

AN ANALYSIS OF SURFACE AND SUBSURFACE CERAMICS IN RELATION TO
FORMATION PROCESSES AT THE ARCHAEOLOGICAL SITE OF
PIRQUE ALTO (CP-11) IN COCHABAMBA, BOLIVIA

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ABSTRACT

The archaeological site of Pirque Alto (CP-11), located in the Parotani valley region of Cochabamba, Bolivia; is a multicomponent site, with components dating back as far as the Formative Period up until Inca times. Previous archaeological work done at this site shows that this site has been impacted by both natural and cultural formation processes. This report examines ceramic artifact remains collected from a systematic surface survey of the whole site from 2005 and subsequent excavations conducted during 2007, both of which were done as a part of the Prehistoric Parotani Settlement Project. Comparisons are made between the surface and subsurface ceramic densities and from these comparisons, I determine the extent to which surface and subsurface artifact densities reflect formation processes active at this site. This research seeks to add to our understanding of how difference processes impact the archaeological record from which interpretations are made.

INTRODUCTION

The archaeological record consists of the physical remains of past human behavior which archaeologists seek out and record in an attempt to analyze and reconstruct the past. Therefore, it is crucial when making interpretations from the materials derived from the archaeological record that consideration is taken as to the nature of the archaeological record in terms of its formation and subsequent transformation, and the processes involved. Archaeologists are now aware that the contexts from which they gather their data are not unbiased, reflecting not only the consequences of past human behavior but also those processes acting on those cultural deposits. This realization has sparked a concern in archaeology about the nature of the archaeological record and its ability to reveal information pertaining to the past. Despite the number of studies and subdisciplines that have come out of this concern, it is not yet fully understood how formation processes alter the record or the degree to which such processes can be detected in the archaeological record. What is known, however, is that the archaeological record is complex and the processes involved in its development and that affect it afterwards complicate the task of interpreting past human behavior.

My research looks at the nature of formation processes at the archaeological site of Pirque Alto (CP-11), a multicomponent site located within the Parotani valley region of Cochabamba, Bolivia (Figures 1 and 2). By comparing the results from a 2005 total surface survey collection with what was recovered from excavations carried out in 2007, I examine the relationship between surface and subsurface ceramic densities with the intent of determining the extent to which surface and subsurface artifact densities reflect those formation processes that are active at Pirque Alto. My research attempts to add to our understanding of the formation processes of the archaeological record by comparing surface and subsurface materials and

examine how different processes impact the archaeological record from which we base our interpretations.



Figure 1. Political map of Bolivia showing the location of the Department of Cochabamba (from nationsonline.org 1998 - 2009).

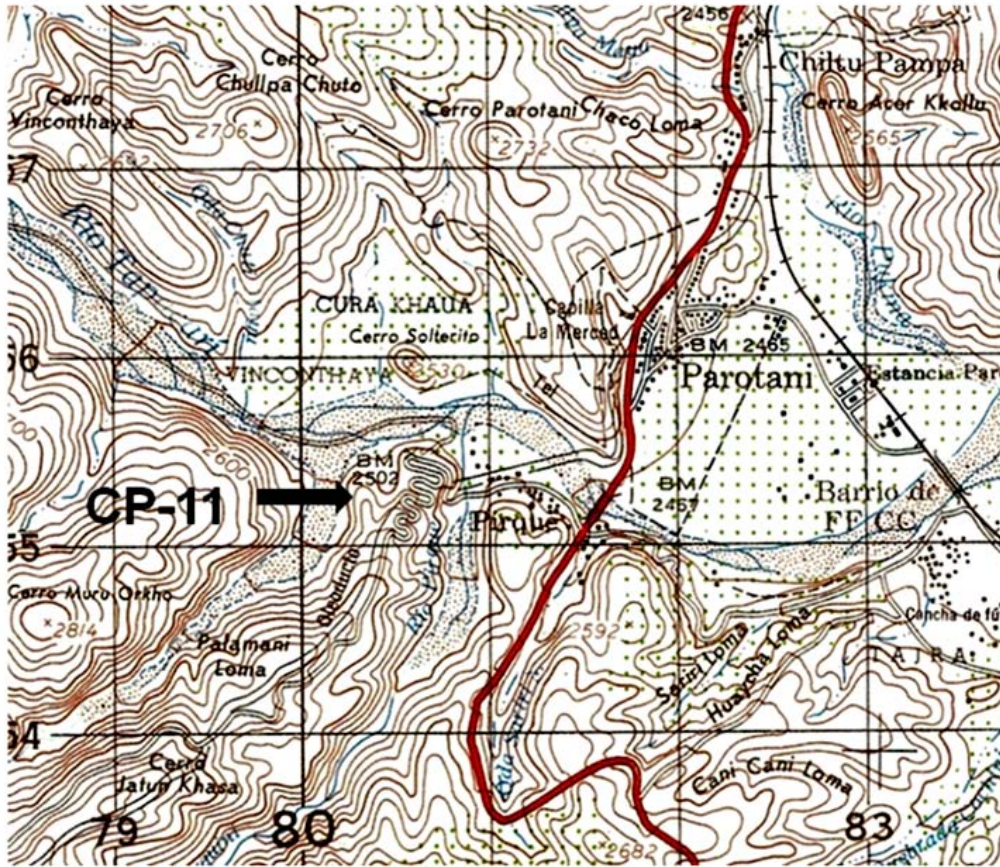


Figure 2. Parotani region of Cochabamba (Instituto Geografico Militar y Cadastral, scale 1:50,000).

In this paper, I have included a background on the development of the study of formation processes in the context of archaeological research followed by a description of the archaeological site of Pirque Alto, including past archaeological research of the area and characteristics of the Parotani region the site itself. Next, I illustrate the methodology I have employed in the analysis surface and subsurface ceramic densities followed by the results of the analyses performed. This is succeeded by a discussion of my interpretations of the results and the factors that may have played a part in the outcomes of the analysis. In addition, I offer suggestions as to the sorts of data collection and excavation methodologies to be employed if future analyses on formation processes are to be done. My final conclusion takes into account those factors that may have affected the results of my analysis and argues that the data shows

that this site is not only affected by those processes of erosion or agriculture, but the collection of data and method of excavation.

BACKGROUND

Formation Processes

Formation processes can be defined as “those processes affecting the way in which archaeological materials came to be buried, and their subsequent history afterwards” (Renfrew and Bahn, 1991). In other words, those processes involved in the formation and transformation of archaeological deposits. Michael Schiffer expands on this definition, stating that formation processes are “the factors that create the historic and archaeological records”, and thus includes those material remains of the past that exist outside a buried context (Schiffer 1987). They can be divided into cultural formation processes and natural formation processes.

Before the nature of the archaeological record and the processes involved in its formation and thereafter were fully understood, archaeologists followed the assumption that the “archaeological record offered a relatively complete and undistorted picture of the societies that had produced it” (Trigger 1989). In other words, the archaeological record was thought to be a direct reflection of past human behavior. It was during the 1950s and 1960s that archaeologists focused on “extracting from archaeological remains as much social and behavioral information as possible” (Schiffer 1983). This was the essence of behavioral archaeology which emphasized the study of relationships between human behavior and artifacts. Behavioral archaeology promoted the growth of experimental archaeology and ethnoarchaeology. Later during the 1970s, geoarchaeology developed in which geoscientific methods were applied to archaeological research (Rapp and Hill 1998; Reid, Schiffer, and Rathje 1975). These subdisciplines and

methodologies furthered our understanding of the nature of the archaeological record and its formation. With these developments in archaeological methods and theories, it was “becoming increasingly apparent that interpretation and explanation of the record must take into account any processes that may mask the relationship between the record and the behavior producing it” (Dancey 1981).

Formation processes are grouped into two types: cultural and natural. Cultural formation processes are those processes in which the agency of transformation is human behavior. Natural formation processes are those in which the agencies stem from processes of the natural environment (Schiffer 1987). Although there have been numerous studies done both within the discipline of archaeology and in interdisciplinary areas (such as geoarchaeology) on formation processes and their effects on the archaeological record, their impacts and identification in the archaeological record is still not fully understood (Schiffer 1987, O’Brien and Lewarch 1981). It has, however, been proven that certain processes will leave a general pattern on the archaeological record or the material remains themselves. As part of my research, I examine the relationship between surface and subsurface ceramic densities across the excavated areas of the site to see if a change is seen in this relationship that can be attributed to different processes acting on the site with the intent of adding to our knowledge of formation processes. Before describing the methodology I will be employing in the study of site formation process, I will provide background on the site of Pirque Alto, including information on known processes that have impacted the site.

The Site of Pirque Alto (CP-11)

The archaeological site of Pirque Alto is located on a terrace overlooking the Tapacari River in the Parotani valley region of Cochabamba, Bolivia. This is a multicomponent site with occupations as early as the Formative Period up until Inca times (from about 1500 B.C. until around A.D.1500) as indicated by diagnostic artifacts found at the site’s surface (see Figure 3). It was identified by Alvaro Hiqueras in the 1990s during a survey of the entire region (Hiqueras 1996).

Chronology

	Period	Ceramic Types
A.D. 1535	Late Period	Ciaco, Inca
A.D. 1100	Middle Horizon	Tiwanaku
A.D. 600	Early Intermediate	Tupuraya
A.D. 200	Formative Period	Formative I, II, III, IV
2000 B.C.		

Figure 3. Chronology for the Cochabamba region (from McAndrews, Rivera, and Jaimes 2006)

In 2005 a systematic surface collection of the whole site was performed and subsequent excavations conducted in 2007, both of which were part of the Prehistoric Parotani Settlement Project (McAndrews 2007). Although the 2007 excavations resulted in the finding of significant subsurface features in areas shown to have a high surface density of artifacts, there is evidence that this site has been impacted by erosional degradation as well as agricultural practices. Such evidence includes the appearance of prehistoric pottery designated to three

distinctive occupational periods together on the surface, the occurrence of both historic and prehistoric materials in the same subsurficial context, the reappearance of ceramic sherds at site's surface two years since the 2005 surface collection (Figure 4), the inability to recover nails used to establish the location of the site grid in 2005, as well as the inability to relocate cultural features found at the site's surface in 2005.



Figure 4. Ceramic sherds found at the surface at the site of Pirque Alto.

There have been a number of studies that address the issue of erosion in the Cochabamba region (Zimmerer 1993; Asmamaw 2003; Saavedra 2005). Overgrazing by livestock and farming practices are the most often mentioned causes behind soil erosion in Bolivia. The regional landscape has been described as having slopes from which soil would be swept down – leaving bare rock and subsoil in addition to the creation of gullies (see Figure 5) – due to heavy rains during the months of November to March (Zimmerer 1993). Evidence for erosion at the Pirque Alto site include erosional and deflated contexts along steep slopes located on the northern, southern and eastern edges of the site (based on the grid coordinates) while the western and central areas of Pirque Alto were intact with a good stratigraphic context. The western edge

of the site, which lies at the base of a slope that rises to the west was reported to have “a very nicely preserved natural and cultural stratigraphy” (McAndrews 2007).



Figure 5. Regional landscape surrounding the site of Pirque Alto.

It is known that this site had been previously cultivated using the techniques of dry farming during the rainy season. It was confirmed by local villages and landowners that the 2003 season was the last time the site had been plowed and cultivated. Excavations from 2007 revealed that in areas not affected by erosion, there was an overlying plowzone measuring about 10 cm in thickness (McAndrews 2007).

This study will consider the effects of these different processes (agricultural activity and erosion) on the outcomes of the analysis between surface and subsurface ceramic densities. Through the analysis described in the following section, I will look to find if these different processes show a contrast in ceramic distributions which would suggest that formation processes may produce a variation between surface/subsurface density relationships.

METHODOLOGY

The goal of this research is to find what patterns exist between the distribution and densities of ceramics recorded from surface survey collections and subsurface collections obtained through excavations at the Pirque Alto site. Through the analysis of these potential patterns, the following questions will be addressed: (1) how well does surface ceramic density reflect the density of ceramics in subsurface contexts, (2) is there a relationship between the variation in ceramic densities horizontally (across the site) and vertically (with depth by excavated level), (3) is there a relationship between the correlation of surface and subsurface densities and the topography of the site, (4) do these relationships change with regard to cultural periods, and (5) do any relationships between surface and subsurface ceramic densities reflect formation processes and therefore show how these processes may have affected the archaeological record. The methodology that has been applied to answer these questions includes two parts: first, a review of existing literature on site formation processes and the surrounding Cochabamba region, and second, a comparison of the data collected from a surface survey collection done in 2005 and 2007 excavations, both of which were conducted as part of the Prehisotric Parotani Settlement Project.

In reviewing existing literature, I have gathered information pertaining to the nature of site formation processes, the environment of the Cochabamba region in contemporary times and potential changes in past environments within the central Andean region, past archaeological studies conducted within the Parotani region of Cochabamba, and cultures associated with the period of occupation relevant to the Pirque Alto site. This review of the literature provides the background necessary to make further inferences concerning the nature of the archaeological record and the processes involved. The information gleaned from the literature will be discussed

later on in this paper in relation to the results obtained through the analysis of surface and subsurface ceramics.

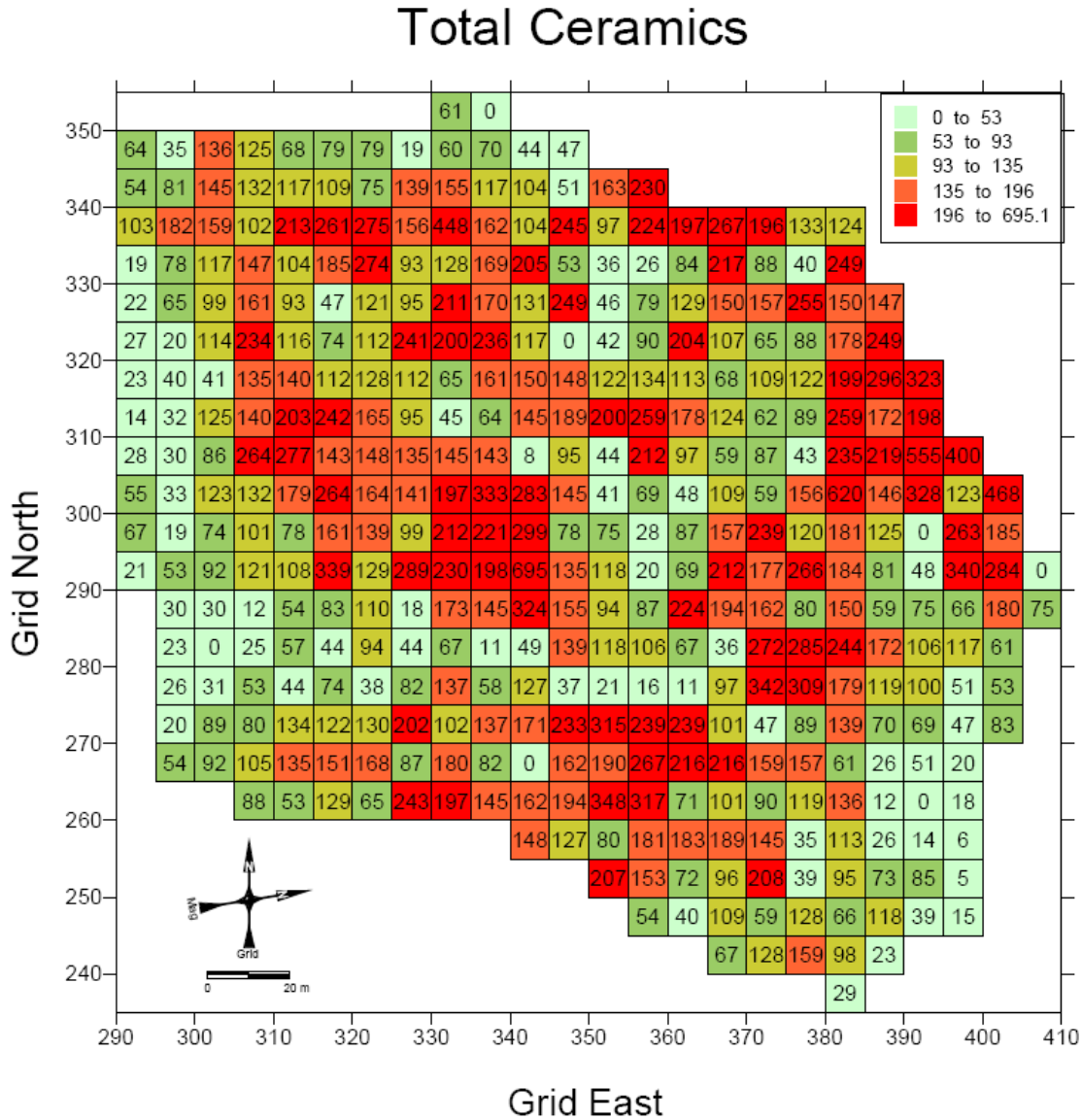


Figure 6. Surface Ceramic Distribution from 2005 Total Surface Survey (from Green 2007).

To compare surface and subsurface artifact distributions and densities from the Pirque Alto site, I will be using data collected during the 2005 total surface collection survey and subsurface excavations collected during the 2007 field season. In 2005, a total surface collection

survey was conducted by students in the UW-La Crosse Archaeological Studies program under the direction of Dr. Timothy McAndrews at Pirque Alto. A five meter grid was established across the site using the Cartesian grid system, dividing the site up into 406 units measuring 5 x 5 meters (Figure 6). All 406 units were systematically surveyed, resulting in a 100% surface collection. Included in this collection was over 13,200 diagnostic ceramics (rims, bases, handles, painted pieces) and over 52,000 non-diagnostic ceramics (those bigger than the size of a U.S. nickel - or 21 mm - not belonging to the diagnostic category) (Green 2007). The analysis of ceramics involved their categorization into temporal periods based on their technological, morphologic, functional, and stylistic attributes of diagnostic sherds based on a hybrid chronology derived from the work of Hiqueras (1996) and Rowe (1945). Spatial analysis was conducted by Elizabeth Green as part of her undergraduate thesis in which tested a variety of experimental sampling methods against the surface recovery data collected at the site of Pirque Alto as a means to better understand how various sampling methods may affect site interpretation (Green 2007). As part of Green's undergraduate thesis, maps were created (using Surfer by Golden Software) as a means of illustrating the density and distribution of diagnostic sherds. These maps display the site area, divided into 25 x 25 meter units, and the total number of ceramics found within each unit as well as numbers of ceramics by temporal periods during which Pirque Alto was occupied. A database was also created all artifacts collected during the 2005 surface survey and queries were set up using Microsoft Access to group artifacts into tables by types and temporal periods (Appendix A). I will be using both the maps displaying the distribution of ceramics in Elizabeth Green's undergraduate thesis (2007) and the Access database of the 2005 surface collections to extract necessary data about surface materials found at Pirque Alto.

In 2007, excavations were conducted at the site of Pirque Alto by students in the Archaeological Studies program of UW-La Crosse, again under the direction of Tim McAndrews. A total of 97 m² was excavated in five different blocks across the site, to varying depths (Figure 7). Units of the following various sizes were excavated: 1 x 1 m units, 2 x 1 m units, and 2 x 2 m units. All excavations were done in arbitrary 10 cm levels and all soils were screened through a five millimeter hardware cloth for artifact recovery. Features were likewise excavated in 10 cm arbitrary levels within internal feature strata. Due to the high quantities of ceramics recovered during excavation, only ceramic sherds equal to or greater than the size of a U.S. quarter (24 mm) were collected for further analysis. The location of features and units were plotted using the site's Cartesian grid system. It should also be noted that the directional units of north, south, east and west of the established grid do not correlate to the true magnetic directions. The depths of each excavation unit varied according to the depth at which sterile soil was encountered. The strategic placement of the five excavation blocks were determined based on the surface artifact densities from the 2005 surface collections, the patterning of surface artifacts across the site, and the potential for intact, stratified deposits (see site report by McAndrews 2007). The results from the 2007 excavations are presented in the site report by Timothy McAndrews, of which includes a topographic map of the site area, maps showing the location of excavation blocks and their relation to artifact densities from the 2005 surface collections, in addition to profile and planviews for the majority of the excavated blocks. Field notes included an artifact bag inventory, level forms, feature forms, and unit summary forms; which provide information pertaining to subsurface densities of artifacts within each excavation unit. Because I was not sure for all excavated levels what method of ceramic collection was applied, I decided to take the counts recorded as ceramics that were collected and kept while keeping in mind that

possible outliers in my data analysis may exist due to a difference in collection method. Also, because excavation blocks I, II, III, and V included the counts of all ceramics (both diagnostic and undiagnostic) that had been collected during excavation where as only the counts of diagnostic ceramics were available for excavation block IV, only four of the five blocks that were excavated in the field season of 2007 were analyzed in this report.

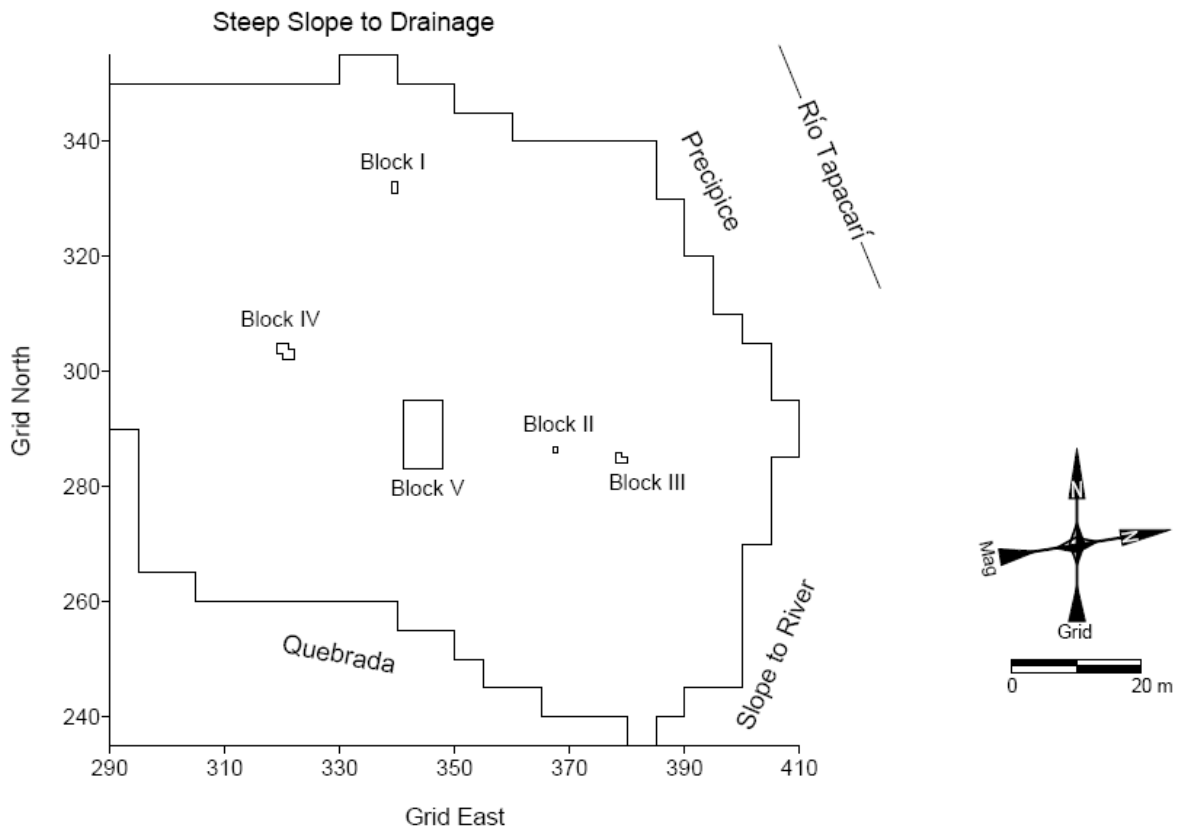


Figure 7. Map of Pirque Alto (CP-11) indicating the location of the 2007 excavation blocks (from McAndrews 2007).

Although research shown by archaeologists such as John W. Rick (1976) and Michael B. Schiffer (1987) show that one indication of formation processes is the nature of the distribution of different types of artifacts (Rick’s research included the differences between bone, lithic, and ceramic artifacts) in relation to slope, the data available from the Pirque Alto site was not

appropriate make such a comparison across artifact types. The 2005 surface survey shows not indication of having collected any bones, and the lithic materials collected during the 2007 excavations have yet to be analyzed to ensure that they have, in fact, been culturally modified. Therefore, I have decided perform analyses on the ceramics only. It should be noted, however, that even the ceramics were found to contain biases. To my knowledge, the 2005 survey collection of ceramics had all been collected from 25 m² units. Also, according to Green (2007) the surface ceramic collection included only those that were bigger than the 21 mm (same as the size of a U.S. nickel). The method of collection of ceramics from the 2007 excavations is somewhat unclear, however. As described above, ceramic materials collected were to include only ceramic sherds equal to or greater than the size of a U.S. quarter (24 mm). However, it is known that this was not always carried out for every excavated level for each unit. Some levels included the counts of ceramics larger or equal to the size of a U.S. quarter, and for others, it is unknown whether the ceramic counts recorded included all ceramics found or only those of the specified size.

Because there was not yet an artifact database made up from the 2007 excavations, I first created an Excel spreadsheet using ceramic data obtained from the field notes. The database includes information pertaining to the total ceramic count per excavated level organized by excavation block and the coordinates of each individual unit (Appendix B). This database was then exported into Microsoft Access where it could be combined with the data from the 2005 surface collection to form the appropriate data table that is used to compare the differences between relative proportions of surface ceramics to subsurface ceramics (Appendix C). To make up for the differences in surface collection units and the excavation units, the ceramic densities were recalculated to a standard measurement for surface and subsurface densities: ceramics per

m² for surface densities and ceramics per m³ for subsurface levels excavated. To do this the total number of ceramics recovered for each 5 x 5 m unit from the surface collection was divided into a proportion of that number that reflects the spatially correlating excavation unit size.

I employ the statistical methods of correlation and regression analyses to compare the surface and subsurface ceramic densities at the site. Both correlation analysis and regression analysis deal with the relationship between variables (Drennon 1996; Fletcher and Lock 2005). Regression analysis looks at the form a relationship takes between variables, while correlation analysis looks at the strength of a relationship between variables. In this case those variables are surface ceramics densities and subsurface ceramic densities. A scatter plot is used to plot surface ceramic densities and subsurface densities against one another and a linear regression used to calculate a trendline (line of best fit) between the two variables. If the form of the relationship is positive, this shows that as surface ceramic densities increase, subsurface ceramic densities also increase. If the form is negative, this shows that as one of these variables increase, the other will decrease in density. If the form of the relationship shows no relationship between the two variables, then surface and subsurface densities do not reflect one another, posing a problem since the whole idea behind doing a surface survey collection is to get an idea of the distribution of cultural deposits subsurface. A correlation coefficient is then used to find how strong the relationship is between surface and subsurface densities. The coefficient calculated ranges between 1 and -1, with numbers closer to 1 having a stronger positive relationship and numbers closer to -1 having a stronger negative relationship. If the correlation coefficient is closer to 0, then the correlation is weak or it is not present.

The relationships looked at include those between surface ceramic densities and level one of subsurface excavation densities of ceramics, surface ceramic densities and average ceramic

densities between all excavated levels per unit. Using the results from the comparison of the surface and subsurface ceramic densities, the differences between surface and subsurface densities are then compared across the site horizontally to test whether these differences change in relation to units found with plowzones and those without. I use linear graphs and scatter plots created in Microsoft Excel to display these relationships. To examine whether the topography of the site has affected the surface ceramic distribution the same statistical method of correlation and regression analyses are employed. Using ceramic density data from the 2005 surface survey, this average density is calculated for survey units that extend along the eastern coordinates of the grid system which correlates to the general slope of the site. This too is displayed using a scatter plot created in Microsoft Excel, in addition to a map displaying ceramic distribution according to site topography using Golden Software's Surfer 8. Through these analyses, the goal is to identify any patterns related to different formation processes that may have impacted the archaeological record at Pirque Alto.

RESULTS

In comparing ceramic densities from the surface to the average subsurface densities from units excavated in 2007 there appeared to be no correlation between the two densities (Figure 8). The correlation coefficient calculated between surface and average subsurface ceramic densities came out to be 0.05, which although this is slightly positive, it is not strong enough of a correlation to conclude that there exists a positive relationship.

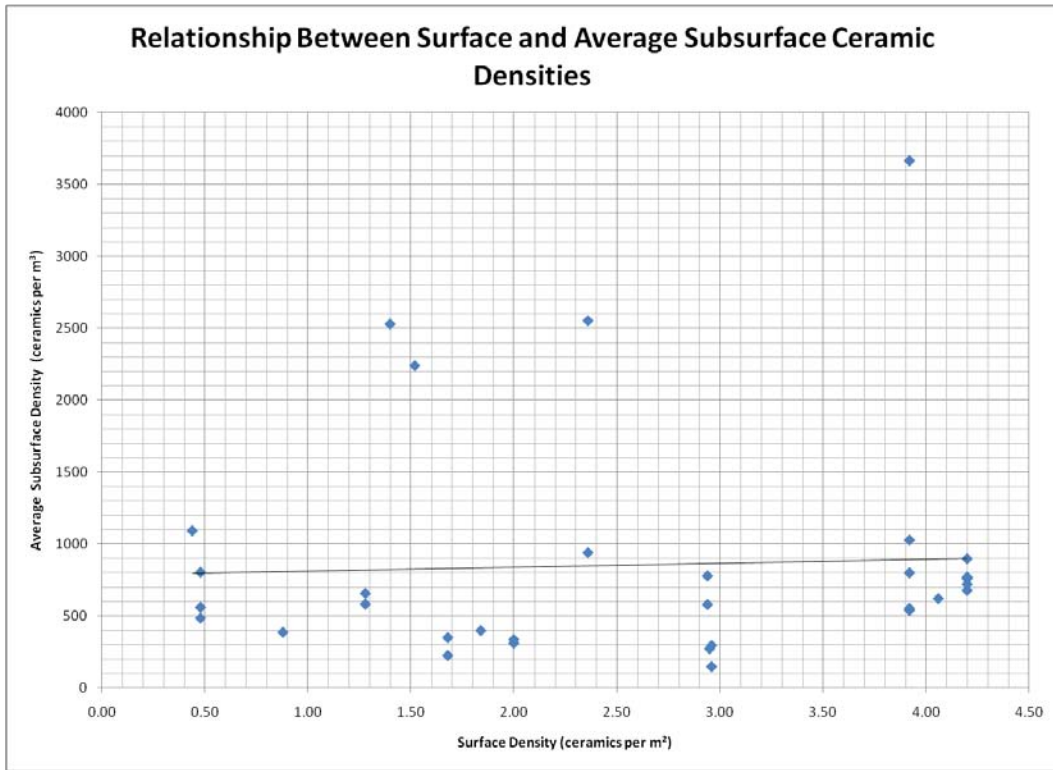


Figure 8. Relationship between surface and average subsurface ceramic densities.

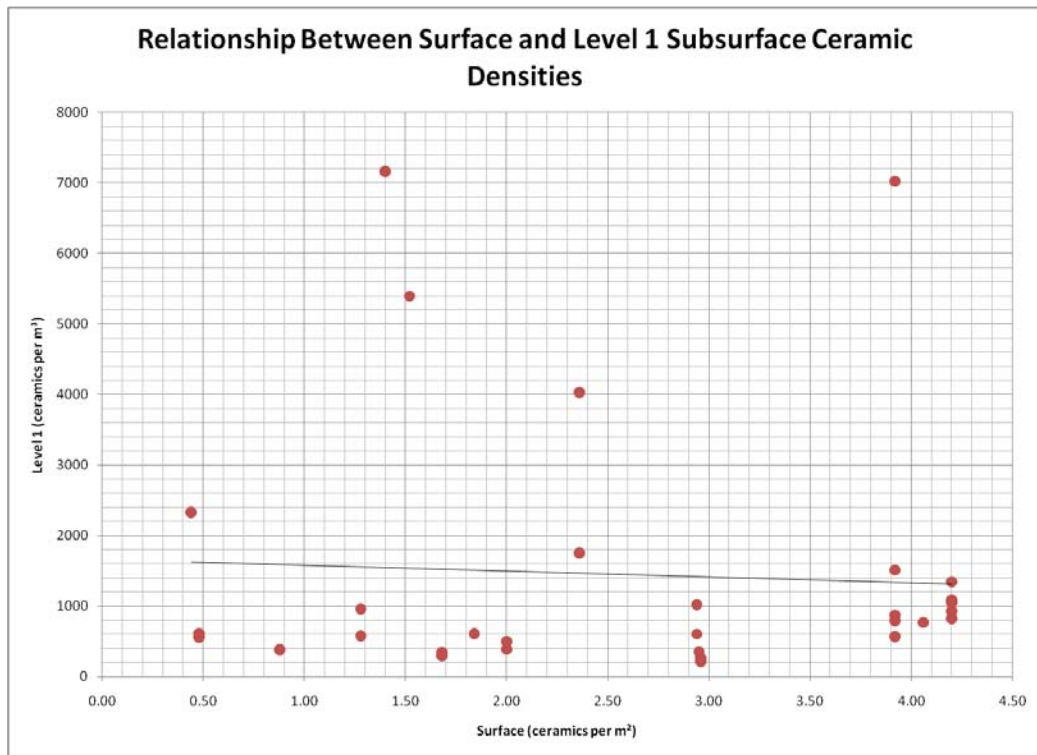


Figure 9. Relationship between surface and level one subsurface ceramic densities.

To better see whether or not the surface density of ceramics was any reflection of subsurface densities, the relationship between surface and level 1 subsurface ceramics was examined (Figure 9). Since level 1 excavations included ceramic densities were at depths ranging anywhere from between 1.0 cm to 15.0 cm, it was originally thought that this relationship would produce a significantly positive correlation where increases in surface densities would reflect an increase in level 1 densities. However, contrary to this prediction, it was found that, as was the case for the relationship found between surface and average subsurface ceramic densities, there was no correlation between surface and level 1 subsurface density. The correlation coefficient for this relationship was -0.03, and thus slightly negative although not strong enough to warrant any correlation between the two variables.

These results were very much unexpected given that the whole idea behind doing a surface survey is to reveal possible areas of high artifact densities may reveal the location of cultural deposits in addition to the fact that those areas that were found to have high ceramic densities in the 2005 surface survey were found to hold significant cultural deposits during the excavations of 2007 at Pirque Alto. To see if outliers were significantly affecting this relationship, the two highest and two lowest densities of subsurface ceramics were not included, and the data recalculated.

After taking out the two highest and two lowest values from the surface and average subsurface ceramic densities, the correlation coefficient showed a slightly negative correlation of -0.11. However, this value does not show a significant correlation between the two variables. Performing the same recalculation between surface and level 1 subsurface ceramic densities, the correlation coefficient also showed a slightly more negative correlation of -0.06, but was not strong enough to say that any correlation exists. Therefore, even after taking out the two highest

and two lowest ceramic density values, the data continues to show no significant correlation between surface and subsurface ceramic densities.

To see if agricultural activity has impacted the relationship between surface and subsurface ceramics, the data was divided into two groups: units that contained a plowzone and those that did not show evidence of a plowzone. The same analysis of comparing surface and subsurface ceramic densities was done using this grouping. The relationship between surface densities and the average subsurface densities (Figure 10) for units without a plowzone has a correlation coefficient of -0.50. This indicates a negative relationship in that as the surface density of ceramics decreases, the average subsurface density increases. The correlation coefficient for units with a plowzone is 0.16, and therefore shows only a weak correlation between the surface and average subsurface densities. Regarding the relationship between surface and level 1 subsurface ceramic densities (Figure 11), the correlation coefficient for units without a plowzone (-0.05) shows that there is no correlation while the correlation coefficient for units with a plowzone (0.14) shows a weak positive correlation. Thus, the strongest relationship seen between surface and subsurface ceramic densities is the negative relationship between the surface and average subsurface for units that have no plowzone.

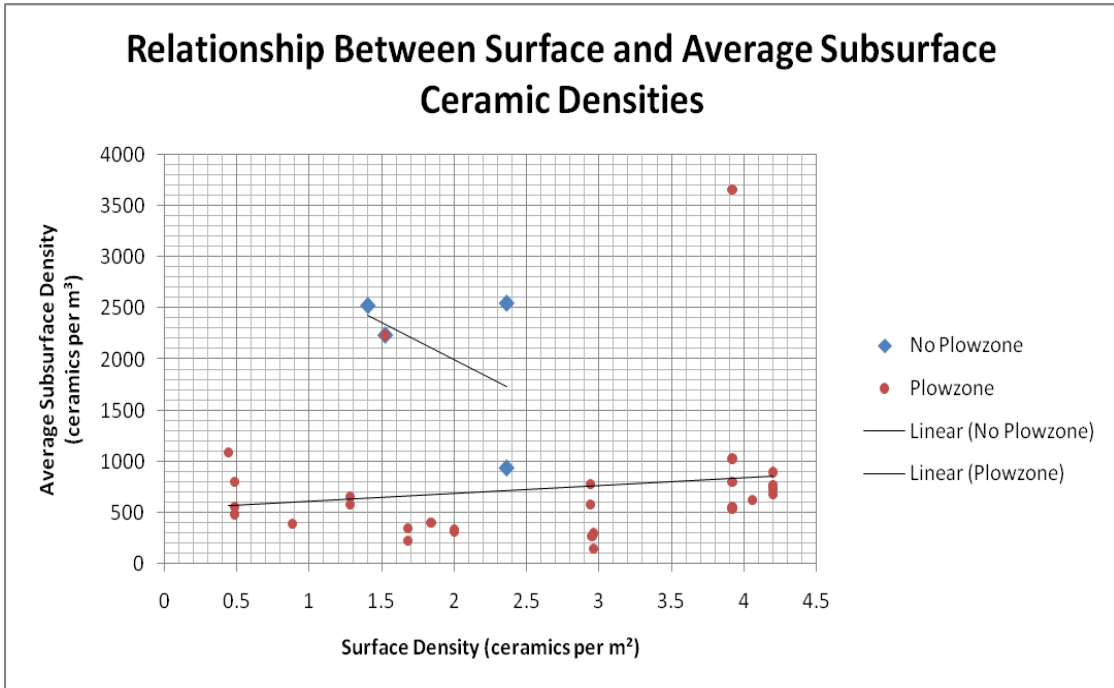


Figure 10. Relationship between surface and average subsurface ceramic densities for units with and without plowzones.

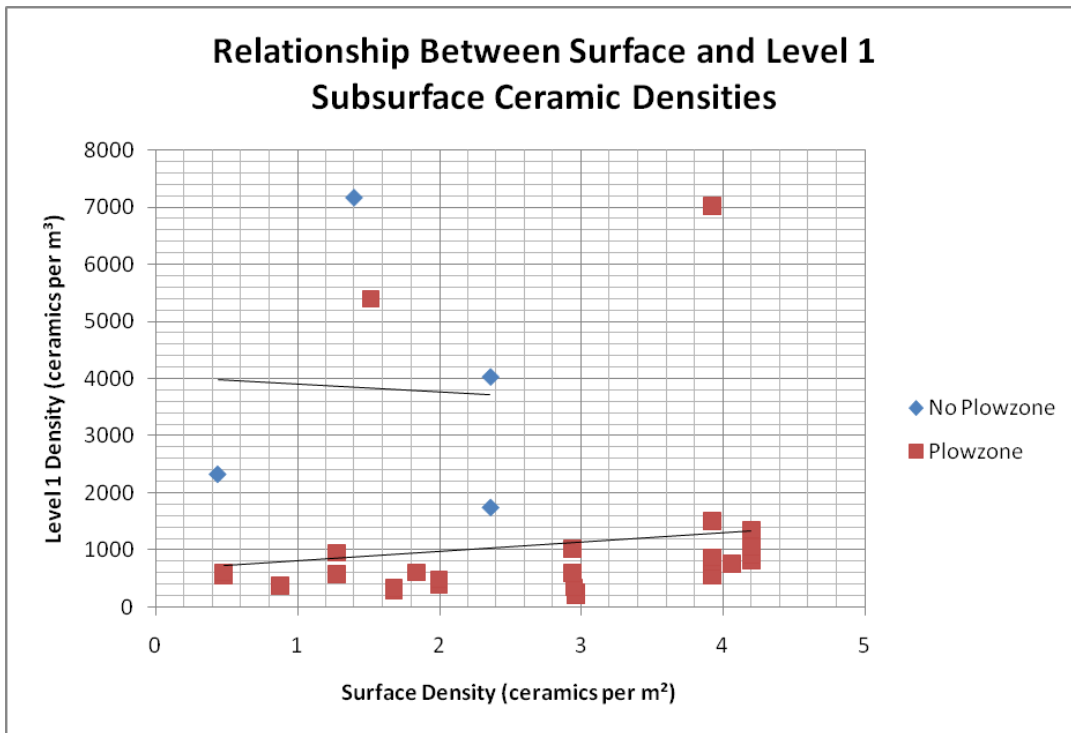


Figure 11. Relationship between surface and level one subsurface ceramic densities for units with and without plowzones.

The analysis of surface ceramic distributions along the eastern grid coordinates down the slope reveals an even stronger correlation, with a correlation coefficient of 0.66 (Figure 12).

This positive relationship shows that the density of surface ceramics generally increases as one goes grid east (which is actually magnetic north). As is seen in Figure 13, the topography of the site generally slopes down towards grid east, although once it hits E 330 and then again at around E 360, the slope direction changes towards grid north (magnetic west) towards lower elevations. It could therefore be said that there is a correlation between the surface artifacts collected in 2005 and the topography of the site of Pirque Alto.

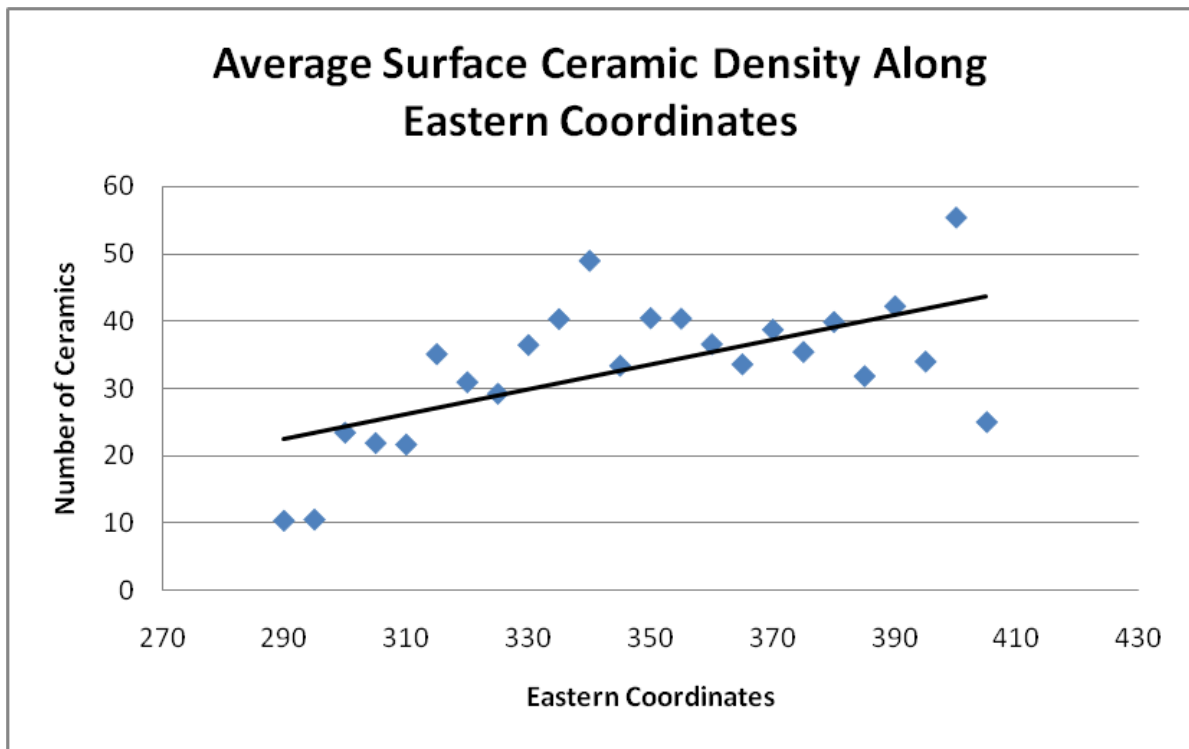


Figure 12. Average surface ceramic density along eastern site coordinates.

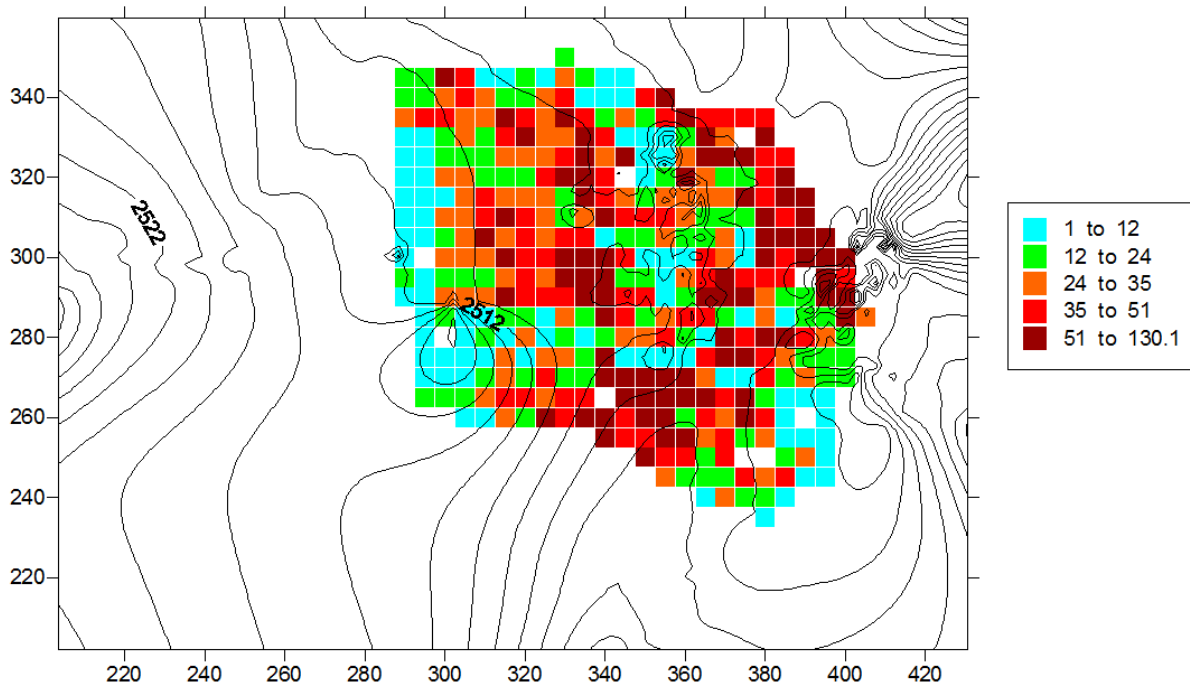


Figure 13. Topographic map showing distribution of ceramic sherd densities from 2005.

Analysis	Var 1	Var 2	Correlation Coefficient	Relationship
Surface-Subsurface	Surface	Average Subsurface	0.05	none
Surface-Subsurface	Surface	Level 1 Subsurface	-0.03	none
Surface-Subsurface w/o Outliers	Surface	Average Subsurface	-0.11	slightly negative
Surface-Subsurface w/o Outliers	Surface	Level 1 Subsurface	-0.06	none
Units with Plowzone	Surface	Average Subsurface	-0.50	negative
Units w/o Plowzone	Surface	Average Subsurface	0.16	slightly positive
Units with Plowzone	Surface	Level 1 Subsurface	-0.05	none
Units w/o Plowzone	Surface	Level 1 Subsurface	0.14	slightly positive
Topography	Surface	Eastern Coordinates	0.66	positive

Table 1. Summary of results from a comparison between surface and subsurface ceramic densities.

The above table (Table 1) displays a summary of the results. These results illustrate that the strongest correlations are found when the comparison was made between surface and average

subsurface ceramic densities within units without plowzones and the surface density of ceramics along the eastern coordinates running downslope. The interpretations that may be made from these outcomes are addressed in the subsequent section.

DISCUSSION

The question that follows is what do those relationships, just demonstrated regarding the nature of surface and subsurface ceramic densities, suggest about formation processes and how they may have affected the archaeological record at the site of Pirque Alto? This section discusses three main concerns regarding the results obtained: (1) the part site topography may have played in surface ceramic distribution as indicated by the increase in ceramic densities east towards lower elevations of the Pirque Alto site, (2) the stronger correlation found between surface and subsurface ceramic densities when units were divided into two groups – those with plowzones and those without, and, lastly, (3) why there is no correlation evident between the surface ceramic densities and subsurface ceramic densities (both in regards to average subsurface density and level one densities). Also included in this discussion is the suggestion for future archaeology regarding methods of data collection and field excavation that ought to be employed if a better understanding of the nature of the archaeological record and the processes acting upon it are to be inferred as well as what specifically this study shows in terms of the nature of the archaeological record and the inferences that may be made in terms of formation processes.

Relationship of Surface Ceramic Densities and Site Topography

The positive correlation of surface ceramic densities along the eastern coordinates of the site grid shows that ceramic densities increase down-slope. In viewing a topographic map of the

site that display the densities of ceramics collected during the 2005 surface survey, it is evident that those areas of lower elevations contain a higher density of ceramics. This may suggest that that the distribution of surface ceramics has been impacted by erosional forces down-slope.

The erosion of slopes tends to produce a mixed distribution of artifacts, especially if erosional processes have been active in an area for a long duration of time. Even so, it has been shown that artifacts subjected to downslope erosion can result in a patterned, mixed distribution that can be used as to determine the type of erosional process responsible (for example whether the agency of erosion is gravity, water, etc.) The use of artifact distribution to help in this identification does, however, get more complicated with increasing time and the number of different processes working on a site (Schiffer 1987).

Artifact features of size, structure, and sorting can also indicate their mode of transport (Schiffer 1987). The effects of an artifacts size due to natural processes can either result in its reduction or the sorting of artifacts according to size. For mass-wasting processes (erosion by gravitational pull), artifacts are often distributed according to their size. Larger artifacts tend to be situated near or at the bottom of slopes while smaller artifacts will be found near the top, or at their point of origin. In terms of gravitational processes size is often correlated with a material's weight or density. Materials with higher weights have higher driving forces and are thus more likely to move downslope than those with smaller weights. Where the agency of transportation is water, it is the smaller and lighter materials that tend to be located further downslope than those that are larger and heavier. The structure of an artifact is more indicative of hydraulic, or water, forces. Transport by water will often result in the rounding of the edges of a material through abrasion (Fanning and Holdaway 2001). For gravitational processes downslope, the form an artifact may take will depend on the type of movement – whether sliding, flowing, or

falling processes (Rapp and Hill 2006). The sorting of artifacts on a site location can be very important. Patterned distributions may occur vertically (with depth) and/or horizontally (at the surface) (Schiffer 1987). Artifacts may be found in a patterned orientation (directionality) on the surface or buried. Many times artifacts that show similar orientation will also share similar shapes. This is only a few of the ways in which the distribution and characteristics of artifacts found can provide information on the active natural processes working on the archaeological site. As was mentioned earlier, artifact distributions that have resulted from gravitational forces on a slope will tend to show a patterned distribution that correlates with artifact weight/density. This is clearly demonstrated by a case study done by John W. Rick (1976) at a preceramic site located in highland Peru in an environment quite similar to that of Pirque Alto.

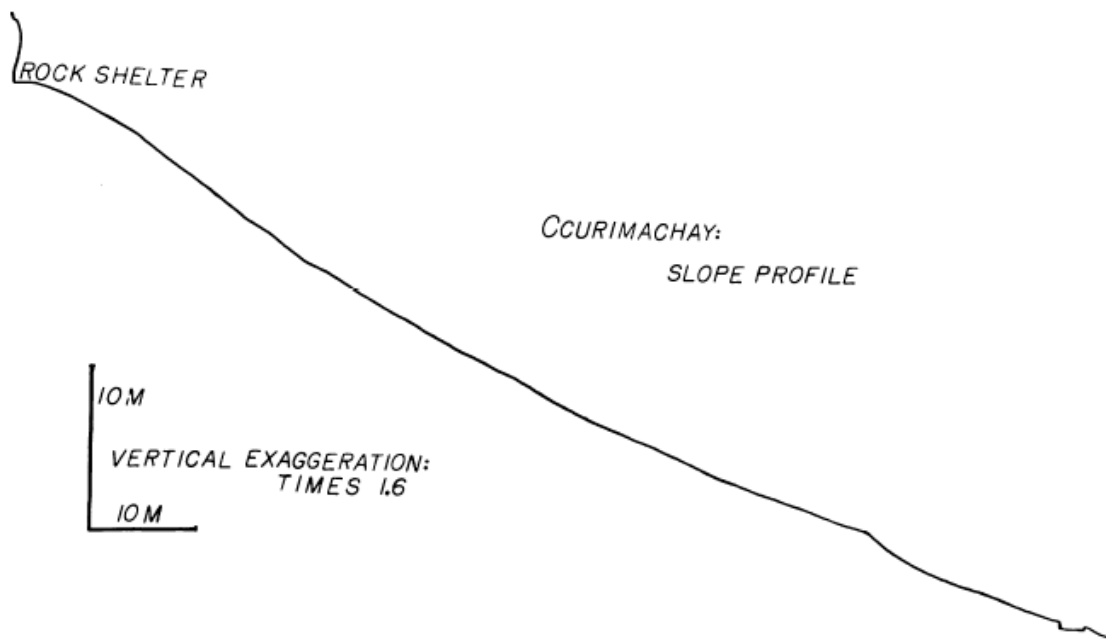


Figure 14. Profile of the site of Ccurimachay (from Rick 1976).

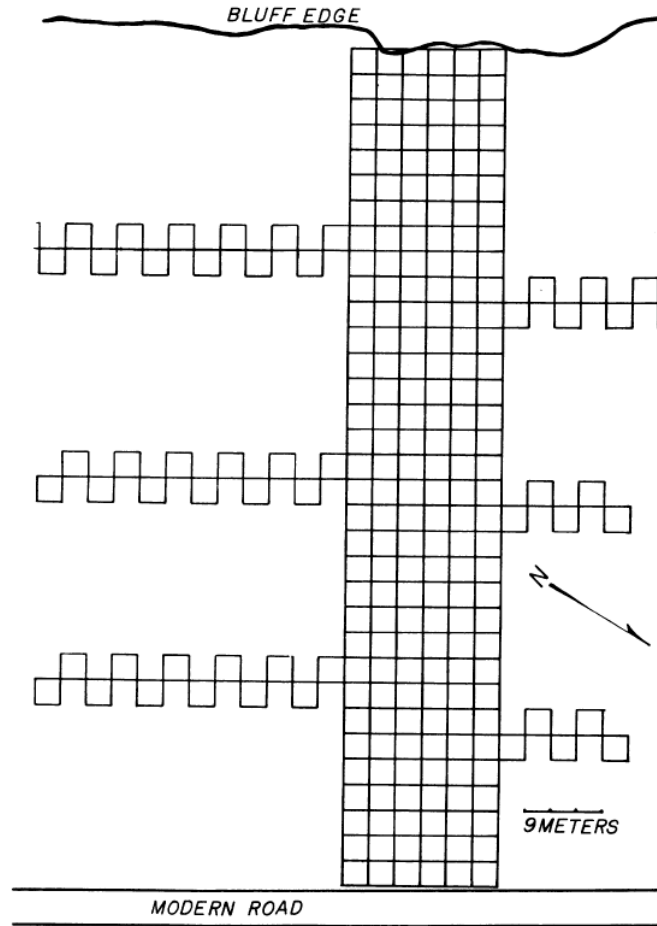


Figure 15. Plan of 3X3 m collection units at site Ccurimachay (from Rick 1976).

John W. Rick (1976) conducted a spatial analysis study at the site of Ccurimachay in Peru to find out if there was a pattern to the surface artifacts found along a slope. He looked at the distribution of three categories of artifacts: bones, lithics, and ceramics. Plotting a total of 252, 3 x 3 meter units horizontally and vertically along the slope (Figure 15), Rick measured each unit's individual slope degrees, the absolute frequencies of each artifact type, and the average weight for each artifact type. Then, using the measurements stated above for each of the three categories of artifacts, he performed statistical analyses to determine relationships between the data across the slope.

Rick found that the strongest correlation was a negative relationship between the average weight of each artifact group and the degree of slope angle: when the gradient of the slope increased, the average weight for each group of artifacts decreased and vice versa. Lithic weight tended to show the strongest negative correlation with regards to slope gradient, while bone was least correlated – ceramic weights were between those of lithics and bone. The distribution of artifacts also differed amongst each other in regards to their placement on the slope as is seen in Figure 16.

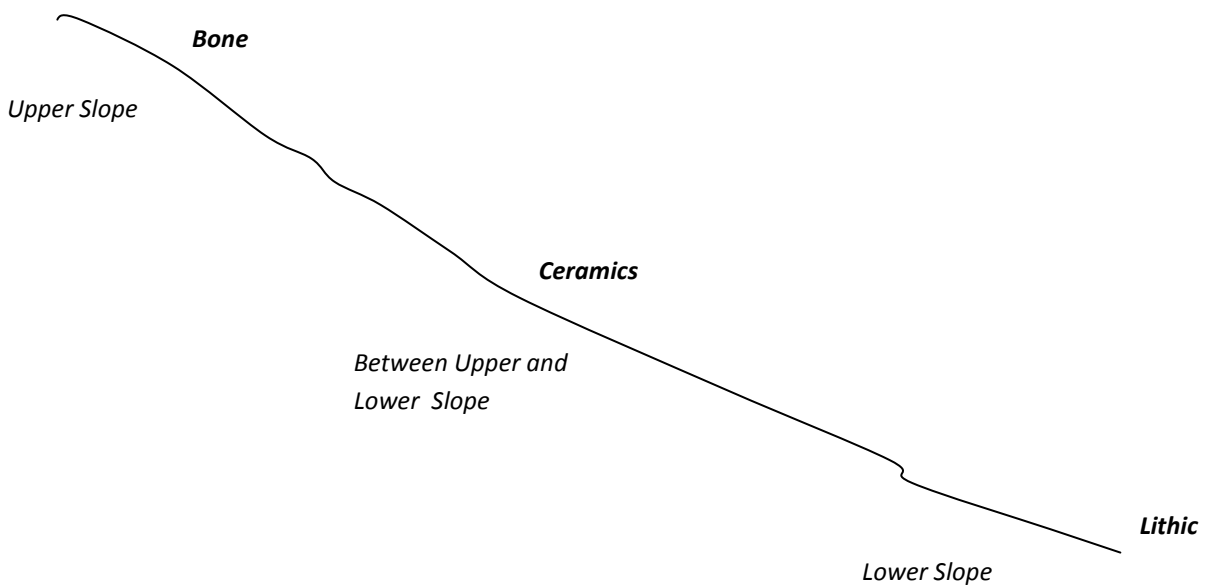


Figure 16. Distribution of artifacts on slope (adopted from Rick 1976).

Rick attributed the different location of the three categories of artifacts to what he referred to as the “critical slope angle” (Rick 1976). The critical slope angle, sometimes referred to as the angle of repose, is the angle at which an object begins to move down the slope or the angle at which a moving object stops or starts to decline in its movement. This can be thought of in terms of the balance between resisting force and driving force in that the critical angle is the point/angle, and which the resisting force overcomes the driving force. If an artifact is on a slope that exceeds its critical slope angle, this results in downward movement. According to Rick’s study, heavier objects tend to have smaller critical angles while lighter objects will start to move at higher slope angles (Rick 1976). Therefore, artifacts that are lighter, it is assumed, will better represent the area where the material originated.

Unfortunately, the data available at this time from the Pirque Alto does not include this information on the size, shape, or weight of the artifacts found during the 2005 surface survey collection. However, there is evidence of erosion found at the site such as the horizontal distribution of artifacts observed in 2005 right up to the edge of the terrace upon which the site is located and the noted eroded surfaces found along the edges of the site. Further evidence of erosion is the lack of a plowzone found within excavated units that were located closer to the site’s edges (this would include excavation blocks I and III).

Of course, the increase in ceramic densities in lower elevations of the Pirque Alto site could still be a reflection of subsurface cultural deposits on the basis that subsurface remains were found after the excavation of areas that showed high surface densities of ceramics. But because the whole site has not been excavated, it cannot be said for sure that there are no

significant cultural deposits below the surfaces with a smaller density of ceramics. Therefore, to say that erosion downslope may be the reason behind the relationship between surface ceramic densities and eastern coordinates along the general direction of the slope, could, given further analysis, be valid.

Differences Found Between Units With and Without Plowzones

The stronger correlation found when units were divided into two groups – those with plowzones and those without – supports the idea that different formation processes may have different effects on the relationship between surface and subsurface materials. A number of studies have been conducted that looks at how the agricultural activities of plowing affect archaeological sites, especially artifact distributions laterally and vertically. Through past research, it has been found that agricultural activities and their impacts on archaeological sites are varied. An important variable in cultivation is “the intensity with which the field is prepared for plowing” (Schiffer 1987) or the method of cultivation employed. For example, does cultivation involve plowing by hand or mechanical tillage using large machinery? The method of cultivation used affects the depth to which the archaeological record may be disturbed. According to Michael Schiffer (1987), in heavily farmed areas of the U.S., tractors are commonly used to pull plows which reach a depth of 30 cm below the surface. Farming in the Parotani valley region today is mostly done by hand with a hoe of some sort; very seldom is heavy farming machinery used for the tillage of soil (Blouet and Blouet 1997). In those excavated areas that were not significantly affected by erosion, the plowzone layer at the site of Pirque Alto measured around 10 cm below the surface (McAndrews 2007), rather than the 30 cm assigned to mechanical plowing, and therefore having less of an impact on the archaeological record.

Naturally, the process of plowing mixes up the stratigraphy of the archaeological record and therefore will destroy any chronological sequence that exists within a given depth. This would account for the mixed temporal periods found within the first and possibly second levels of excavation and could possibly affect the temporal associations interpreted from diagnostic surface remains, depending on the depths at which cultural deposits are spaced.

Studies have been conducted that examine how materials are distributed after plowing and have found a general trend in the size grading of materials (Lewarch and O'Brien 1981 ; Schiffer 1987). For example, Dennis E. Lewarch and Michael J. O'Brien generated and tested a series of propositions which accounted for artifact distribution in the plowzone. They used a variety of artifact density patterns which were subjected to different rates of disk plowing. Lewarch and O'Brien did a comparison of pre- and post-tillage surface frequencies of three artifact size classes. This comparison was then used this comparison to evaluate recovery of initial population, change in relative proportions of each size class, and amount of pattern dispersion. From their results Lewarch and O'Brien were able to identify a number of factors that had an effect on the structure of surface assemblages. These factors included direction and number of equipment (mechanical plow) passes; size, shape, artifact density, and structural complexity of the pattern, and frequencies and relative proportions of different size classes of artifacts. In terms of size classes, it was found that larger artifacts tended to have a higher percentage of recovery than smaller artifacts, illustrating the size-grading component of plowing processes. This introduces a bias towards larger artifacts on surfaces that have been plowed.

The cultural process of plowing does alter the relationship between surface and subsurface artifact densities, and therefore, can be distinguished from other areas of a site that have not been affected by agricultural methods. This would explain the difference seen in the

results when units were separated out into those containing plowzones and those that did not. The units containing plowzones tend not to display any significant relationship and it could be said that it is because of the mixing of the materials. Those without, especially when comparing surface with average subsurface densities, now reflect a relationship, although one in which as surface materials increase, subsurface materials tend to decrease. It is important to note that these units without plowzones are located towards the edges of the site and have been eroded. Therefore, this relationship could be the result of the eroding away of a cultural deposit in which more cultural materials may be found at the surface than subsurface.

Comparison of Surface and Subsurface Ceramic Densities

The results from the correlation and regression analyses of the surface and subsurface artifact densities collected from four of the five blocks excavated at Pirque Alto illustrates that the surface ceramic densities do not reflect the densities from the subsurface, whether it was average subsurface densities, or just those within level one. Even when the two highest and two lowest point values were taken out, thus removing some of the more dramatic outliers, no relationship appeared between these two variables. The conclusion would therefore have to be that the surface does not reflect subsurface cultural deposits. But if this were true how was it that the areas of the site found to contain the highest concentration of surface ceramics from the 2005 survey were found to contain significant cultural deposits subsurface? Another process that may have played a role in the outcome of this study are those that concern the process of archaeology, mainly data collection and excavation methods. As is pointed out by Michael Schiffer, the processes involved when doing archaeology are often overlooked when assessing the data and the interpretations that stem from it (Schiffer 1987). Some of the potential biases that may have affected the data used here in the comparison of surface and subsurface ceramic

densities include sample size, unit and level dimensions, documentation, collection methods, and the materials collected. It is important to note that the excavations conducted at Pirque Alto were not done with this study in mind and therefore was not carried out as such. The research questions that are the basis of any excavation automatically introduce a bias. It is illustrated below just how the methodology established to accomplish the goals of a research project limit the types of analyses possible and the inferences that can be validly argued.

The method of collection employed in the 2005 and 2007 field seasons at Pirque Alto included the collection of all ceramics that were larger than a quarter. During the 2007 excavations the method of collection included the collection of all ceramics larger than a 5mm wire mesh screen, but only those ceramics larger than 24 mm were to be kept. Looking at the field notes used for this analysis, there was not always separate counts for ceramics that were kept (greater than 24 mm in size) and those that were not. For some excavated levels, only one number was given for ceramics, making it uncertain as to whether this number included all ceramics that were screened or only those greater than 24 mm in size. There is no doubt that this would have a big impact on the resulting data to be compared against the 2005 surface ceramic densities since there tends to be more smaller sherd fragments than larger ones. This is even evident in the artifact counts from the field notes when the ceramics kept are compared to those that were not. In addition, because of the size-grade employed in the surface survey, the method of using the distributions of artifacts based on size as an indication of downslope processes may not be as informative.

The excavated depth of individual levels from the 2007 excavations may have also impacted the results. The excavations done in 2007 were to be done in arbitrary 10 cm levels, although this was not always the case. When calculating the ceramic densities per m³ it was

found that depths for level one alone varied from 1 cm to 15 cm. The ceramic density of a level excavated at a depth of 1cm would likely be different, and less accurate if a comparison was to be made between level one for each unit, than that same excavated down to 15cm. Although, if a level ran into part of a cultural deposit with a higher density of ceramics it could also cause a significant change in ceramic density. A better way to correct for this would have been to compare ceramic densities by natural stratum across the site, thus eliminating the possibility of coming into contact with a cultural deposit at different depths within a level.

The goal of the 2005 total surface survey collection was to allow for a detailed spatial analysis of cultural components represented at Pirque Alto through surface materials (McAndrews, Rivera, and Jaimes 2006) and investigate the influence of the Tiwanaku culture in the area through the cultural remains present at the site (Green 2007). This produced data that included ceramic densities per 5x5 meter unit across the total site area. Field work done during 2007 involved the excavation of a total of 97 m² in five different blocks. These excavated blocks included units of various sizes, including 1 x 1, 2 x 1, and 2 x 2 meter units (McAndrews 2007). The excavations from 2007 cover a small area of the total site and were located in areas in which high densities of artifacts were found at the surface in 2005. Thus, the comparison between surface and subsurface ceramic densities in this study is at a smaller scale within an area that, at a larger scale, produced a denser concentration of material remains. To answer whether or not the cultural deposits excavated in 2007 were truly reflected by a high density of surface ceramics, additional excavations would have to be done in areas outside that area where densities were shown to be lower.

In addition, the difference in unit collection sizes has shown to produce a problem in the analysis of surface and subsurface materials. As was discussed in the methodology, to account

for the difference in sizes, the 5x5 m unit ceramic densities were divided by 25 m² to get a ceramic density per m². Some of the excavation blocks, however, were located within the same 25 m² unit. This would mean that I would be comparing different subsurface ceramic densities to the same surface ceramic density (see Fig.17), and may not see the same relationship as would be the case if the surface survey collections were done using 1 x 1 meter units.

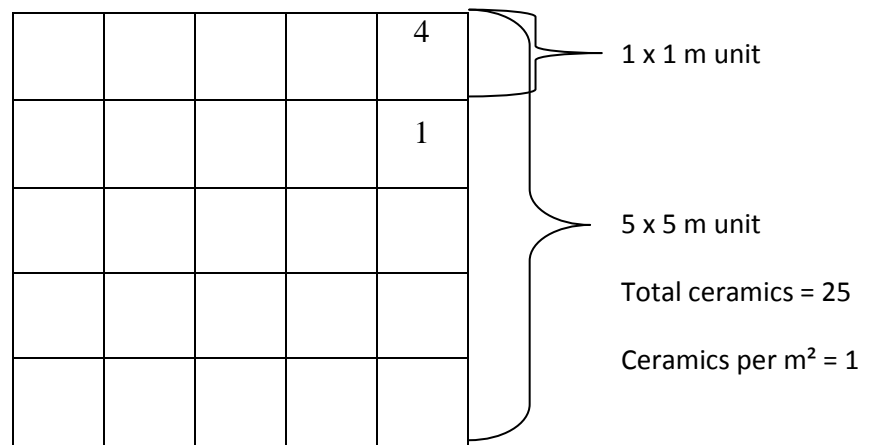


Figure 17. Difference in sample sizes.

It is possible that any combination of these biases may have altered the data significantly in such a way so that the relationship between surface and subsurface materials was non-existent. To correct for the many biases that tend to enter through the collection or analysis of data and therefore become evident in interpretations made it should at least be noted where these biases may have come from and how they may have altered the results by a detailed record of the process of applying archaeology.

CONCLUSION

It is important to note that the excavations conducted at Pirque Alto were not done with this study in mind (that is to determine whether surface and subsurface ceramic densities reflect active formation processes and how these processes have affected the interpretations to be made from surface and subsurface evidence) and therefore was not carried out as such. If such were the case, a surface collection using smaller unit sizes would have been used to provide for a higher resolution of surface ceramic densities to match that of the excavated units. Also, ceramics would have been size-graded to account for any sorting that would appear as a result of different formation processes. The depths of units, in order to be consistent across the site, should have been measured by natural stratums rather than by arbitrary levels. And as stated above, more excavations would be carried across the whole site rather than just within the area found to contain.

After noting the biases that may have impacted the data used in this analysis, some evidence does point to a possible reflection of the processes of erosion and agriculture (via plowing) through the comparison of surface and subsurface materials. Although further analyses would need to be done before a solid conclusion could be developed, it is felt that the analysis illustrated above does suggest that different formation processes do create different relationships between surface and subsurface remains and therefore could provide additional insight as to how formation processes may impact the archaeological record.

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APPENDIX A

2005 Surface Survey

NORTE	ESTE	SumOfQuantity
235	380	6
240	370	29
240	365	7
240	375	22
240	380	14
240	385	4
245	355	24
245	360	14
245	365	16
245	370	13
245	375	42
245	380	33
245	385	38
245	390	5
245	395	1
250	350	81
250	355	45
250	360	42
250	365	22
250	370	38
250	385	20
250	390	25
250	395	2
255	340	57
255	345	40
255	350	40
255	355	79
255	360	69
255	365	30
255	370	48
255	375	12
255	380	31
255	385	6
255	390	2
255	395	3
260	305	10
260	310	6

260	315	34
260	320	20
260	325	60
260	330	36
260	335	72
260	340	71
260	345	45
260	350	130
260	355	121
260	360	14
260	365	44
260	370	28
260	375	60
260	380	46
260	385	3
260	395	4
265	295	12
265	300	17
265	305	17
265	310	28
265	315	45
265	320	49
265	325	25
265	330	42
265	335	35
265	345	60
265	350	105
265	355	127
265	360	93
265	365	60
265	370	50
265	375	56
265	380	20
265	385	11
265	390	4
265	395	3
270	295	7
270	300	6
270	305	10
270	310	14
270	315	28

270	320	17
270	325	35
270	330	23
270	335	18
270	340	51
270	345	64
270	350	121
270	355	89
270	360	91
270	365	31
270	370	5
270	375	10
270	380	37
270	385	23
270	390	28
270	395	15
270	400	17
275	295	8
275	300	5
275	305	8
275	310	5
275	315	29
275	320	5
275	325	26
275	330	27
275	335	12
275	340	78
275	345	6
275	350	4
275	355	6
275	360	3
275	365	35
275	370	127
275	375	59
275	380	46
275	385	26
275	390	19
275	395	22
275	400	16
280	295	7
280	305	6

280	310	12
280	315	11
280	320	25
280	325	8
280	330	14
280	335	4
280	340	12
280	345	32
280	350	34
280	355	36
280	360	14
280	365	6
280	370	61
280	375	35
280	380	59
280	385	75
280	390	36
280	395	27
280	400	21
285	295	7
285	300	12
285	305	3
285	310	3
285	315	12
285	320	22
285	325	9
285	330	32
285	335	15
285	340	98
285	345	50
285	350	16
285	355	31
285	360	36
285	365	38
285	370	23
285	375	11
285	380	32
285	385	9
285	390	13
285	395	20
285	400	80

285	405	25
290	290	7
290	295	8
290	300	32
290	305	24
290	310	28
290	315	54
290	320	44
290	325	46
290	330	50
290	335	63
290	340	105
290	345	42
290	350	39
290	355	8
290	360	16
290	365	56
290	370	59
290	375	84
290	380	30
290	385	21
290	390	18
290	395	83
290	400	89
295	290	20
295	295	5
295	300	16
295	305	17
295	310	22
295	315	34
295	320	39
295	325	32
295	330	53
295	335	56
295	340	80
295	345	17
295	350	19
295	355	9
295	360	28
295	365	42
295	370	56

295	375	41
295	380	42
295	385	37
295	395	95
295	400	42
300	375	11
300	290	10
300	300	34
300	305	32
300	310	24
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300	320	48
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300	340	84
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300	385	37
300	390	109
300	395	54
300	400	123
305	290	3
305	295	7
305	300	22
305	305	31
305	310	54
305	315	31
305	320	44
305	325	25
305	330	42
305	335	48
305	340	1
305	345	17
305	350	22
305	355	27

305	360	17
305	365	15
305	370	28
305	375	10
305	380	57
305	385	52
305	390	114
305	395	113
310	290	2
310	295	6
310	300	29
310	305	30
310	310	45
310	315	57
310	320	45
310	325	33
310	330	16
310	335	26
310	340	63
310	345	45
310	350	41
310	355	36
310	360	27
310	365	22
310	370	16
310	375	21
310	380	68
310	385	42
310	390	98
315	290	5
315	295	7
315	300	8
315	305	27
315	310	36
315	315	29
315	320	32
315	325	26
315	330	17
315	335	53
315	340	35
315	345	31

315	350	23
315	355	34
315	360	30
315	365	26
315	370	25
315	375	51
315	380	39
315	385	67
315	390	78
320	290	3
320	295	1
320	300	27
320	305	24
320	310	17
320	315	14
320	320	23
320	325	43
320	330	59
320	335	69
320	340	39
320	350	11
320	355	15
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320	370	17
320	375	21
320	380	37
320	385	55
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325	320	29
325	325	25
325	330	45
325	335	61
325	340	30
325	345	56
325	350	9

325	355	10
325	360	33
325	365	58
325	370	53
325	375	55
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330	380	52
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335	310	33
335	315	51
335	320	35
335	325	28
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335	340	15
335	345	27
335	350	21
335	355	46
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335	365	39

335	370	48
335	375	37
335	380	42
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340	295	19
340	300	29
340	305	37
340	310	25
340	315	21
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340	340	11
340	345	9
340	350	36
340	355	51
345	290	12
345	295	16
345	300	55
345	305	48
345	310	9
345	315	11
345	320	17
345	325	2
345	330	26
345	335	13
345	340	7
345	345	9
350	330	13

APPENDIX B

2007 Excavation Unit Size Measurements

BLOCK	UNIT	SIZE (m)	AREA (m ²)	AREA (cm ²)	LEVEL	SW (cm)	NW (cm)	NE (cm)	SE (cm)	CENTER (cm)	AVG DEPTH (m)	Volume (m ³)
I	N 331 E 339	1 X 1	1	100	1	10.00	14.40	12.60	11.60	9.60	0.116	0.116
I	N 331 E 339	1 X 1	1	100	2	7.60	2.70	2.00	5.90	7.80	0.052	0.052
I	N 331 E 339	1 X 1	1	100	3	8.30	10.10	7.40	8.60	6.50	0.082	0.082
I	N 331 E 339	1 X 1	1	100	4	9.90	15.20	11.10	3.50	11.40	0.102	0.102
I	N 332 E 339	1 X 1	1	100	1	11.80	11.00	10.00	14.40	9.30	0.113	0.113
I	N 332 E 339	1 X 1	1	100	2	10.80	9.00	12.00	9.80	12.40	0.108	0.108
I	N 332 E 339	1 X 1	1	100	3	10.40	9.10	9.10	9.50	8.00	0.092	0.092
I	N 332 E 339	1 X 1	1	100	4	9.50	9.20	10.90		9.30	0.097	0.097
II	N 286 E 367	1 X 1	1	100	1	9.50	8.50	9.50	8.00	11.00	0.093	0.093
II	N 286 E 367	1 X 1	1	100	2	9.50	10.50	9.50	9.50	9.00	0.096	0.096
II	N 286 E 367	1 X 1	1	100	3	9.40	9.00	9.40	8.70	10.30	0.094	0.094
II	N 286 E 367	1 X 1	1	100	4	10.10	10.00	10.50	9.00	9.20	0.098	0.098
II	N 286 E 367	1 X 1	1	100	5	13.00	12.50	12.10	11.80	9.50	0.118	0.118
III	N 284 E 378	1 X 2	2	200	1	1.00	1.00	2.00	1.00	2.50	0.015	0.030
III	N 284 E 378	1 X 2	2	200	2	8.80	13.00	12.50	8.00	12.00	0.109	0.218
III	N 284 E 378	1 X 2	2	200	3	10.00	6.00	6.50	11.00	9.00	0.085	0.170
III	N 284 E 378	1 X 2	2	200	4	10.50	7.00	7.50	7.00	8.50	0.081	0.162
III	N 284 E 378	1 X 2	2	200	5	6.50	10.00	13.00	12.00	10.50	0.104	0.208
III	N 285 E 378	1 X 1	1	100	1	0.50	1.00	0.00	0.50	1.00	0.006	0.006
III	N 285 E 378	1 X 1	1	100	2	11.00	12.00	9.00	10.50	10.00	0.105	0.105
III	N 285 E 378	1 X 1	1	100	3	10.50	11.00	7.50	10.00	12.00	0.102	0.102
III	N 285 E 378	1 X 1	1	100	4	13.50	13.00	11.50	19.50	17.00	0.149	0.149
III	N 284, 284, 285 E 378, 379, 378	three 1 X 1's	3	300	5/6	0.00	1.00	1.50	0.50	1.50	0.009	0.027
III	N 284, 284, 285 E 378, 379, 378	three 1 X 1's	3	300	7	8.00	10.00	10.00	5.50	5.50	0.078	0.234
III	N 284, 284, 285 E 378, 379, 378	three 1 X 1's	3	300	8	0.50	9.00	3.50	4.50	8.50	0.052	0.156
V	N 283 E 341	2 X 2	4	400	1	13.50	11.00	10.00	12.50	14.50	0.123	0.492
V	N 283 E 341	2 X 2	4	400	2	5.40	7.30		4.20	6.20	0.058	0.232
V	N 283 E 343	1 X 1	1	100	1	8.50	8.50	10.50	11.00	10.00	0.097	0.097
V	N 283 E 344	2 X 2	4	400	1	8.50	9.40	10.20	10.50	10.80	0.099	0.396
V	N 284 E 343	1 X 1	1	100	1	10.00	11.00	10.50	10.00	10.50	0.104	0.104
V	N 284 E 343	1 X 1	1	100	2	8.50	10.00	9.00	8.00	9.00	0.089	0.089
V	N 285 E 341	2 X 2	4	400	1	9.50	9.50	9.50	9.50	11.00	0.098	0.392
V	N 285 E 343	1 X 1	1	100	1	10.50	12.50	9.00	8.50	9.00	0.099	0.099
V	N 285 E 343	1 X 1	1	100	2	15.00	12.50	11.00	7.50	10.00	0.112	0.112
V	N 285 E 344	2 X 2	4	400	1	10.00	9.50	9.00	9.50	9.50	0.095	0.380
V	N 285 E 344	2 X 2	4	400	2	10.00	9.00	12.00	10.00	11.50	0.105	0.420
V	N 285 E 346	2 X 2	4	400	1	12.50	15.50	10.50	15.00	11.50	0.130	0.520
V	N 285 E 346	2 X 2	4	400	2	12.00	7.50	10.00	1.50	9.00	0.080	0.320
V	N 286 E 343	1 X 1	1	100	1	10.50	11.50	10.00	7.00	12.00	0.102	0.102
V	N 286 E 343	1 X 1	1	100	2	14.50	4.00	10.50	1.00	10.50	0.081	0.081
V	N 287 E 341	2 X 2	4	400	1	10.00	9.50	10.00	8.50	10.00	0.096	0.384
V	N 287 E 343	1 X 1	1	100	1	9.50	9.50	9.00	10.00	10.00	0.096	0.096
V	N 287 E 343	1 X 1	1	100	2	3.00	8.50	9.50	10.50	9.00	0.081	0.081
V	N 287 E 344	2 X 2	4	400	1	10.00	10.00	9.00	13.50	9.50	0.104	0.416
V	N 287 E 344	2 X 2	4	400	2	9.50	9.50	5.00	4.00	11.00	0.078	0.312
V	N 287 E 346	2 X 2	4	400	1	10.00	10.50	10.00	10.00	9.00	0.099	0.396
V	N 287 E 346	2 X 2	4	400	2	7.00	5.00	3.00	3.50	5.00	0.047	0.188
V	N 288 E 343	1 X 1	1	100	1	7.00	9.00	8.00	8.50	8.50	0.082	0.082
V	N 288 E 343	1 X 1	1	100	2	11.00	11.00	10.50	9.50	9.50	0.103	0.103
V	N 289 E 342	1 X 2	2	200	1	14.10	15.00	12.50	11.30	10.00	0.126	0.252
V	N 289 E 342	1 X 2	2	200	2	8.90	12.50	9.30	10.70	11.50	0.106	0.212
V	N 289 E 342	1 X 2	2	200	3	8.80	7.90	9.40	11.30	9.10	0.093	0.186
V	N 289 E 343	1 X 1	1	100	1	10.00	10.00	9.50	8.50	12.00	0.100	0.100
V	N 289 E 343	1 X 1	1	100	2	2.00	0.00	9.50	10.00	10.00	0.063	0.063
V	N 289 E 344	2 X 2	4	400	1	14.00	15.00	13.00	9.00	13.00	0.128	0.512
V	N 289 E 344	2 X 2	4	400	2	10.50	16.00	7.00	11.50	3.00	0.096	0.384
V	N 289 E 344	2 X 2	4	400	3	6.50	5.00	8.00	8.50	3.00	0.062	0.248
V	N 289 E 346	2 X 2	4	400	1	10.00	7.50	10.00	9.50	8.50	0.091	0.364
V	N 289 E 346	2 X 2	4	400	2	10.00	12.00	7.00	9.50	4.00	0.085	0.340
V	N 290 E 343	1 X 1	1	100	1	8.00	10.00	8.50	8.00	11.50	0.092	0.092
V	N 290 E 343	1 X 1	1	100	2	0.00	2.50	10.50	10.50	10.00	0.067	0.067
V	N 290 E 343	1 X 1	1	100	3			10.00	12.00	12.50	0.115	0.115
V	N 291 E 342	1 X 2	2	200	1	14.50	12.50	13.00	11.00	10.00	0.122	0.244
V	N 291 E 342	1 X 2	2	200	2	12.00	10.00	10.50	11.50	13.50	0.115	0.230
V	N 291 E 342	1 X 2	2	200	3	9.70	10.60	9.50	12.00	12.70	0.109	0.218
V	N 291 E 343	1 X 1	1	100	1	14.30	14.00	11.00	8.50	15.50	0.127	0.127
V	N 291 E 343	1 X 1	1	100	2	1.00	3.00	11.00	11.00	13.50	0.079	0.079
V	N 291 E 344	2 X 2	4	400	1	10.00	9.00	8.50	8.00	13.00	0.097	0.388
V	N 291 E 344	2 X 2	4	400	2	9.00	10.50	3.50	10.00	9.50	0.085	0.340
V	N 291 E 346	2 X 2	4	400	1	10.50	10.50	9.00	8.00	10.00	0.096	0.384
V	N 291 E 346	2 X 2	4	400	2	9.10	8.70	11.00	9.60	10.00	0.097	0.388
V	N 292 E 343	1 X 1	1	100	1	13.10	9.50	12.10	10.90	16.90	0.125	0.125
V	N 292 E 343	1 X 1	1	100	2	3.40	5.50	8.50	5.10	13.70	0.072	0.072
V	N 293 E 343	1 X 1	1	100	1	16.40	13.00	9.60	9.60	13.50	0.124	0.124
V	N 293 E 343	1 X 1	1	100	2	8.60	9.30	9.70	12.50	7.10	0.094	0.094
V	N 293 E 344	2 X 2	4	400	1	11.10	8.20	11.70	14.20	9.20	0.109	0.436
V	N 293 E 344	2 X 2	4	400	2	12.00	14.60	11.10	7.80	7.80	0.107	0.428
V	N 293 E 346	2 X 2	4	400	1	13.50	11.00	11.50	9.50	11.00	0.113	0.452
V	N 294 E 343	1 X 1	1	100	1	11.10	9.70	9.50	6.40	8.10	0.090	0.090
V	N 294 E 343	1 X 1	1	100	2	9.00	11.10	9.90	11.20	6.00	0.094	0.094

APPENDIX C

Ceramic Densities per Level Excavated and Average Density per Unit and Surface

BLOCK	UNIT	NORTE	ESTE	SURF (m ²)	LEVEL 1 (m ³)	LEVEL 2 (m ³)	LEVEL 3 (m ³)	LEVEL 4 (m ³)	LEVEL 5 (m ³)	total	Avg Density (m ³)
I	N 331 E 339	331	339	2.36	4034	4481	988	696		10199	2550
I	N 332 E 339	332	339	2.36	1752	546	750	701		3750	937
II	N 286 E 367	286	367	1.52	5398	3854	1032	684	220	11188	2238
III	N 284 E 378	284	378	1.40	7167	885	653	537		9242	2310
III	N 285 E 378	285	378	0.44	2333	714	441	436		3925	981
V	N 283 E 341	283	341	0.48	585	1017				1603	801
V	N 283 E 343	283	343	0.48	557					557	557
V	N 283 E 344	283	344	0.88	384					384	384
V	N 284 E 343	284	343	0.48	615	348				964	482
V	N 285 E 341	285	341	1.28	579					579	579
V	N 285 E 343	285	343	1.28	960	348				1308	654
V	N 285 E 344	285	344	2.96	266	319				585	292
V	N 285 E 346	285	346	2.00	390	225				615	308
V	N 286 E 343	286	343	3.92	569	531				1099	550
V	N 287 E 341	287	341	3.92	797					797	797
V	N 287 E 343	287	343	3.92	875	198				1073	536
V	N 287 E 344	287	344	2.96	216	74				290	145
V	N 287 E 346	287	346	2.00	495	170				665	333
V	N 289 E 342	289	342	4.06	770	561	522			1853	618
V	N 289 E 344	289	344	2.95	350	146	310			805	268
V	N 289 E 346	289	346	1.84	613	179				792	396
V	N 290 E 343	290	343	4.20	1087	851	87			2025	675
V	N 291 E 342	291	342	4.20	828	543	931			2302	767
V	N 291 E 343	291	343	4.20	1346	89				1435	718
V	N 291 E 344	291	344	2.94	606	547				1153	576
V	N 291 E 346	291	346	1.68	297	147				444	222
V	N 292 E 343	292	343	4.20	1080	444				1524	762
V	N 293 E 343	293	343	4.20	927	585				1513	756
V	N 294 E 343	294	343	4.20	1056	734				1790	895
V	N 288 E 343	288	343	3.92	7024	301				7325	3663
V	N 289 E 343	289	343	3.92	1510	540				2050	1025
V	N 293 E 344	293	344	2.94	1025	526				1551	775
V	N 293 E 346	293	346	1.68	347					347	347

