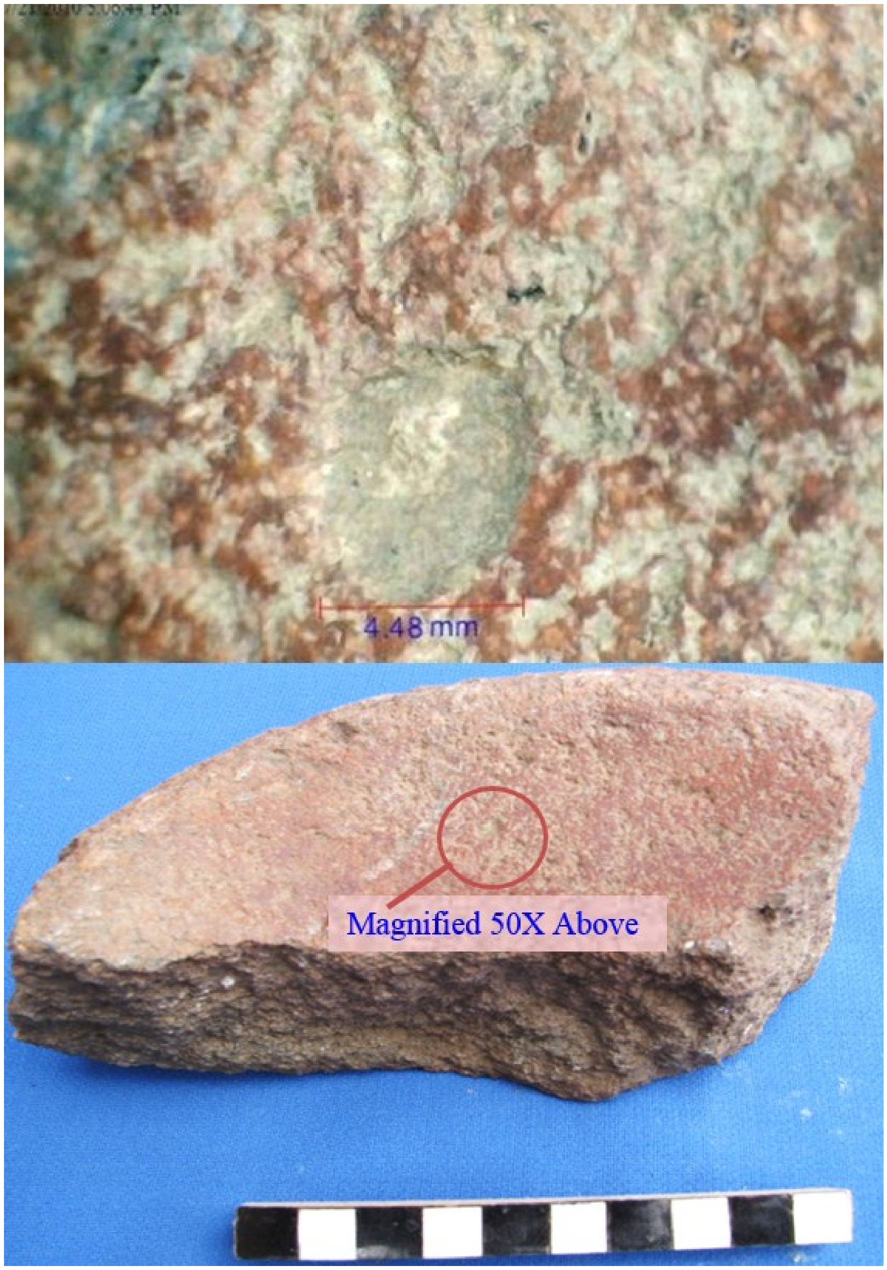

Figure 4.9. Pecks: on surface of a metate fragment

Figure 4.10. Linear indentation: on a mano fragment

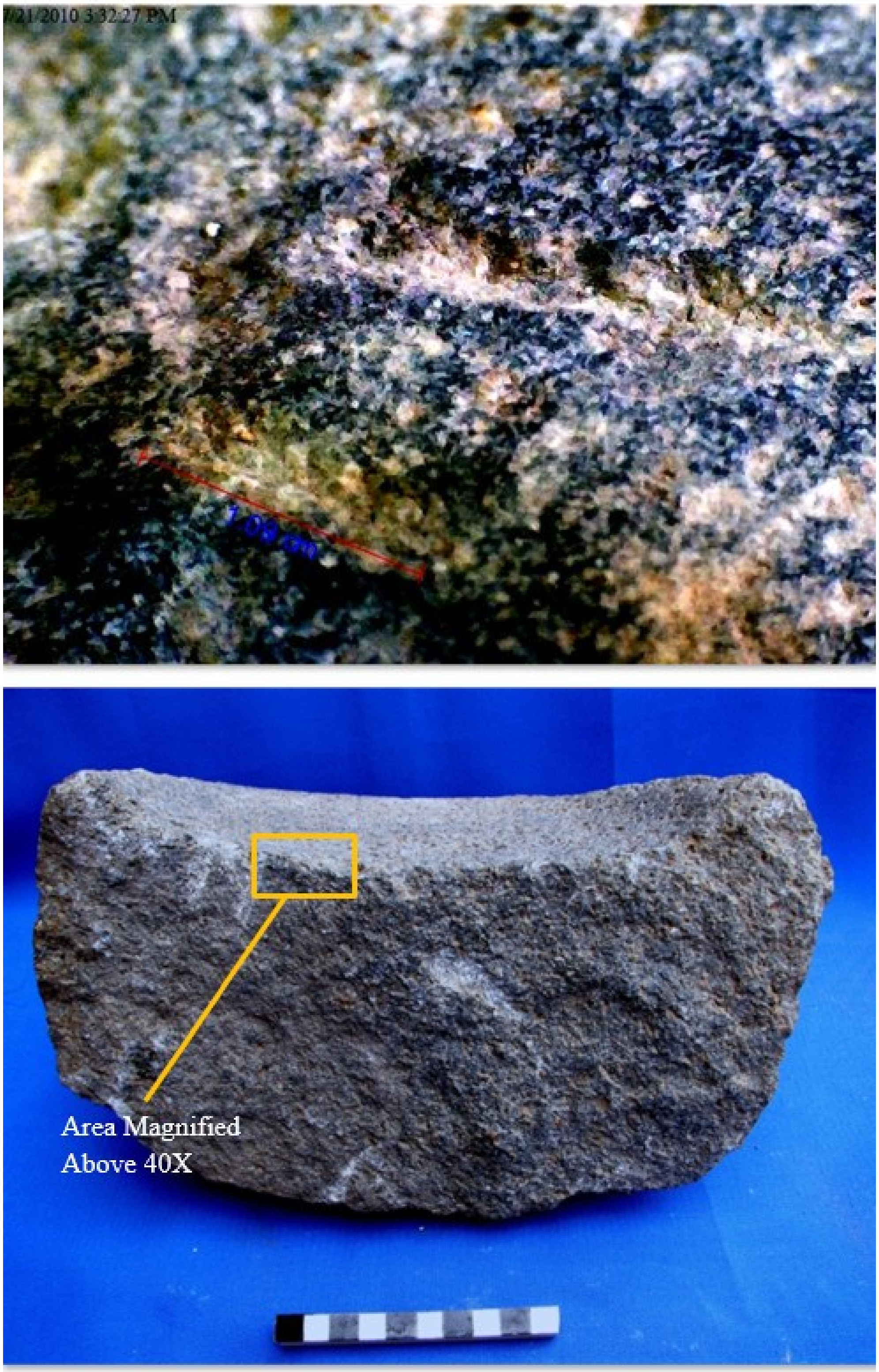

Figure 4.11. Linear indentation: on a metate fragment

B. Analytical Techniques

Fragmentation analysis was intended to provide insight into Pre-Columbian destructive action and its possible relation to ritual activity. Previous sections in this paper provide examples of intentionally fragmented objects from archaeological and ethnographic contexts. Many of the archaeological examples of intentional fragmentation from the Andes are related to ritual and funerary contexts.

1. Re-fitting

The purpose of re-fitting fragments was to explore questions regarding the order in which tools were fragmented; the original tool size; disparities in the treatment of fragments (e.g., whether re-used or discarded), and to determine the minimum number of manos and metates from the site. The primary method used to match fragments was to compare attributes related to lithic material for respective artifact types including color, granularity, inclusions, and vesicular structure. After these attributes were collected for each specimen they were entered into a database. Those specimens in the database sharing similar raw material characteristics were then physically compared in the lab. The secondary method used to re-fit fragments was to physically compare like specimens during the data collection phase of the project detailed here.

2. Experimental Archaeology

The methodological model constructed to analyze breakage derives from previous archaeological research, ethnohistoric references, ethnographic data, and an experiment I performed in March 2012, designed to better recognize intentional breakage for stone metate-sized slabs. What follows is a summary of that experiment:

a. Experiment Summary

An experiment was designed to evaluate the ways in which stone breaks when methodically struck at specific points with specific hand tools. The objective of the experiment was to measure the effects of force and to collect data on the appearance of different modes of purposed destruction including: percussive strikes, pecking, hammering and throwing. When initiating the experiment, I operated under the hypothesis that many metates from Inca-Caranqui were intentionally and methodically broken.

Within the framework of methodical breakage, I considered one possible mode of fragmentation involving an orchestrated sequence of activities leading up to the actual moment that a tool was destroyed. Within this scenario, metates may have been readied in advance of smashing by first repetitively striking the use surface of these implements in a relatively patterned and concentrated manner. The thinnest part of many metates is generally the area that had experienced the greatest amount of use. The activity of concentrated and prolonged pecking at a specific point within the thinnest zone of the tool would further weaken the structure. Once repetitive strikes had all but destroyed the metate, it was effectively primed for smashing. The final act, and that which would result in fragmentation of the tool, facilitated the enactment of theatrics likely integral to the efficacy of ritual performance. An over-head heaving of a metate may have resulted in the apparent instant smashing that could prove quite dramatic in some contexts. The illusion, of course, is that breakage occurred instantaneously, when actually it was the result of a planned sequence of events. Observers are none the wiser that the metate heaved was thoroughly weakened through pecking before the ritual.

b. Materials and Procedures

Untreated limestone landscaping slabs from a quarry in southern Indiana were used to perform the experiment since they could be considered roughly similar to flat metates.

Specimens (*N*=5) were initially chosen according to approximate weight, thickness, and if they could be effectively be used as metates. The experiment consisted of a control, *Group A*, and a non-control or experiment group, *Group B*. When the experiment began each specimen was 3.75 cm thick. The range in weight for the specimens was 2.26 kg to 6.5 kg, with an average weight of 4.3 4k g, and a median weight of 2.3 kg. The range in length was 10.1 cm to 30 cm, with an average length of 19.35 cm, and a median length of 20.4 cm. The range width was 8.8 cm to 18.7 cm, with an average width of 13.26 cm, and a median width of 13.05 cm. A summary description of specimens is presented in Table 4.1. Tests were conducted outdoors on generally dry specimens, each was timed and the resulting debris was collected and weighed.

Table 4.1. Summary of specimens used in experiment

Object	***Group***	**Weight (kg)**	**Length (cm)**	**Width (cm)**	**Surface Description**
1	*A*	2.3	11	9	Small flat
2	*A*	4.7	18.1	14.2	Medium flat
3	*A*	6.5	24.2	18.7	Large flat
*3b**	*A*	2.26	10.1	8.8	Modified Small to med flat
4	*B*	4.2	30	11.9	Modified Medium concave
5	*B*	6.0	22.7	17	Large flat

**Object 3b* was added to the sample after the experiment began

c. Research Design

Each specimen was fragmented using a specific method and the resulting condition was measured against an expected finding. These methods included: *Group A, object 1* was modified through striking with a metal 3 lb. rock hammer[24] (1.36 kg); *object 2* was modified with a blunt

[24] Terminological clarification: a *rock hammer* (also known as a *stone hammer*) is a modern metal hammer used to break stone. Geologists, paleontologists, sculptures, and stone masons, among others, commonly utilize these metal tools to effectively break rock.

metal chisel held at approximately an 80˚ to 90˚ angle to the surface of the stone and struck sharply on the edge with the 3 lb. rock hammer; *object 3*, was pecked with the beveled end of a 24 oz. (~0.7 kg.) metal ball peen hammer and then thrown from a height of approximately 3.7 meters above the surface of the ground; subsequently *object 3b*, a resulting fragment of *object 3*, was added to the sample and re-thrown from the same height; *Group B*, *object 4* was modified by unpattern pecking with a stone pecker[25] and hammered with a hammerstone;[26] and *object 5* was modified by pecking in a concentrated area with a stone pecker and hammered using a hammerstone in precise locations.

A variety of cobbles ranging in size and lithic material were employed as the stone hand tools, percussive tools and hammerstones that were for the non-control group experiments. The weights of these items varied from approximately 0.45 kg to1.36 kg. As prescribed by Whitaker (1994), the percussive tools used in this study were selected based on their relative hardness and comfort while in hand. As the experiment progressed, an additional hammer stone was fashioned from a large flake removed from *object 4* during its modification.

d. Results

Control results, *Group A*: *object 1* fragmentation occurred in ≤ 20 minutes with somewhat random hammering over the center of the surface of the specimen resulting in two 2 major fragments and several small splinter-like and particle fragments; *object 2* fragmentation occurred in <5 minutes with the chisel placed in the precise center was struck with a hammer resulting in four approximately equal sized fragments; *object 3*, was pecked with the beveled end of a ball peen hammer for approximately 3 hours (approximately 10 minute intervals over the

[25] In this instance, the *stone pecker* is an expedient stone tool used to puncture the surface of stone.

[26] The *hammerstones* used in the experiment were un-hafted expedient stone hand tools that were not attached to a shaft during use.

course of 3 days) and then thrown from a height of 3.7 meters. *Object 3* landed approximately 5.4 m from where it was thrown, fragmented immediately upon impact with the ground, and resulted in two different sized fragments. The larger of theses, referred to as *object 3b*, was re-thrown from the same height, with approximately the same amount of force yet failed to fragment.

Results for the experimental, *Group B*, contained specimens that were fragmented with stone pecking and hammering tools. *Object 4* was subjected to pattern-less pecking over the surface that was somewhat concentrated in the center of the specimen for more than 4 hours (conducted in two intervals, each lasting more than 2 hours with brief pauses) before a concentrated hammering technique was employed at the center of the surface with a large hammer stone in short intervals, constantly for ~2 hours with a medium-sized hammerstone. The specimen was then hammered with a larger hammerstone for < 15 minutes before breaking. Fragmentation resulted in four fragments, two of equal weight and two others of equal weight. *Object 5* was altered through a combination of pecking in a concentrated area at the center of the object for approximately 3 hours in approximately 10 minute intervals, then later, hammering the same concentrated area in two separate nearly continuous one hour intervals. Fragmentation resulted in two unequal-size fragments.

e. Discussion

The hammer and chisel technique (in which a metal chisel and hammer were used) was the most effective of those tested in the experiment. This method resulted in evenly broken surfaces and large pieces that were approximately equal-size and weight. Controlled fracture in this way required sharp hard strikes to the chisel. The effectiveness of this method rests on the chisel transferring the sharp force, created by the heavier hammer. The use of the stone hammer alone broke the *Group B* specimens into smaller, unequal-sized pieces. Before fragmenting the specimen, this method produced an abundance of flakes, thus reducing the item hammered. It was an effective method for breaking stone but lacked the control and accuracy that the hammer and chisel technique afforded. The hammer alone was not effective in breaking the slabs into large, somewhat evenly-sized pieces.

After performing this experiment, I concluded that the technical and physical aspects required to break stone are similar to those used during the shaping of stone (sensu Hoffman 1999). Desired outcomes sought during the making and breaking of stone objects is dependent on the technique employed. Similar to the shaping of stone, fragmentation requires the right tools for the job. Fragmenting stone to create a desired result (e.g. shape or size of broken pieces) is similar to shaping stone –the technique and tools chosen to perform the task are crucial to the outcome.

While lighter hammerstones may have been effective for the shaping stones, they were less effective in fragmenting the stone into larger pieces. Smaller hammers would have afforded users more control than larger ones, and were likely used during the finishing stages of ground stone manufacturing when precision is valued. One benefit of lighter hammerstones is that they are easier to handle, yet often seem to require more than one strike to perform a task, which can affect the size and number of resulting fragments. Although more fatiguing, larger hammerstones were likely used to perform the roughing-out stages of metate manufacture, wherein power is more desired than control. Similarly, they would also be more effective in the fragmenting of large, dense basaltic metates. I believe that a hammer and chisel would have been the best tools for fragmenting heavy, thick metates. Breaking rocks in this fashion, with a chisel and hammerstone, is more nuanced than pecking a tool surface until it is nearly exhausted of its utility and then smashing it. In a sense, there is in art to both making and breaking stone objects.

The constraints of the experiment are somewhat obvious. Ideally the experiment would benefit from the sole use of stone implements to perform the tasks of hammering and pecking. The choice to use a metal ball peen hammer, rock hammer and chisel for *Group A* specimens came only after failing miserably in attempts to fashion hammerstones on shafts. Those I created were inadequate for the task of breaking rock; knowledge is required to obtain desired break patterns. (and further illuminate the skill needed to make and break stone objects in the pre-Columbian Ecuador). Since all rocks do not break in the same way, another constraint of the experiment is that the lithic material used to perform the experiment is different than those raw materials used to create the food processing assemblage from Inca-Caranqui.

3. Morphological Classification

The aim of creating a typological classification scheme for metates and manos was to address cultural variation at Inca-Caranqui. As discussed previously each ground stone artifact was analyzed morphologically and metrically. The typological divisions created here are based primarily on functional and stylistic attributes. I sought to create logical classifications for homologous tool types that could be applied throughout the northern highlands.

The purpose of conducting typological analysis of metates and, subsequently, manos from Inca-Caranqui was to gain insight in Pre-Columbian subsistence and economic factors relating to craft production. For metates, it appears from ethnographic information derived from Central America that stylistic attributes and lithic material type should be relatively specific for production within a given locale. Experimental data illustrate that a result of use is the modification of the grinding surface, which typically tends to modify the original style of the tool in relatively predictable ways. This was considered when sorting and attempting to type metate fragments. As previously noted, the attributes used to construct the ground stone tool typology included: raw material, shape, style, estimated original dimension, the number and location of facets (for manos), use, finish, secondary modifications, and recycling. During the sorting and classification of tools, it was noted that some specimens could fit into more than one category. Following Adams' (2002:12) suggestion, these objects were typed as belonging to more than one category.

a. Metates

Metates were taxonomically sorted using three hierarchical divisions: groups, types and sub-types. As used here, "group" refers to whether a tool was of expedient or strategic design. Surfaces were divided into those containing restrictive borders adjacent to the use surface and those that are unrestricted. Restricted surfaces were divided for analysis into those restricted from use (concavity that incidentally forms a border, for instance basin metates) and those manufactured/designed with consistent restricted margin or lip (e.g., trough metates). The trough type metates were further subdivided according to the configuration of grinding surface. For troughs, sub-divisions and varietal distinctions were made later based on finer stylistic differences (some distinctions may have also served minor functional purposes). Other tool areas modified during manufacture, such as borders, margins and corners were also considered when determining typological variations.

b. Manos

Manos were taxonomically sorted using two hierarchical divisions: group and form (shape of transverse cross-section). In addition to the shape of the cross section, the attributes used for distinguishing manos include the shape and number of grinding surfaces or facets. Other attributes considered for manos included plan-view shape and the shape of edges and ends. Manos were also analyzed with respect to for how they were held during use, e.g., with one hand or two. The proximal and distal edges of manos were determined in relation to the wear indexed on respective tools.

4. Function Analysis

There is not a standard model of functional analysis in ground stone research. Present frameworks for interpreting tool use are based on wear patterns noted on tool surfaces and tribochemical[27] wear resulting from mechanical changes to stone surfaces. Functional interpretations are regionally specific and reliant on experimental data and, in some areas, ethnohistoric reference or ethnographic analogy. Respective regional models do not necessarily easily transfer to other locations or contexts since these frameworks are devised to consider specific variables, such as lithic material, the types of foodstuffs processed (e.g. grain, salt, or dried fish), or whether materials were processed in wet or dry states. Currently information regarding food processing techniques in the northern highlands of Ecuador is primarily informed by ethnohistoric references and ethnographic information.

As a consequence the approach to analyzing use wear for the food processing assemblage from Caranqui did not benefit from a comparative model based on regional experimental data. It was outside the scope of this thesis to perform use wear experiments. Since maize was found in archaeological contexts at Inca-Caranqui and also at neighboring sites, I drew analogies from grindstones analyzed in the Southwest and Central American. Based on research in these regions, I adopted terminology and methods to study the mechanisms of wear for the specimens in the

[27] Tribochemical wear resembles polish or sheen on the surface of tools and is described by Adams (2002), who explains that it is chemical interaction producing visible oxides or films and occurs through processes of adhesive wear, abrasive wear, and fatigue wear.

sample (primarily from, Adams 1988; 1993; 2002; Clark 1988; Ortman 2000; Wright 1993). All descriptions of wear are my interpretations based on analysis of the contact areas of specimens and reflect the knowledge I acquired from the local spectrum of lithic materials and wear traces on other ground stone artifacts including those from previous archaeological research and site reports, modern use by indigenous farmers, as well as those in museums, archaeological site assemblages, and private collections.

The probable functions of implements were determined by pairing morphological attributes and use-wear features. In instances where function could not be determined, the descriptive attributes collected from specimens were later used in making other comparisons within the assemblage. During the sorting and classification of tools it was possible to recognize that some specimens also fit into more than one functional category, so, as noted above, these objects were tallied in each of the relevant functional categories. These specimens are referred to as multiple-use items. They include objects that were used concurrently in different activities (e.g., grinding and hammering) or used sequentially for one task before becoming utilized for another. Experimentation in previous research demonstrations that during use, the repetition of certain mano strokes modifies the contact surfaces of the metate in specific and recognizable ways.

a. Surface wear

Wear is the physical manifestation of use that is registered on tool surfaces. Use-wear damage attributes are linked to the behavior of tool users. The presence of *wear* was recorded for all specimens that exhibit this attribute. Contact surfaces for manos are sometimes referred to as *use facets*. Manos can possess one or multiple use facets. The terms *contact surface*, *grinding surface*, *use surface* or *zone* refer to the same area. For basin metates this area is referred to as *the basin* and for trough metates it is referred to as *the trough*. For both mano and metate, this is the area that the tools come into contact with each other during use.

For the wear analysis, it was first necessary to determine the texture of the rock comprising the tool. This was performed by comparing the texture of respective contact surfaces with other areas of the tool. Broken surfaces were ideal for gaining understanding of the true texture of specimens. For complete mano specimens, un-used or less-used surfaces were analyzed when available. Wear was assessed by analyzing the surface topography of specimen with and without the visual aid of a hand lens of l0x magnification and by exposing respective tool use zones to incandescent rake lighting. Some specimens were examined with low-power microscopy lit with light-emitting diode (LED) to evaluate wear.

Four distinct types of use-wear are identified by Adams (2002; 2013), which include *abrasive wear, adhesive wear, fatigue wear,* and *tribochemical wear.* Within a tribological framework, Adams (2002) outlines four processes of wear formation: adhesive wear results from the attraction between contacting surfaces molecularly; fatigue wear is the crushing or fracturing of rock grains resulting from contact; abrasive wear refers to impacts through gouges and scratches to the softer surface via the asperity of a harder surface; and tribochemical wear, is a build-up resulting from chemical reactions created through the interaction of the two surfaces. The author notes that these mechanisms are not mutually exclusive and their respective effects can result in similar alterations of stone (Adams 2013:2). These processes result in distinct wear patterns on the contact surfaces of both manos and metates which was used to reconstruct the manner in which contact occurred. Adams (2002, 2013), as well as Dubreuil and Savage (2014), explain that the reductive natures of abrasive and fatigue wear are associated with cracks, fractures, gouges and striations and also that grains loosened by adhesive wear can become abrasive and hasten the development of patterns of abrasive wear. Friction of the mano and metate contacting each other can result in a reflective sheen or polish on the contact surfaces of tools (Adams 2002, 2013; Dubreuil and Savage 2014:141).

Use-wear is analyzed by examining the *topography* of the contact surface of specimens at the *macrotopographic level*, and through the use of low-powered microscopy at the *microtopographic level* (Adams 2002:29; 2013). Some fragments in the sample were too small and for topographic analysis, however these specimens were also useful for making comparisons for texture for different rock types.

The *orientation of wear* results from the stroke pattern employed when using tools. Possible values for this variable include: *rotary* (circular); *diffuse* (containing no apparent direction); *linear* (single direction); *multi-directional* (two or more directions relative to the edge or surface of manos); and *reciprocal* (back-and-forth). *Wear polish* is another indicator of use, for example, curves accentuated in multiple directions from the center of the use surface indicate rotary motion and large rectangular-shaped areas indicate reciprocal strokes (Clark 1988: 97). *Polish* or *patina* on the use surface of tools is shiny and resembles a sheen or gloss and results from tribochemical wear, in which tool surfaces become chemically altered allowing oxides and films to visibly change the appearance of the use area or working surface. Polish does not contain striations and is a type of abrasive wear.

While not mutually exclusive*, wear traces* were characterized as *smoothed, pecked*, *pounded*, and *striatiated.* One type of wear can overlie another and eventually mask the underlying wear through extensive or intensive use. *Smoothing* refers to the appearance of an even or smooth use surface. *Pecking* refers to small impact fractures often located on the use surface of metates, created by a mano or other hand tool containing an end that is either rounded or pointed enough to penetrate the metate use surface upon contact. Pecks often resemble pocks or pits and generally occur in a series in a concentrated area of the use surface of a metate. The action of pecking has been associated with the processing of material atop a metate, during the refurbishing or curation of metates to sharpen their surfaces, and also to intentionally fragment a tool. *Pounding* refers to wear trauma at the ends of manos.

Striations are linearly patterned, parallel, line-like grooves often occurring in series. The presence or absence of *striations* was noted, as well as the *directional orientation of striations* on the use surface with the following range in values: *longitudinal*, *lateral,* and *multidirectional.* Striations and consistent smoothing running parallel with the long axis of metates are indicative of reciprocal motion, while circular striations or concentric wear patterns indicate a rotary motion was used (Clark 1988: 97). The presence and absence of striations on the interior side walls of metates was also noted. *Use* manifests on tool surfaces as *wear traces* and is associated with a specific action. Methods from analyzing use through wear are adopted from Clark (1988). The use of tools was determined using the aid of Adams (2002:21-25). *Surface texture* is a contributing indicator of use and was considered relationally and measured tactilely for the use surfaces of tools in the assemblage. Abrasiveness of the surface was sometimes intensified by re-roughening the worn surface (Horsfall 1987). Stone can be naturally smooth yet the use surface of a tool is rough. This value was measured tactilely and visually with possible values consisting of *smooth*, *rough* or *varied*.

Use intensity is measured by the amount of time spent at each grinding task (Adams 1993; 2000:118). Extensively used metates can be used for several years. Adams (2002:118,271) offers the example of intensively used metates lasting 50 years rather than just one year that an intensively used tool may last. In contrast, an intensively used tool was used for tasks that occurred over long durations for example five hours a day rather than one hour a day (Adams 2002:119,271). Comfort features and wear management strategies (Adams 2002:118) may be more indicative of intensive than extensive use. *Attrition,* or the degree of use for metate grinding surfaces, was relationally estimated for metate fragments. Evidence for the degree of use, whether intensive or light, was relationally assessed. *Level of use* for metates was considered on a relational basis with the range of possible values being: *light*, *moderate*, or *intensive*.

b. Curation

The curation of tools is associated with surface modifications and can vary for metates and manos. For metates, curation-related features generally involve the refurbishment or resharpening of the use surfaces via intentional pecking. This action conditions the use surface and keeps it viable. The surface sharpening of metates has been recognized archaeologically and ethnographically and is understood as a management strategy during the use-life of tools, especially those intensively used. For example, manos and metates manufactured of non-vesicular material are sometimes pecked to increase tool efficiency by sharpening (or re-sharpening) the use surfaces of tools that had become dulled through use. Indicators of *surface refurbishment* are recorded for the tools in this sample.

Post-manufacturing modifications to manos indicate the addition of comfort features and the performance of wear management strategies intended to distribute the effects of wear or to sharpen a tool surface. Comfort features aid the user by offering comfortable and effective handles or grips (Adams 2002:94-96; Woodbury 1954:90-93). Wear management strategies include employing techniques intended to counteract the unevenly distributed effects of wear. One strategy is to rotate a mano during use, thus dispersing wear to other facets (Adams

2002:114). Resharpening can help to maintain the viable surface of tools but may come at the expense of damaging the tool (see Adams 2002:114).

The *presence of comfort features* was recorded for the manos, as were the *number of comfort features* present on each specimen (generally ranging from 1 to 4). The *appearance of comfort features* was determined relationally as to whether grips appear to be *formally* created (presumably by the maker) or *informally* created (presumably after use begins). The *location of comfort features* was also recorded. These attributes were analyzed through cross tabular analysis of frequencies related to comfort features as compared to other criteria including the location of grips and the location/direction of wear; the location of grips and mano type; the number of grips and location/wear direction; the number of grips and mano type; and the location of grips and lithic material.

c. Residue

Objects were examined macroscopically for traces of *residue* that may have been deposited on tool surfaces. If present, the *appearance of residue* was recorded. This relational construct included the following categories: plaster, pigment, smoke blackening, or grease. The *residue location* was also recorded and can aid in determining at which phase in the life history of a tool that the residue was deposited. For instance, was the tool exposed to fire before or after being broken? Possible values for the location of residues included: *broken surfaces* (inner of tool), *use surface, base* (for metates), *breaks and base*, or *covering the entire specimen*.

d. Recycling

Secondary wear and secondary modifications are associated with the recycling, reuse and repurposing typically of fragmented tools, though complete tools can also sometimes be repurposed. Indications of recycling are similar to those of primary wear characterized above. The values to describe wear associated with repurposing are the same those used for the appearance of primary wear and include pecking, pounding, smoothing, and striations. Secondary wear overlaps primary wear and can obscure the original function of tools. Re-use may be recognized for specimens by the location of the secondary wear. It may extend over a broken area of specimens, often dulling a broken edge. It is also recognized by wear that is located in an area of a fragment that is considered outside of an area that wear typically accumulates on tools. Secondary wear may also be directionally distinct from primary wear or the direction wear would typically be found in a respective area of tool. Recycling may also be indicated through the presence of residue, especially if the residue extends over and onto the broken edge of a fragmented tool. There are a few specimens that contain an area of orange-ish coloring on some of the rock grains that appear to be iron staining.

V. Analysis

A. Inca-Caranqui Food Processing Tool Typology

1. Metates

Metates specimens (*n*=295) were morphologically analyze in order to reveal aspects related to the manufacturing of these tools. An important element of this study was to determine if the ground stone tools at Inca-Caranqui had been produced by craft specialists. If specialized techniques were employed to make the metates from Inca-Caranqui, one approach used in previous lithic research suggests that tools should reflect the quality of having been crafted by specialist through standardized consistency or homogeneity in morphology (sensu Blackman *et al.* 1993; Costin 1991). In previous research metate craft specialization has been quantified by using the comparative method of calculating the corrected coefficient of variation for two respective samples or distributions (see VanPool and Leonard 2011).[28] To test this assumption, metric and non-metric attributes relating to morphology were analyzed for purposes of identifying any degree of standardization that may be exhibited.

Using this framework as model to analyze morphology, specialized skill on the part of tool crafters could not be conclusively established in this study for the metates from Inca-Caranqui. In part this is due to the fact that many fragments were not large enough to extract measureable attributes related to morphology and also because there was a lot of variability among specimens, even those of the same type. The analysis of metates from the site reveals that there were a variety of processes employed to craft the raw materials from which these tools were made. Also suggested is the fact that a good number of stone tool producers possessed a

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[28] VanPool and Leonard used the corrected coefficient of variation (corrected CV) to analyze two functionally equivalent trough metates types excavated Paquime and compared them with metates from another site. They calculated the mean values for chosen performance characteristics and results of their calculations suggest standardization of morphology for metates from the site (VanPool and Leonard 2002:72).

highly developed understanding of the raw materials involved in manufacture. This understanding would have governed the crafters abilities to retain the original tensile strength of the stone, which has, in some contexts, been linked to the long use-life tools.

Drawing from the research summarized previously for specialization (Blackman *et al.* 1993; Costin 1991; Rice 1991), and the specialized manufacture of metates, which include: morphological standardization within assemblages (VanPool and Leonard 2002); raw materials used to make metates (Huckell 1986); raw material as a technological choice wherein manos and metates manufactured for maize processing were made of a higher raw material than other complementary food processing kits (Bostwick and Burton 1993).

Based on an analysis of these factors, a typology of metates was constructed for the ground stone assemblage from Inca-Caranqui. I interpret the distinctions in metate types discussed below to reflect different degrees of skill both in tool manufacture and also in the foodstuffs being processed. These difference may also reflect the way in which maize grinding was organized and accomplished at the site of Inca-Caranqui.

A. *Basins metates* (*n*=11) in the assemblage from Inca-Caranqui, contain grinding surfaces that are either circular or elliptical and became altered through circular strokes with a mano or a combination of circular and reciprocal strokes (Fig. 5.1). The use surfaces of these specimens reveal that basin metates found at the site were extensively used (i.e., frequently used for short durations). Evidence to support the premise of extensive use for basin metates derives from the presence of the narrow channels found within the depths of the use surface for most basin fragments in the assemblage. These channels, which developed through use, became worn in the use surfaces of these metates as users did not employ in wear management strategies for these tools. Many smaller-sized edge-ground cobbles and lenticular shaped manos appear to have been compatible with most basins based on size and the orientation of wear found on these metate fragments as well as certain manos in the sample. Other manos forms in the assemblage could also have been used with the reciprocal stroke if longitudinally oriented (parallel to the length) the use surface of a basin metate.

Figure 5.1. Basin metate fragment

Those specimens containing wear consistent with both circular and reciprocal mano strokes (n=8) indicate that these metates were not designated for a single function. Many of these tools exhibit post-breakage secondary use or recycling (n=8) that is evidenced through traces of wear extending over and broken edges, thus dulling break surfaces. Secondary wear is evidenced in the striations found on tool surfaces a top, what appears to be, primary wear that created a smooth texture on tool use surfaces. The materials processed with re-purposed basin fragments was apparently more abrasive than previously processed materials. Many of the striated wear traces contain relatively deep gouges. Basin specimens evidence modifications made during manufacture but less so than other metate categories. The bases of basin metates in the sample are convex and most exhibit evidence of manufacturing modifications (*n*=9), including chipping. Most basins are made with non-vesicular material (*n*=8) but a few are made of vesicular material (*n*=3).

The basin metate specimens in the sample are all fragmented as metric information was collected for specimens. The range in length for these fragments is from 10 to 22.3 cm. The average length of these fragments is 13.3 cm with a median length of 13.5 cm. The range in width for this category of metate fragments is 9 to 22.3 cm. The average width is 13.2 cm and the median width is 11 cm. The weight range is 0.2 to 3 kg. The average weight is 1.3 kg, with the median weight at 1.1 kg.

B. *Flat metates* (*n*=46) in the assemblage generally consist of a flat, even plane, although some specimens have an inclination on the side of the grinding surface (fig. 5.2). Most all of these fragments are well crafted and exhibit evenly honed exteriors and flat, level bases. Some flat metates are ovoid in shape (*n*=18) (*n*=14 high grade vesicular material and *n*=4 non-vesicular material), while others are rectangular (*n*=10) (*n*=2 high grade vesicular and *n*=8 non-vesicular material), and still others are trapezoidal in shape (*n*=18) (*n*=16 high grade vesicular and *n*=2 non-vesicular material). The bases of the flat metate fragments in the sample correspond to the shape of the use surface, whereas the outline shape of the base and the use surface are similarly fashioned. Although manos alter the use surface of metates, these particular specimens retained much of their original manufactured shape. Most all of those specimens made of vesicular material (*n*=32), were produced using a variety of different rock types which are harder and denser in comparison to the other vesicular materials present in the sample and therefore considered high grade. Some of these exhibit a subtle blue hue with Munsell color assignments within a blue/gray range (e.g., 5PB 5/2, Grayish blue and 5PB 3/2 Dusky Blue).

Figure 5.2. Flat metate fragment

The range in length for these metate fragments is 6.5 to 35 cm. The average length of these fragments is 16.7 cm with a median length of 14.5 cm. The range is width for this category of metate fragments is 6.3 to 43.5 cm. The average width in 15.5 cm and the median width is 13 cm. The range in weight is 0.3 to 20 kg. The average weight is 3.3 kg, with the median weight at 1.3 kg.

C. *Flat/concave* metates (n=21) are similar to flat metates but a have a slight concavity to more pronounced that is largely produced through wear caused by the use of manos shorter than the width of the metates are used. Wear traces on these tools indicated that they were primarily used with a reciprocal stroke of the mano. There is a fair bit of variety within the metate type in this assemblage. For example, some of these specimens exhibit flat bases (*n*=10) (fig. 5.3) while others have convex bases (*n*=11) (fig.5.4). From contexts in the Southwest US, Adams (2002:103) finds that flat/concave metates are typically originally designed as flat and become concaved through use. The design premise of use surfaces beginning flat and developing concavity only through use may not apply to all of the flat/concave metates specimens in the assemblage from Inca-Caranqui.

Figure 5.3. Flat/concave metate fragment with a relatively flat base

Figure 5.4. Flat/concave metate fragment with a convex base

Metric information was collected for flat/concave metate specimens (table). These items are fragments. The range in length for the flat or concave metate fragments is 11 to 33.3cm. The average length is 15.9 cm with a median length of 16.1 cm. The range in width is 9 to 29 cm. The average width is 15 cm and the median width is 14 cm. The range in weight is 0.35 to 10 kg. The average weight is 1.90 kg, with the median weight at 1.3 kg.

D. *Trough metates* (*n*=180) are the largest group of ground stone tools excavated at Inca-Caranqui. Trough designs can be further divided into subtypes based on shape and other varietal characteristics. This design represents more than half of all the metate fragments recovered from the site. They contain intentionally manufactured, enclosed trough-like grinding surfaces. The trough designs in the assemblage from Inca-Caranqui are considerably larger and heavier than the basin metate specimens found at the site. The production effort involved in the manufacture of trough metates can vary considerably and may include the addition of features not associated with other metate types (e.g. shaped bases, tapered sides, rims or margins). The sides of trough metates are designed to keep the processed material from spilling off the sides.

Figure 5.5. Open-trough metate

All but one of the trough specimens in the sample are fragmented. Metric information was collected for each specimen. The range in length of the trough metates in in the Inca - Caranqui assemblage is 10.1 to 50.4 cm. The average length is 25 cm and median length is 22.3 cm. The range of width is 11to 55 cm. The average length is 24 cm and the median 23 cm. The range in weight is from 0.3 to 20kg. The average weight is 2.3 kg and the median weight is 1.9 kg.

D.1. The category *general trough metates* (*n*=74) was created for metates fragments that belong in the trough metate design category but are too small to be positively assign to a particular sub-type of trough metate. Attributes related to raw material, morphology, function, and fragmentation were collected for this category of specimens, but many of these artifacts were not included in statistical analyses. The range in length for the metate fragments in this category is 7.3 to 50.2 cm. The average length of the fragments in this category is 14.7 cm with a median length of 13 cm. The range in width for this category of metate fragments is 5.7 to 49 cm. The average width is 14.7 cm and the median width is 12.55 cm. The range in weight for this category of metate fragments is 0.07 to 5 kg. The average weight is 1.03 kg, with the median weight at 0.07 kg.

D.2. *Open-trough* metates (*n*=50) are a subtype of trough that are rectangular with borders only along the length of the sides (side walls); leaving both ends (proximal and distal) open (fig. 5.5). On the use surface of these specimens the trough bottoms (the area where manos are applied), are generally flat and exhibit concavity where at the interior margin walls meet the use surface (side walls). The bases of these metates are generally thick and have been purposefully ground to create stability. The exterior of the side wall (margin walls), are generally vertical and straight, as are the ends. This variety of trough design has been identified from sites in other parts of the Americas as a metate type commonly associated with maize processing (Shelley 1983). There are open troughs that are flat and originally rectangular in shape, while there are others that are sloped away from the proximal end (that closest to the body), which allows the foodstuffs being ground to fall "downhill."

Figure 5.6. Three-quarter trough metate fragment

All but one of the open-trough metates are fragmented. Metric information was collected for the entire group of metates. The range in length for the metate fragments in this category is 11.1 to 48.0 cm. The average length of the fragments in this category is 22.8 cm with a median length of 20.6 cm. The range in width for this category of metate fragments is 9.0 to 50.4 cm. The average width is 33.6 cm and the median width is 30.62 cm. The range in weight for this category metate fragment is 0.27 to 10.0 kg. The average weight is 2.11 kg, with the median weight at 1.38 kg.

D.3. *Three-quarter trough metates* (*n*=56) have restrictive borders that run the length of both sides and along one end (the back wall, which is located on the proximal end) (fig. 5.6). Many of the three-quarter trough metate fragments in the assemblage are rectangular or sub-rectangular (*n*=19), but there are several that are trapezoidal (*n*=22), and oval with rounded corners and exterior margins that round towards a flat base (*n*=15). When rectangular in shape, the exterior of the margin walls are generally tapered to the base as are ends. However, there are also some three-quarter trough metates specimens in the sample that are rectangular and have vertically straight exterior margin walls and ends.

The three-quarter trough specimens in the sample are all fragments. Metric information was collected for these artifacts. The range in length for the metate fragments in this category is 9.0 to 50.4cm. The average length of the fragments in this category is 18.40cm with a median length of 17.2cm. The range in width for this category of metate fragments is 6.5 to 48 cm. The average width is 14.36cm and the median width is 14.75cm. The range in weight for this category metate fragment is 0.21kg to 10.0kg. The average weight is 3.02kg, with the median weight at 1.44kg.

E. A category of *"special" metates* (*n*=3) was created for metate and "metate-like" specimens that are different from the rest in the assemblage (fig. 5.7). Although I have grouped them all in one category, these three special artifacts are dissimilar. This category of objects was not included in statistical analyses. The first of these items in this category resembles a tiny metate with a carved lip and side walls (fig. 5.7a). This special find from the site exhibits only a minor break –only one corner was been broken but since it is so small the corner missing constitutes over 20% of the object. Almost toy-like, this miniature metate measures 12.5 cm in length, 9 cm in width, 3 cm thick, and weighs only 0.48 kg. Its composition is pumiceous and it doesn't exhibit smoothing, pecking, or striations, which are indicative of use. This raw material is too friable and thus it would not be suitable for an actual regular size metate; it would crumble immediately upon use. This raw material is not represented with other specimens in the sample. The supposed dorsal and ventral surfaces of this artifact are flat with the exception of a small rim that restricts three sides of the dorsal surface similar to the restrictive rim of a three-quarter trough metate.

Figure 5.7. Special metates

The second special metate shares approximately the same dimensions as the first (9 x 12.5 cm) yet weights 1.47 kg and is 6.5 cm thick. At first glance it resembles a small brick but further investigation reveals that it contains a margin or lip similar to trough metates (fig. 5.8b). Given its form and lack of definition, it is difficult to determine if this object is fragmented or complete. It too is composed of material not used during the manufacture of other specimens in the assemblage from Inca-Caranqui. It is a fine-grained variety of dacite.

Unlike the previous two special metates, the final specimen is not a miniature but rather a corner fragment of a very curious metate form. It consists of a triangular-shaped fragment that exhibits a right angle (fig. 5.7c). The break pattern on this fragment is very curious insofar as it is cleanly broken. The fragment measures 25 cm in length, 19 cm in with, and is12 cm thick. The specimen appears to have a double base along the lines of a pedestal. No evidence of use is registered on the artifact. It exhibits a margin wall and resembles a metate yet is extremely exact in all details. For example, the lines that form the margin wall are extremely consistent and the narrow gully between the margin and work surface is seamless. I believe that this item is a palette.

F. Non-identifiable. In addition to the metate designs listed above, the assemblage from Inca-Caranqui also contains some metate fragments that could not be categorized (*n*=34), either these specimens were too small to categorize or contained no exterior edges (used to help to determine type). Although attributes related to morphology, raw material, and fragmentation were collected from these specimens, they were not included in most statistical analyses. The range in length for uncategorized metate fragments in the assemblage is 4.2 to 18.5 cm. The average length is 9.4 cm and the median length is 8.7 cm. The range in width is 4.8 to 16 cm.

The average width is 9 cm and the median width is 8 cm. The range in weight is 0.07 to 1.5 kg. The average weight is 0.8 kg and the median weight is 0.6 kg.

2. Manos

Manos (n=169) found at Inca-Caranqui can best be described in terms of the metates designs to which each respectively corresponds with (e.g., manos used on basin metates as opposed to those used on trough metates or flat metates). Size, wear traces, the configurations of wear facets, and in some instances, shape were examined to determine the type of metates that the respective mano was used with. In addition to determining corresponding metates, manos were sorted with respect to a cross-sectional view of the individual artifacts. The lithic raw materials used during the manufacturing of manos vary within the sample yet, in general, respective types are quite homogeneous. In most instances color and granularity varies little within the discrete rock varieties used to manufacture each mano, yet there are some exceptions.[29]

As previously discussed, Adams (1993; 2000) finds that use wear was managed on large manos by periodically flipping tools over and by rotating their ends. The employment of a wear management strategy that included the flipping and rotating of a mano that is used with a flat metate surface and a reciprocal grinding stroke (back and forth) which should produce an ideal mano shape –one containing two opposite use facets with use wear traces that are parallel to the natural strata of the stone. If employing the same manner of flipping and rotating with a mano

[29] For example, there are two mano specimens that serve as exceptions to this general observation. Both are composed of a granitic (hypidiomorphic-granular) material, with a texture containing crystals that are bounded by crystal faces, as well as crystals that are only partly bounded by crystal faces, and also crystals that are not bounded by faces, within subtle linearly concentric bands containing layers of varying color. I offer these examples to illuminate the dynamic nature of the raw materials that were used when making the lithic tools found at Inca-Caranqui.

used with a rocking stroke,[30] four grinding surfaces of approximately the same width should cut at an angle through the natural strata of the stone (Ortman 2000:108).

In attempting to ascertain the reductive sequence of manos (e.g., the order in which they became worn) in the Inca-Caranqui assemblage and how it relates to the variation in transverse cross-section of manos, I found that the fragmented manos specimens in the sample respectively entered the archaeological record at different stages of use. For instances, some specimens exhibit little evidence of use-wear, while others are well-worn and exhibit evidence of the wear management strategies described by Adams (1993; 2002) wherein tools were flipped to create new use surface and rotated end to end to balance the effects of wear.

A. Edge-ground cobble manos (n=33) are generally not altered from their natural cobble shape (fig. 5.8). Some researchers referred to this category of mano with the generic name handstone (Adams 2002:13). Edge-ground cobble are expedient tools. They generally lack evidence of intentional manufacture and shaping. These tools do not contain overall morphological modifications seen on other manos in the sample (though most are relatively oval-shaped in profile). Aside from the indexes of use wear, many of these are scarcely modified cobbles but most contain the addition of comfort features in the form of figure and hand grips (*n*=27). There are also specimens, which I suspect, were selected based on the natural notches or groves in the rock (*n*=5) that likely served as grips. Edge-ground cobble are a diverse grouping of manos and likely were used with all metate designs.

[30] The rocking stroke involves an angular placement of the mano, which results in two adjacent, beveled grinding surfaces (Ortman 2000).

Figure 5.8. Edge-ground cobble mano

Figure 5.9. Plano-convex mano

The length of the complete edge-ground cobble manos (*n*=19) ranges from 9 to 25 cm. The average length of complete manos of this type is 15 cm with a median length of 14.5 cm. The range in width for complete manos of this type is 5.4 cm-16 cm. The average width is 9 cm and the median width is 10 cm. The range in weight is 0.27 to 2.7kg. The average weight is approximately 1 kg, with a median weight of 0.9 kg.

The range in length for fragmented edge-ground cobble manos (*n*=14) is cm. The average length of fragmented manos of this type is 13.8 cm with a median length of 13 cm. The range in width for fragmented manos of this type is 5.1 to 14 cm. The average width is 8.7 cm and the median width is 7.7 cm. The range in weight is 0.14 to 2.0 kg. The average weight is 0.89 kg, with a median weight of 0.75 kg.

B. *Plano-convex manos* (*n*=40) are strategically designed manos intended for use with trough metates (fig. 5.9). This variety of mano could also be compatible with flat metates. In general, they are virtually flat on the ventral side and have a convex dorsal side. These tools have finished ends and, somewhat, resemble a small loaf of bread. This convex arc served as a comfort grip. Most all of these tools also have additional separate figures grips chipped into one or end ends.

The range in length for the complete manos (*n*=5) of this type is 13 to 24 cm. The average length of complete plano-convex mano is 16.2 cm with a median length of 15 cm. The range in width for complete manos of this type is 6.5 to17 cm. The average width is 9 cm and the median width is 10 cm. The range in weight is 0.48 to 2.1 kg. The average weight is 1.16 kg, with a median weight of 1.1 kg.

The range in length for fragmented plano-convex manos (*n*=35) is 10 to 15 cm. The average length of fragmented plano-convex mano is 12.2 cm with a median length of 13 cm. The range in width for fragmented manos of this type is 6.5 to15cm. The average width is 8.5 cm and the median width is 9.4 cm. The range in weight is 0.37 to 1.88 kg. The average weight is 0.98 kg, with a median weight of 0.82 kg.

Figure 5.10. Triangular mano

C. *Triangle manos* (*n*=12) are generally strategically designed and were used with trough or flat metates (fig. 5.10). The one complete mano of this type is 13 cm long, 8.2 cm wide, weighs 0.41 kg. The range in length for fragmented triangular manos (*n*=5) is 6.2 to13 cm. The average length of fragmented manos of this type is 8.5 cm with a median length of 8.3 cm. The range in width for fragmented manos of this type is 6.1 to 8.5 cm. The average width is 6.9

cm and the median width is 6.7 cm. The range in weight is 0.21 to 0.39 kg. The average weight is 0.3 kg, with a median weight of 0.29 kg.

Figure 5.11. Sub-rectangular mano

D. *Sub-rectangular manos* (*n*=10) are generally strategically designed (fig. 5.11). This variety is referred to as sub-rectangular because these specimens are relatively rectangular in profile although some contain rounded corners. There are two complete sub-rectangular manos. One of these artifacts measures: 14.2 cm in length, 9.6 cm in width, 5.3 cm thick and weighs 0.87 kg. The other complete sub-rectangular mano measures: 16 cm in length, 15 cm in width, 6.7 cm thick , and weighs 0.98 kg. The range in length for fragmented specimens (*n*=8) is 11.3 to 14 cm. The average length of fragmented manos of this type is 12.9 cm with a median length of

13 cm. The range in width for complete manos of this type is 9.2 o15.1 cm. The average width is 13 cm and the median width is 13.8 cm. The range in weight is 0.73 to 0.96 kg.

E. *Wedge-shaped manos* (n=2) are tools that are assumed here to exhibit their shape due to wear (fig. 5.12). Wear management strategy help to preserve tools by preventing wear to build-up on one facet or side of the mano. These manos were maintained not maintained through wear management strategies such as periodically flipping manos so that use wear becomes distributed more equally across a larger part of the tool instead of one or two sections. One of the two wedge-shaped manos measures 10 cm in length, 4.8 cm in width and weighs 0.67 kg. The other is 7.5 cm in length, 5.2 cm in length and weighs 0.79 kg.

Figure 5.12. Wedge-shaped mano

Figure 5.13. Sub-circular mano

F. *Sub-circular manos* (*n*=16) are generally strategically designed (fig. 5.13). Many of these appear to have been used with flat metates and open-trough metates. The range in length for the complete manos (*n*=5) of this type is 15 to 21cm. The average length of complete sub-circular manos is 16 cm. The range in diameter for complete manos of this type is 10 cm to 14 cm. The average weight is 1.3 kg. The range in length for fragmented sub-circular manos (*n*=11) is 12.3 cm to 16.1cm. The average length of fragmented sub-circular mano is 14.3 cm. The range in the diameter for fragmented manos of this type is 10 to 14 cm. The average weight is 0.81 kg.

Figure 5.14. Bi-convex mano

G. Biconvex manos (n=46) are strategically designed and most appear to have been used with trough metates (fig. 5.14). The assemblage contains biconvex shaped manos exhibiting several stages of use. The range in length for the complete manos (n=5) of this type is 23 to 20 cm. The average width is 2.5 cm. The average weight is 1.1 kg. The range in length for these manos (n=41) is 8 cm to16.7 cm. The average length of fragmented specimens is 13 cm. The range in the width for fragmented manos of this type is 2.1 to 2.9 cm. The average weight is 0.7 kg.

Figure 5.15. Lenticular mano

H. Lenticular manos (n=4) are round with a flat dorsal (use) side and slightly convex on the ventral side (fig. 5.15). The wear registered on these tools is circular and diffuse. The convex side acts as a hand grip. The range in length for the complete manos (n=2) of this type is 7.8 to 8.9 cm in diameter. The average diameter is 8.35 cm. The weights of the two complete lenticular manos are 1.1 kg and 1.3 kg.

Figure 5.16. Punted mano

I. Punted manos (n=6) are strategically designed (fig. 5.16). Include a descriptive sentence about their shape. The complete manos in this type (n=3) are all approximately the same size: ~9.3 cm x ~6.5 cm, and ~2.5 cm thick, each weighing approximately ~0.8 kg.

Figure 5.17. Multi-purpose tool

J. Multi-purpose tools (n=5). This category contains some manos and metates that were repurposed and others that may have served purposes other than grinding. One mano specimen is similar to a grooved abrader with a curved arch (fig. 5.17). This item was possibly intended to curve twigs or branches during the construction of roofs. In some examples, the differentiation between single-purpose tools and multiple-purpose tools is somewhat unclear, a matter amplified by the somewhat flexible nature of some tool forms and also may extend beyond what the tools was designed for (intent vs. actuality).

Many of the manos analyzed exhibit skill in manufacture and standardization of form, especially punted manos and many bi-convex and plano-convex.

3. Cross-tab Correlations

When comparing the general mano groups of expedient and strategic design, implements with the variable condition (e.g., complete/incomplete), a statistically significant relationship was found (Table 5.1).

Table 5.1. Mano condition and design

	Expedient Design	Strategic Design	Total
Broken	14	104	118
Whole	19	23	42
Total	33	127	160

A χ^2 score of 21.074 for one degree of freedom is associated with a significance level above 0.001 (p = <0.0005). These results are highly significant. Based on the sample, this test provides 99.9% confidence for a relationship between fragmentation and mano design. It appears that raw material selection was an integral aspect of the design process for certain tools. This means that manos are more likely to be broken if they were strategically designed.

The design style of specimens (e.g., expedient versus strategic) was also correlated with general tool type groupings (e.g., manos or metates). Table 5.2 represents the frequency of manos and metates exhibiting either expedient or strategic design.

Table 5.2. Mano and metate design

	Expedient Design	Strategic Design	Totals
Manos	33	127	160
Metates	78	180	258
Totals	111	307	418

A statically significant relationship was found when comparing tool types (mano vs. metate) to tool design (expedient vs. strategic). A χ^2 score of 4.825 with one degree of freedom has a significance level above 0.05 (p = 0.028). This test provides between 95% and 98% confidence for a relationship design and tool type. This indicates that metates are more likely to be strategically designed than manos.

I interpret this finding to mean that design was a more important variable for metates than it was for manos: the hand tool only need to possess a specific set of qualities (e.g. weight, length, and a broad surface area) but the metate needed to possess a broader set of design criteria (e.g. restrictive margin walls and a sturdy, level base).

A comparison between the "raw material" used to make ground stone tools and the general manufacture of artifacts was also explored. Table 5.3 presents the distribution of the raw material in a sub-set (e.g., those specimens that the variable(s) relating to raw material were recorded) of the sample (*n*=415), for both manos and metates of expedient and strategic design.

Table 5.3. Mano and metate design (expedited vs. strategic) by raw material type

Material	Expedient Design	Strategic Design	Totals
Non-vesicular (granular)	59	197	256
Vesicular	50	109	159
Totals	109	306	415

Table 5.3 demonstrates that the raw materials used for expedient tools are relatively closely split between granular and vesicular material. For those specimens exhibiting strategic design, the proportion that are non-vesicular (granular) is greater. A relationship was found, yet not statically significant since it was below the 95% confidence level, when comparing material type (non-vesicular vs. vesicular) to tool design (expedient vs. strategic). A χ^2 score of 3.573 for one degree of freedom is associated with a significance level between 0.1 and 0.05 (p = 0.028). This test provides between 90% and 95% confidence for a relationship design and material type. These results are not statistically significant but I have included it here because it is close to statistically significant. Before compiling the frequencies for these two variables, raw material and design, my expectation was that vesicular material would have been preferred for more finely crafted tools, e.g., those labelled as strategically designed. That expectation was not met according to the sub-set of the sample presented above.

The variables "raw material" and "general manufacture" were also cross-tabulated for metates alone. Similar to the previous table, Table 5.4 compares design (expedient or strategic) and material type (non-vesicular or vesicular) for a sub-set of the sample, (*n*=255) metate fragments.

Table 5.4. Metate design and raw material

Material	Expedited	Strategic	Totals
Non-vesicular (granular)	37	116	153
Vesicular	40	62	102
Totals	77	178	255

A statistically significant relationship was found when comparing raw material (vesicular vs. non-vesicular) to tool design (expedient vs. strategic). A χ^2 score of 6.561 with one degree of freedom is associated with a significance level between 0.02 and 0.01 (p = <0.01). Based on the sample, this test provides 98% to 99% confidence for a relationship between material type and tool design for metates. I interpret these results to mean that raw material type was a significant factor when crafting metates and that non-vesicular stone was the material of choice for the manufacture of metates.

In addition to the cross-tabs presented above, several other attributes and variables were considered and tested yet proved not to be statistically significant. There were also other tests that I wanted to perform but sample size of those artifacts with archaeological provenience was limited.

4. Functional Features

The analysis of use wear reveals recognizable functional differences between metate types, and also some similarities. Distinctions in wear traces were also recognized that correlated with manos types and which were found to correspond with functional differences. The margins on most troughs are at least a few centimeters wide and exist presumably to prevent the spillage of the material being ground. The shape and size of the use surface of many flat and trough metates, the large size of many manos in the assemblage, and the reciprocal direction of wear traces on tool surfaces indicate that these tools were used to process seeds such as maize. Many of the troughs specimens made of non-vesicular material, exhibit evidence of the re-widening of their respective troughs as a form of wear management strategy that is associated with intensively used metates. Re-widening a trough allows users to introduce a new mano to the metate or exploit an unused surface on the mano that the miller was already using.

Of the 154 manos on which certain observations could be made, 85% (n=131) were found to contain comfort features (e.g., finger or hand grips). All potentially related variables were statistically analyzed against the presence and frequency of finger grips on manos using a

Pearson's Chi-squared test. No significant correlations were found between raw material and grips; mano design (expedient or strategic) and grips; mano type and grips; or condition (whole or fragmented) and grips. Comfort features are common but do not appear to be correlated with any of the above listed attributes. There may be a correlation between wear and grips but further analysis is necessary to determine if a significant relationship exists. The manos that do not contain grips, exhibit little if any use wear and all are fragments. It is also possible that they could have had grips but that that portion of the tool is not extant.

Most all grips and groves, except those built into the design of a tool, such as those found on plano-convex manos and punted manos, appear to have been made post-manufacture and even plano-convex manos sometimes have additional grips added post-manufacture. I argue that these grips were created "aftermarket" based on their appearance. They are generally crude in shape and occur on tools that were both expedient and strategically designed. I believe that if ground stone manufacturers created these grips during the primary production or the finishing process, the grips would likely have been fine in appearance. Additionally, grip locations vary greatly and presumably reflect the size and shape of an individual hand. Finger grips were found on all mano profiles, yet only two, plano-convex and punted manos, exhibit formal figure grips. In this instance, the term "formal" is intended to mean that grips are part of the design of these tools, whereas with the other manos in the sample, grips are not built into the design but rather were etched in after the tool was finished. Among these two types, plano-convex and punted manos, only the former contain additional grips.

For expedient manos, it is likely that users themselves created the grips (and likely the tools as well). My belief is that most grips found on strategically designed manos were also created by users or under the direction of the users, based on the crude appearance of grips and locations where they are found on the manos. Perhaps users acquired stock manos and after few initial runs on the metates, they determined where best to install the grips, making the tools ergonomically customized for individual need. Once manos were worn, new grips could be created in different locations on the tool as needed. Or perhaps, if one acquired a mano from a previous user, new grips were installed to accommodate the new hand, new function, new metate, or the increasing slope of a well-worn metate. Multiple grips may indicate multiple users, multiple or changed functions, or increased intensity

B. Tool Fragmentation

The broken specimens were subdivided by the appearance of breaks. General observations about breaks include the following: most specimens contain either jagged-looking (*n*=145) or even-looking breaks (*n*=200), and some specimen exhibit both (*n*=79). Break appearance (e.g., jagged or even) are not specific to different rock varieties. Linear scars (fig) are not found on specimens containing jagged breaks (unless those specimens also contain even breaks). The assemblage contains metates specimens that appear to be one half of their respective original size (*n*=38). For these specimens, breaks appear to be located in the center of the tool widthwise, perpendicular to the direction that which the wear on the specimens follows (fig.). These "halved" specimens are flat metates (*n*=20), and troughs types (*n*=18). Most all of these specimens are composed of hard vesicular material (*n*=36). Of these, many specimens exhibit even-looking breaks (*n*=32) and some linear indentations on their use surfaces at or near breaks (*n*=18). Those with uneven breaks or a combination of even and jagged breaks do not also evidence the linear scars found on specimens with evenly broken edges. I believe that these linear indentation scars signify how these tools were broken, e.g., struck with hard blows from with a percussive device.

The "halved" metate specimens in the sample share some interesting characteristics. First, they all represent the proximal end of their original tool. These tools also do exhibit secondary wear associated with the recycling of broken metates. Many of these specimens appear to have still been useful at the time they were broken. This is especially apparent in those "halved" metates that are composed of durable vesicular material (fig.)

Some mano specimens also exhibit an interesting break pattern in which both ends of tools are essentially removed. Drawing from Stroulia and Chrounda (2013), this form of fragmentation is referred to as a "mid-section" break pattern. Manos exhibiting this form of fragmentation (n=51) are generally made of dense, durable non-vesicular material. These tools are mostly biconvex (n=23) and sub-circular (n=21) in cross-sectional shape. Some of these specimens contain the same linear indentation scars (n=19) that are found on many of the "halved" metates described above.

Given the large number of broken tools in the Inca-Caranqui assemblage relative to the number of whole implements, my working assumption was that some of these items had intentionally been broken. Analysis of the broken specimens in the assemblage does suggest that fragmentation for many items likely did occur from intentional action. Evidence to support this idea is found I the metates specimens listed that are "halved" and manos exhibiting "mid-section" break patterns.

While that intentional action may have caused much of the fragmentation noted, it's also possible that some of the specimens in the food processing assemblage from Inca-Caranqui may have broken through attrition and accidents, and possibly climatic conditions. However it is reasonable to assume that if fragmentation had resulted from environmental events that many re-fitted pieces would have been located together archaeologically.

This manner of fragmentation seems somewhat unlikely for the tools from Inca-Caranqui since there is only one example of adjoining fragments found *in situ*. In this case, the fragmented metate/palette was either a fragment that became further broken once deposited in the archaeological record, or the two adjoining fragments were deposited together in the same context and the other fragment(s) from the original tool were not deposited within this same context. Only two other refits were found within the entire sample.

The accidental fragmentation of tools may have occurred during curation (e.g. the installation of comfort enhancements) or refurbishment, or as a result of misuse, or damaged during transportation. Attrition (exhaustive wear to tool surfaces) can result in the accidental or incidental fragmentation of tools since it is likely that some heavily worn items may have broken more easily.

Intentional fragmentation can generally be achieved through the mechanisms of hammering, pounding and pecking, which are characterized as repetitive tapping or hammering at the center of the object until it becomes substantially weakened and also as deliberate percussive striking at precise locations on the surface of the original tool. The majority of metate fragments in the Inca-Caranqui assemblage are not overly worn and there for were not exhausted through use, suggesting a considerable use-life still remaining in the tool. Surface modifications relating to manufacture, use, and refurbishment were readily distinguishable from scars related to breakage, unless there was evidence that modification from one other activities directly led to breakage (e.g. extensive wear to a tool made of less durable raw material or accidents).

Based on the size and shape of the linear indentation scars found on tool surfaces near breaks, I believe that chisels were used to break many of the metates, and also some manos from Inca-Caranqui. These tools were probably large, stout, and containing a flat, thin edge at the bit end chisels, that were held at an angle just off perpendicular when used to perforate stone. Scars located on use surfaces near break precipices were recognized as small peck-mark divots (a few millimeters in area and depth), large peck-mark divots and linear indentations (≤5cm in length).

1. Accidental Breakage

Some manos and metates from Inca-Caranqui likely broke as a result of the incidental effects of wear and attrition during refurbishment of a tool's surface whether for maintenance purposes or while attempting to improve comfort enhancements such as grips, or for manos when thrown or dropped (as described by Hayden 1987 and Clark 1988), though these actions are impossible to quantify. This seems a less likely scenario for metates since many are relatively heavy and cumbersome, so individuals would likely be moving them less.

2. Intentional Breakage

a. Smashing

This form of fragmentation occurs only on the metates in the sample. As previously discussed, the action of pecking or tapping was employed to condition the use surface of metates in order to make them rougher, thus maintaining their efficiency. Scars associated with this form of sharpening generally resemble small (<1cm) round or triangular peck marks that follow the lateral (axis) of the use surface. When pecking or tapping is employed for the purpose of the intentional breakage of the object, the marks are generally found to occur in a somewhat circular pattern near the center of the use surface. Scars resulting from the circular pecking mode are indexed through heavily concentrated pecking, beyond what is found on accidentally fragmented metates presumably broken during refurbishment. Some of the raw materials used for the metates found at Inca-Caranqui are coarse and vesicular in nature and likely would not have required this form of intensive conditioning.

As previously discussed, many ground stone researchers have found that for intensive maize grinding purposes, course-grained igneous rock, like vesicular basalt would have been preferred by users because the surfaces of tools made from those material types may likely did not have to be re-conditioned as frequently. Drawing from Adam (2002; 2008), I believe that the pecked use surfaces found on some of the metates from Inca-Caranqui, which are made from coarse-grained vesicular materials, did not result from surface conditioning and sharpening but rather are indicative of intentional breakage. The breaks that I am suggesting to have likely occurred through a circular mode of pecking, are often jagged or circular in appearance (fig.). It is possible that some metates from the site were exhaustively pecked and then broken once heaved or thrown.

b. Percussive Striking

This method of intentional fragmentation is the most prevalent in the sample and is found for both manos and metates as discussed above. Some fragments exhibit little evidence of use yet appear to have been broken in through percussive striking. This type of fragmentation shares similarities with the manufacturing insofar as it is very precise and likely required similar tools as those used in that latter stages of manufacture. An intermediary device, like a wedge, chisel, or similar such stone, would have been placed between the metate and the hammerstone or other stone. The hammerstone would strike the wedge or chisel, thus driving it into the metate. The method used to identify this type of breakage consists of specific observations made at and around the point of impact damage. The action used in this type of fragmentation is indexed through linear scars located near breaks precipices on the work surface. Scars that occur as a result of percussive hammering may be thought of as misfires; slightly off-mark or lacking the power needed to break the tool. The percussive hammering mode of fragmentation may not always be indexed through scars, as the breaks occurring from this mode of action may also be even-looking (e.g., relatively linear or straight) and consistent through the tool surface. Some specimens contain both pecks and linear indentations at or near broken edges. Of the sample analyzed here complete ground stone tools are limited to manos. Generally, the fragmented items in the sample do not exhibit dulling at broken edges or on the surfaces of the breaks, which typically would be expected for recycled tools yet this is not entirely true when we think of reuse. This indicates that for many of these items, their utility ended at upon becoming fragmented.

c. Refits

Few positive matches were established for manos or metates during attempts to re-fit. Only two matches were made for both metates and manos (two specimens in each match, but in neither instance do the refits make an entire original tool). Among manos, there was a small collection of other potential refits (*n*=10 potentially comprising five complete respective tools), but I could not conclusively make matches for these items since all showed indications of recycling which altered their respective broken edges. The same was true for the metates, though one was positively refit in the 2008 field season (Fig.). These two fragments comprise less than one quarter of the original tool.

Munsell color assignments, used in this portion of analysis, were not necessarily reliable for re-fits since the appearance of rock can be altered by weathering, therefore two halves of the same complete stone object may have weathered differently when found in different areas of a site, making these items harder to refit. The recycling of fragments can affect the color as well. The method used to match fragments included comparing recorded observations organized in a field database. Data relating to the raw material characteristics (e.g., texture and the appearance of inclusions) was compared re-fits were attempted for specimens sharing similar attributes.

This approach was chosen based on the relatively large number of specimens in the assemblage that were heavy and not necessarily easy to move within the analysis and data collection space. This method of re-fitting differs from the more typical approach used in refitting studies of ceramics and other materials in which re-fits are made through the visual determination of the individuals attempting to perform re-fitting. That method was also used in the research project presented here but could not be relied on due to the conditions mentioned above.

VI. Discussion and Conclusions

Assessing the food processing implements recovered from Inca-Caranqui has provided insight into activities that occurred at, or in close proximity to, the site. Based on the predominance of trough metates in the assemblage, especially open-trough and three-quarter trough designs, it is reasonable to conclude that, dried maize and other seeds were likely processed in large quantities at the site. Since the many of the groundstone tools from the site lack specific provenience, it was not possible to determine the temporal association of a large percentage of the assemblage (e.g., whether they pertained to the pre-Inca or Inca occupation). Given the fact that a large percentage of these tools were found during initial clearing operations at the site prior to the initiation of systematic excavations, it is unfortunately the case that relatively few specimens can be assigned with certainty to occupational level. However, given the depth of the earlier Caranqui occupation at the site (typically 70-100 cm below surface), the fact that this lower component was found to be generally intact during subsequent excavations, and the fact that the initial clearing of the site had been aimed at exposing surface features rather unearthing buried deposits, I believe that a significant percentage of the ground-stone tools in the assemblage were associated with the Inca occupation of the site.

The quantity and quality of trough metates recovered (comprising seventy percent of the metate assemblage) suggest that the grinding of foodstuffs may have been a more intensive activity rather than an extensive behavior, yet without further evidence to support the activity of intensive grinding, it is not possible to determine if these tools were used in short durations over the course of many years or if they were used in lengthy grinding episodes. If intensive grinding activities occurred, the foodstuffs processed would likely have been utilized in food and beverage preparation beyond those of the needs of individual domestic units. These domestic units may have participated in the preparation and consumption of a portion of the foodstuffs milled during intensive grinding sessions but I believe that these materials were not ground exclusively for individual use. Rather, if intensive grinding did occur on a large scale (as the number and size of tools), the foodstuffs processed would have been intended for specific communal, economic, or ritual purposes, perhaps relating specifically –given the imperial and ritual context of Inca-Caranqui –to *chicha* consumption. Those performing the task of grinding in this manner, were participating in activities outside of their respective domestic units, though this work may have comprised part of the duties imposed on domestic units in the form of labor or products. Depending on how maize and other seed were stored[31] or when they were harvested, intensive grinding may also have been a seasonal activity.

The abundance of trough metates and large flat metates composed of high grade vesicular material in the assemblage as well as the shape and size of their surface configurations, make it is plausible to think that these tools were used to process maize that was purposed for making *chicha de maíz.* In ethnographic contexts from the southern Andes and also contexts from the greater U.S. Southwest and Mesoamerica, food processing tools of similar size, shape and surface configuration are associated with intensive maize grinding (see Mauldin 1993). Homogeneity, with regard to trough forms and corresponding manos, suggests highly standardized methods of preparing maize and other seeds.[32] Design, in this instance, is a technological factor related to how foods were prepared; the desired consistency of foodstuffs being ground as required by particular culinary preferences, affected how implements were

[31] Currently, there is not archaeological data available in the northern highlands pertaining to whether ground foodstuffs such as meal or flour was stored.

[32] In addition to maize, other pre-Columbian seed foods in the Andes include amaranth (*Amaranthus* sp), quinoa (*Chenopodium quinoa*), kaniwa (*Chenopodium pallidicaule*), and other *Chenopodium* species. In addition to maize kernels removed from cobs, the grinding of cobs has also been established archaeologically.

configured by craftspeople and the food preparers who used the tools (Adams 1991, 2002:121). Intensive grinding also indicates standardized methods of food and beverage preparation.

Other features at the site of Inca-Caranqui suggest the likelihood of *chicha* was used at the site. Activities associated with the ritual precinct of the site would likely have required the use of the fermented beverages; charred maize was located archaeologically in pre-Inca contexts at the site and also at other Caranqui sites in the region; manos and metates have been found in archaeological contexts associated with *chicha* making at other sites in the Andes (e.g., Moore 1989; Morris1979; Moseley *et al.* 2005; Prieto 2011; Shimada).

In addition to the prevalence of large metate specimens in the assemblage appear to have also been used intensively. Most of the open and three-quarter trough metates and flat metate fragments are large tools made of high quality vesicular material, and many contain a sheen or polish consistent with the mechanisms of tribological wear. The flat metate specimens were used with large manos, which, based on the surface configurations of metates, extended to, and in some cases, beyond the width of the metate, making them both size compatible and highly efficient since their large size made it possible to utilize all of the metate surface area. In some instances these specimens contain a small but defined margin on the sides which follows the longitudinal axis, making them somewhat trough-like in form due to this slight ridge that would have acted as a barrier, potentially preventing matter from spilling over the side when grinding.

Other metate forms in the sample, including flat/concave and basin exhibit a variety of use-wear traces. I speculate that many of these tools were utilized in daily food preparation activities for short-term, frequent grinding activities rather than for intensive grinding tasks. The lack of provenience for much of the sample made it impossible to definitively ascertain continuity in food processing technology for the site and whether tool forms changed over time.

Previous researchers have suggested that the presence of better[33] grinding tools indicates a specialized grinding tool industry to meet the demands of intensive maize preparation. This remains to be investigated at pre-and-post late Imperial sites in the Andes.

In addition to evidence of intensive and extensive use, there are other types of variation present among the ground stone tools in the assemblage from Inca-Caranqui. These variations are interpreted here to represent a wide range of use activities and also a continuum of skill, ranging from users making their own tools to skilled craftspeople making tools for local clientele. Non-trough metates and other ground stone implements, of approximately similar function (e.g., morteros) found at the site, indicate that different tools were used for different activities, as suggested by Clark (1988) in contexts from Mexico and Hayden (1987) in contexts from Guatemala. Based on analogy with ethnographically derived information from neighboring Otavalo and Peguche communities, the use of stones for the processing of *aji* described by Colloredo-Mansfeld (1997) and Parson (1946) illustrates that contemporary indigenous households in the region use more than one set of grinding stones. Cobo, as cited previously (Cobo 1964 [1653]: Bk.4, Ch.25:172-173). Cobo also describes smaller foodstuffs being ground on a mortar-like concave tool with a small elongated pestle that was found in every home (Cobo 1990 [1653]:195). From the central Andes, Isbell (1978) offers a similar example of multiple grinding toolkits in her description of the preparation of the ritual liquid *llampu*. I take these variations to indicate the common use of complementary food processing toolkits in the Andes– one set for grinding maize and other seeds and another toolkit for grinding other foodstuffs.

Since a chronology of tools distribution could not be explored, other possible explanations for the range of forms in metates may include a preference for flat metates when processing damp material and other surface configurations, such as troughs, for dry processing.

[33] Stable bases, high quality durable vesicular material, large grinding area

Variants could also potentially indicate more dynamic strategies for processing food or variables related to respective domestic units. Grain processing was likely more intense for some individuals, domestic units, or work groups than others, and thus the intensity of processing activity may be reflected in the equipment used to perform the tasks. Freeman (2011), for instance, found that differences in metate and mano forms may simply indicate the prevalence of the toolkit in the Quijos River valley with many individuals making and using the tools that made, suggesting that perhaps all domestic units possessed these items (Freeman 2011).

Activities associated with the secondary use and recycling or repurposing of specimens was recognized through the presence of residues, non-distinct wear traces (recognized outside common food-processing wear patterns), and indications of exposure to fire. The replacement, recycling, and "re-use in post-grinding contexts" may well evidence the changing usage of tools (Schelberg 1997:1016). Some ground stone researchers refer to tools that are repurposed or the secondary use of manos and metates outside of the realms of food preparation, as generic *handstones, lapstones, and netherstones.* Indeed, such observations seem to apply to many of the specimens in the present sample which appear to have been re-purposed (*n*= ~32) or used as *multipurpose* implements (*n*=11), since they appear to have been engaged in more than one form of processing or activity within approximately the same timeframe (e.g., one side of a mano utilized to abrade while the other side used to grind).

The activities associated with the wear traces registered on most re-purposed tools was not systematically recorded during analysis but a few patterns can be nonetheless noted. For instance, a sample of metate fragments contain white pigment (*n*=3). These same three tools were also manufactured from the same raw material –a particular variety of dacite. The groundmass of this particular raw material is pale gray –almost white, with a porphyritic texture that contains amphiboles. The curious aspect of these three specimens is that they are not only the specimens in the assemblage composed of this material; they are also the only specimens that contain white pigment. Initially, I had interpreted these three metates fragments as re-purposed because of wear noted underneath the white pigment. It is possible, however, that the pigment is related to primary use since the grinding of clay for ceramics, although more abrasive, resembles the grinding of maize and other seeds (e.g., reciprocal wear patterns and linear striations). These specimens contribute to the notion that the selection of lithic raw material was an important technological factor –e.g., that particular raw materials were chosen for particular purposes.

Manufacturing cost and curation rates are understood in this paper to indicate the importance placed on these tools, especially when present in those items of strategic design, the "costs" illustrating the perceived importance of these tools within the context of use. If broken in the course of normal use, one would expect that these tools had had long lives of extensive use, exhibiting indexes of maintenance, and especially marginal re-sharpening. But the design of tools in the sample varies considerably. Many emphasize long use-lives and standardized usage, while, others suggest portability and multi-functionality. The skill involved to the production of quality trough metates (e.g., those constructed of durable high grade material, with stable bases, and of somewhat symmetrical design) indicates that individual crafters possessed detailed knowledge of properties pertaining to lithic materials.

Previous research in the Southwest has illustrated that the use of vesicular materials was, and still is, preferred for maize grinding. For the assemblage from Inca-Caranqui, the use of vesicular material, when both vesicular and non-vesicular materials were clearly available, indicate the significance of technological choice. In other parts of the Americas, vesicular rock is the preferred material for metates. At Caranqui, if vesicular material was abundantly available, why then are there metates made of non-vesicular (granular) material? High quality troughs are made of both vesicular and non-vesicular material at Inca-Caranqui, while lesser quality tools of expedient manufacture are rarely produced using vesicular stone and those that are characteristically scoriaceous, making them brittle and also likely less effective.

It is probable that both the vesicular and non-vesicular materials used to make the tools in the Inca-Caranqui assemblage derived from nearby Mt. Imbabura. Based on my observations in this area, I noticed that non-vesicular material, size appropriate for manos and small to medium-sized metates, is readily available and can be collected without skill or experience from nearby *quebradas*, obviating the need for quarrying. For vesicular material, I observed outcrops on the slopes of the volcano but little in quebradas that was of a durable quality or size appropriate for metates. The range in variability found within the sample demonstrates that stone-crafting was a highly developed skill in this portion of the northern highlands during the Late and Inca Periods.

Analysis of the grinding surface configuration of metates in the Inca-Caranqui sample revealed that most trough forms made of vesicular material lacked a vertical slope. I interpret this to indicate one of two things: either a slope was not desired, or that some vesicular materials may have proved less than ideal –e.g., not pliable enough –to create a slope. Based on both ethnographic studies that suggest that "vesicular basalt" is the most desirable lithic material for the production of troughs metates and that the highest quality troughs are made from the same, it seems more plausible that a sloped interior surface was not desired. Interpreting the same data in another way, it may be suggested that flat, open trough metates of vesicular stone became preferred (or for some functional reason were preferred) to three-quarter troughs with vertical slopes, though this cannot be substantiated without stratigraphic information for a larger portion of the sample. In contrast, examples of vesicular metates in the Southwest were located in contexts in which the tools were anchored in place at an angle in the floor such that they were permanently fixed at a propped angle (sometimes referred to as milling bins). Both vesicular and non-vesicular trough metates from Inca-Caranqui are well crafted. Many of the non-vesicular examples of trough metates from Inca-Caranqui are very well crafted, suggesting that specialists perfected the crafting of certain material types.

Fragmentation

Intentional breakage is understood in this study as the manifestation of symbolic action. Purposive destruction appears to have been a calculated activity for many of these objects based on indications of incremental breakage and fragmentation via percussive striking. Accuracy seems to have been important during the both the making and breaking of these tools based the uniformity found in design and also in breakage patterns. Based on the lack of refits found for manos and metates, many of the broken tools documented likely entered the site in already fragmented form having been broken elsewhere.

When comparing data from other sites excavated in the region from various time periods, it appears that Inca-Caranqui contains a high frequency of food processing tools (for an exception see mano frequencies in Villalba 1988). Throughout the Andes, these artifacts are often recorded in archaeological contexts in fragmented condition. The ceremonial sector of the site of Inca-Caranqui from which the assemblage for the current study derives, is likely only a small portion of a much larger Inca complex that was constructed on or adjacent to a pre-existing Caranqui community. Today, the site proper is surrounded by a neighborhood containing modern structures, making it somewhat difficult to determine where certain activities associated with the site would have been located. What can been known, based on existing Inca constructions at Caranqui (the semi-subterranean water temple, canals and great hall structure), is that the complex would have required skilled labor and all manner of service personnel, including food preparers and *chicha* brewers. It is not difficult to imagine that the water temple was the preeminent ceremonial feature within the Inca complex and the epicenter of ritual activity. The abundance of smashed food processing implements associated with this feature supports interpretations of the water temple as the focus of the site, substantiated through the food-processing tools that were smashed there or brought to the temple fragmented as offerings.

Given the lack of re-fits at the site, it is reasonable to consider that the fragmentation of tools occurred outside the site, with some portion of the resulting fragments carried to and deposited within the ritual precinct of the site. Conversely, these items could have been smashed during activities at the site proper, with a portion of the resulting fragments being subsequently carried away from the site. These items were perhaps not broken in one event or episode, as Stroulia and Chondru (2013) have suggested for fragments of the same tool found in different levels of occupation. These authors believe this indicates that items were kept around and deposited elsewhere later (Stroulia and Chondru 2013:123, footnote 5). In the enchainment model proposed by Chapman (2000), the broken parts of a single object represent the means to create and maintain lasting bonds between members of the same community or between different groups. Either of these interpretations may explain why fragments from a once complete object become separated and were not found together in the archaeological context of Inca-Caranqui, also accounting for the absence of re-fits.

Why break metates? There are a few possible scenarios: The Inca were not a welcome presence in the Pais Caranqui. The multi-year battle that took place between the Inca and the ethnic Caranqui, prior to the Inca imperial constructions found at the archaeological site of Inca-Caranqui, likely led the Caranqui to despise the power imposed upon them by the Inca. The breakage of metates could have been a form of protest or defiance. Or perhaps the arrival of the Spanish was viewed by the ethnic Caranqui as a release from Inca Imperial subjugation and the destruction of food processing tools was performed as a symbolic act of liberation.

Interpretations offered for the intentional fragmentation of similar objects from other regions, particularly from the greater Southwest where maize was intensively processed, are worth considering. However these models cannot be directly transferred to the Andes. The effect of *chicha* on the food production matrix in Andean contexts underscores that tools may likely have been perceived differently here, more so than in other regions. Moreover, stone is perceived in special ways, throughout the Andean realm, often transmitting specific kinds of information (Dean 2010; Janusek *et al.* 2013; Ogburn 2008). Cultural aspects pertaining to *chicha* and stone aside, the diversity or adversity of ecological and geophysical features define all places but can be especially important in considering archaeology within the Andean realm. This seems especially true in the northern highlands, where lithic source material can be as rich and abundant as the multitudes of plants species indigenous to the by inter-Andean valleys. This seems especially true for the northern highlands, where scarcity of food or lithic resources does not appear to have been a problematic issue during the Late and Inca Periods.

When considering fragmented tools in relation to Inca-Caranqui, it’s apparent that accidentally broken food processing implements would not be deposited at a palace, nor would fragments have been stored at a ceremonial location to be later recycled for other purposes. The quantity of intentionally broken tools deposited at a ceremonial site suggests that the intentional breakage of ground stone tools was a normative practice during the Late Period and perhaps earlier. Based on the condition, context and sheer number of these tools found at the site, I interpret their presence as having some type of ritual significance, rather than simply representing insignificant discarded materials. The fact that people associated with the site went to the trouble of breaking these things illuminates their importance. If these objects were not important to ritual processes, they wouldn't have gone to the trouble to break them. In this instance, the action of breakage and the resulting fragments seem to have been meaningful.

Ritual for the Inca was a supervised performance full of spectacle and pomp that was directed by state authorities in a public locale, often involving spectators (Arkush and Stanish 2005:14). They utilized public displays and exploited the public staging potential that a location like a plaza could offers (Arkush and Stanish 2005; Bray 2013; Morris 1989). Intentionally broken manos and metates from pre-Inca contexts at Inca-Caranqui suggest that the smashing of food processing tools was likely not an Inca innovation but rather an earlier practice. If we accept the premise that *chicha* was made for use at Inca-Caranqui, perhaps then we need to consider that manos and metates were potentially ceremonially broken, indicating that prosaic tools were important agents participating in social processes at the site.

The sum of the evidence pertaining to the ground stone food processing assemblage indicates that these objects were not perceived in binary terms, equating certain materials with elites and others with utilitarian work. Rather, it is possible that these implements were venerated for their transformative qualities; capable of altering maize from solid form to an eventual liquid state. The connection of Andean elites and maize is described by Goodman-Elgar (2008) for activities that occurred during agricultural ceremonies that allowed elites to demonstrate their power by ritually engaging in agricultural work in imperial maize fields (Goodman-Elgar 2008:86). Similarly, Inca elites, administrators and food processors would have recognized food processing toolkits as the catalyst for the production of *chicha* through the metonymic associations of physical and causal links between tools and substance (sensu Lakoff and Johnson

1980). The use of these implements for the large scale processing of maize for *chicha* production lifts these tools out of the realm of common place.

A review of interpretations for the intentional fragmentation of objects in prehistory from other geographic regions was important for attempting to understand why useful things may have been purposely destroyed. Nonetheless, the explanations of destructive acts from other regions are not automatically transferable to broken tools from Inca-Caranqui. Manos and metates can be understood as the material manifestations of a coordinated sequence of events, illustrating stages of production, use, fragmentation, discard and, in some cases, interment. Determining how fragments entered the material record at the site is not possible. What can be known is that many of these artifacts share the same approximate location, in or immediately west and north of the water temple feature. For most specimens, this information does not include the levels of occupation that the tools came from but it does suggest that many were from one general area. This evidence suggests that fragments may have been transported to the vicinity of water temple and deposited within relatively close proximity to one another.

The association of these implements with ritual is suggested on the basis of both function and context in the northern highlands. It seems curious that a large number of utilitarian food-processing tools which are typically associated with low status work would be found within a palatial context that appears to lack domestic units –a matter further confounded by the fact that most of these implements are broken. The breakage and depositing of these still vital items was not accidental but rather seems to have been essential to the efficacy of symbolic action. These objects are the symbolic components of the transformative effect of chicha. The large quantity of fragmented food processing tools could be interpreted as indicative of specific ritual practices. The abundance of fragmented tools from Inca-Caranqui, a ceremonial site, suggests they were deeply embedded in ancient Andean symbolism. My analyses suggests that the food processing assemblage from Inca-Caranqui was both utilitarian and symbolic, both functional and ritual objects.

In exploring the ethnographic record, Colloredo-Mansfeld (1999) reports that in the nearby town of, some modern families living in the rural highlands memorialize their farming past by placing a grinding stone on a patio for decoration while many of their neighbors still use these tools for weekly tasks (1999:208). Similarly, outside of my lodgings in San Clemente, a mano and metate sat on the corner of the patio near the front entrance. On a nearby trail that led to agricultural fields, I would regularly walk by a trough metate –not an uncommon sight in this area; I also knew of two other metates, at the edges of adjacent fields and I had once observed one of them in use. Returning home at dusk one evening in haste, I was surprised by the sight of a young pig enjoying dinner from one of the metates –the *trough* was literally serving as a trough. This incident illuminates the multi-functionality of these tools –memorialized in the first example by being set on the patio of an indigenous family, used as originally intended in the second instance, and finally, utilized as a container for the food of a domesticated animal.

In another instance, I had the opportunity to view a local parade during an annual indigenous festival, the main event which involved the crowning of a new queen who was chosen from among the fresh-faced teenage beauties of the local indigenous communities. Symbols of indigenous identity were represented on floats, during choreographed performances, in the costumed musicians, and among the spectators themselves. Some of the day's performances depicted mythical scenarios or themes of indigenous freedom from Colonial rule and the hacienda system. In some performances, men dressed as *gauchos,* unruly beasts, and the masked *Diablo Huma,* an obscure figure who signifies complex issues involving indigenous identity, agency, and the dualism of the universe. The beds of small pick-up trucks served as the platforms for floats, acting as moving stages for expressions of community pride. Many trucks were adorned with roses, a reminder that the Ecuadorian industry supplies the world with this most beloved flower genus. Other pick-up beds were covered with vines, fruits, stalks of dried maize or textiles as they carried llamas, children and other important aspects of highland farming culture. A few of the floats depicted rainbows, in reality not an uncommon sight to see in surrounding skies. The *wipala,* or rainbow-colored flag, is today used to symbolize indigenous rights in Ecuador.

Of particular interest for me was a float that contained a woman grinding maize with a metate and mano adjacent to a pot readied for the preparation of *chicha* (Fig. 6.1). The happenings of the parade were outside the realm of tourism, so she was not performing for the gaze of tourist but rather for her community. I think it is important to mention this because although the act of making chicha on the float is mimetic, the sentiment expressed was not. In contrast, at the famous indigenous market in the town of Otavalo, there is a considerable degree of embellishment intended for the gaze of visitors, arguably even during indigenous festivals, such as, Inti Raymi. The activity portrayed in Figure 6.1 was intended solely for the gaze of the community and underscores the representational potential of the mano and metate toolkit as thoroughly rooted in Andean symbolism and tradition.

The intent of this thesis has been to interpret activities associated with the ground stone food processing assemblage from Inca-Caranqui and to explore the participation of these tools in ritual activities that took place at this ceremonial site. To this end, manos and metates were examined in terms of functional importance and also their broader social significance. Information primarily garnered from ethnohistoric sources and ethnographic reports was used to draw functional inferences about food-processing and to outline characteristics associated with maize grinding for use in *chicha* production in the northern highlands. By all accounts both maize and *chicha de maíz* were esteemed by the Inca. My study suggests that while the food-processing implements recorded at Inca-Caranqui were undoubtedly used to process a variety of foodstuffs, the surface configurations of the majority of tools in this assemblage indicate that they were predominantly used to grind large quantity of seeds, likely maize and *Chenopodium*.

The primary objective of this study was to systematically analyze the manos and metates from Inca-Caranqui in order to demonstrate that many of these tools were intentionally broken. To that end, this study examined patterns of breakage registered on these tools and found that many of the implements were likely broken intentionally.

This thesis aimed to go beyond rudimentary stone tool descriptions, a common approach to grinding tools at Andean sites, in order to demonstrate that significant data can be derived from utilitarian stone artifacts for addressing broader cultural questions. Stone tools provide discreet information, only obtainable through their study (Clark 1988). For the metates and manos from Inca-Caranqui the intentional breakage of these objects lifts these tools from the realm of the common place and suggests their possible role in the ritual aspects of the site.

At Inca-Caranqui, it appears that these items were highly valued since they were brought to (or from) the site as broken objects, or after being broken. The abundance of smashed food processing implements associated with the water temple supports interpretations of the feature as a ritual focal point as posited by Bray and Echeverría (2014). Fragmentation at Inca-Caranqui appears to have had was symbolic significance. Perhaps it was only when certain objects were broken that their ritual potential could be realized. In this instance, the recognition of ritual performance is understood through material symbols whose attached meaning was important to rituals at the site.

Many of the examples from previous research presented in this paper demonstrate that the intentional fragmentation of food processing tools also pertains to contexts outside the Andes. Therefore, the analytical approach used in this study can be applied to the identification and interpretation of intentionally broken ground stone artifacts from other contexts. These analyses reflect the aim of facilitating comparative regional quantitative and qualitative investigation in the future. This thesis has sought to recalibrate archaeological interpretation of grinding implements in the Andes. If it serves to inspire others to more closely examine ground stone artifacts in assemblages in the northern highlands and other areas of the Andes, then it will have served its purpose.

Figure 6.1. *Chicha*-making demonstration

APPENDIX: SUPPLEMENTARY BOXPLOTS

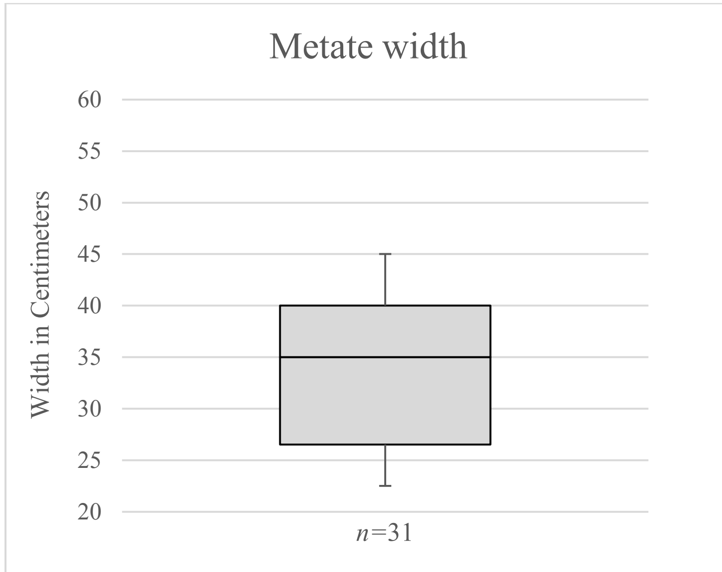

Figure B-1. Boxplot showing medians and distributions of values of "halved" metate widths.

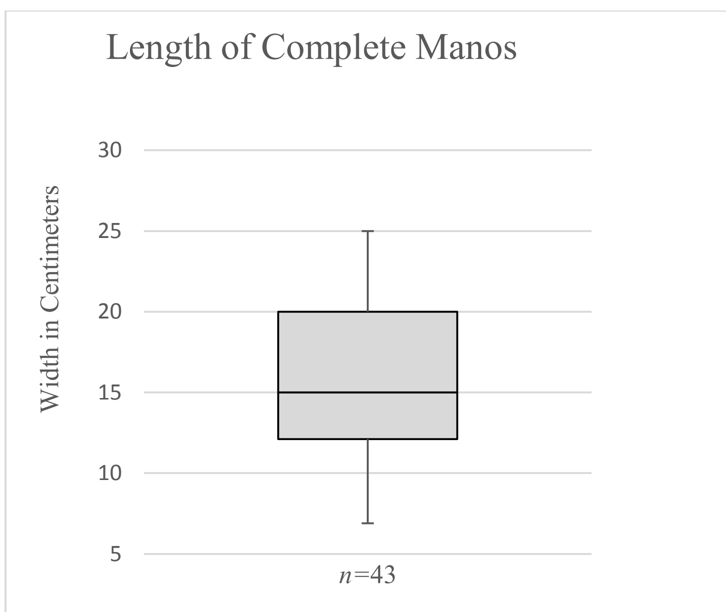

Figure B-2. Boxplot showing medians and distributions of length for complete manos.

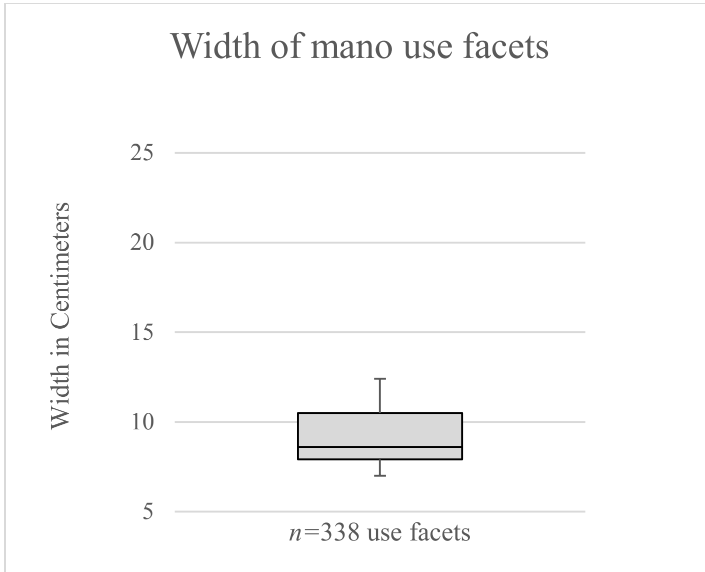

Figure B-3. Boxplot showing medians and distributions of the width of mano use facets.

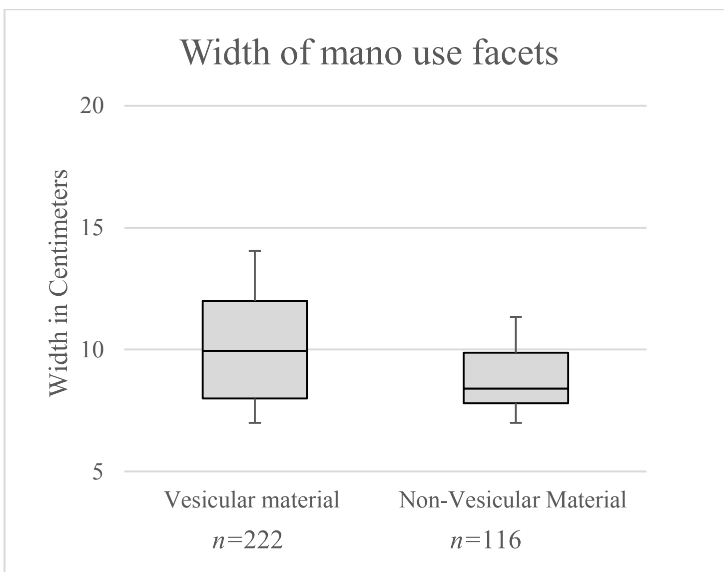

Figure B-4. Boxplots comparing medians and distributions of the width of mano use facets for vesicular and non-vesicular raw materials.

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ABSTRACT

SMASHED: CEREMONIAL INTOXICANTS AND INTENTIONAL TOOL DESTRUCTION IN THE NORTHERN HIGHLANDS OF PRE-COLUMBIAN ECUADOR

by

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This thesis examines fragmented ground stone food processing tools referred to as, manos and metates, that were found at the palatial late imperial Inca site of Caranqui located in the highlands of northern Ecuador. This region represents the northern frontier of the Inca Empire and was the last region to come under control of the Inca just prior to Spanish invasion. Manos and metates were integral to the production of chicha, a beverage often used for it intoxicating effects by the Inca and other Andes peoples during ritual and stately events. A temple and other features found at Inca-Caranqui would have necessitated the use of the beer-like beverage. The presence of an abundant number of fragmented utilitarian ground stone tools within the ritual precinct of the site suggests that these tools were engaged in other realms of social life outside their intended utility. The paper explores intentional fragment as a possible explanation for the fragmented state of many of the broken food processing tools from Inca-Caranqui.

AUTOBIOGRAPHICAL STATEMENT

Amy Krull is a native of the Great Lakes region. She developed an interest in Andean archaeology and ground stone research during her undergraduate studies when receiving a bachelor's degree in anthropology. In addition to archaeological field work in North and South America, she has been informed by her experiences contributing to museum and laboratory research, and also through her interactions with individuals from respective communities where she has participated in projects.