RECONSTRUCTING ANCIENT TECHNOLOGY – THE ANALYSIS OF PRE-COLUMBIAN ECUADORIAN TEXTILES

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ABSTRACT

Ancient civilizations of South America constructed textiles that reflected their culture. In ancient Ecuador, the people of the Guangala cultural phase (500 BC – AD 800) left no recorded history. Archaeologists have uncovered pottery sherds with impressions of textiles. With high resolution microscopy and comparison to modern Ecuadorian textiles, scientists can reconstruct the ancient textile structure. Upon additional analysis it is also possible to reconstruct aspects of the Guangala culture, economy, and technology.

INTRODUCTION

Archaeology, as a science, merges the physical and experimental sciences with history. Archaeologists unearth and examine ancient artifacts to rediscover their functions and cultural implications. These remains can range from small pottery sherds to entire cities. Upon careful analysis of artifacts, scientists translate their observations and data into reconstructions of customs, values, and technology – essentially recreating an entire culture. Archaeology is dedicated to resurrecting unknown ancient peoples and making their culture accessible to modern civilizations.

Spanish colonial documents offer a glimpse of pre-conquest societies of the Andes Region, which include those of Ecuador. In these societies, textiles were worth more than gold. The social status of a person could be determined by the clothes he or she possessed. Extremely wealthy people would have worn finely woven garments with vivid colors and intricate designs [1]. The creation of complex textiles would have taken several months of work by numerous people, mostly women. The wealthy would often bury textiles with the remains of their loved ones [2]. Based on the importance of these materials in the economic, political and social realms of the culture, the study of textiles offers archaeologists insight into all of these aspects of ancient societies.

Archaeologists ideally study actual textiles for reconstructions. Unfortunately, textiles are rarely preserved. In fact, on the coast of Ecuador, no textiles have ever been recovered due to climatic conditions which hinder preservation of these delicate materials. However, archaeologists have discovered sherds (pieces of pottery) with textile impressions [3]. Such impressions are most commonly found inside hollow figurines, on the bottoms of pots, and around curved surfaces [4]. These impressions are the primary evidence of the textile structure of ancient societies of the coast of Ecuador. Casts taken from textile impressions on such artifacts

have been analyzed to reveal information about the textiles' characteristics, such as warp, weft, weave type, spin, fiber type, thread diameter, thread density and regularity [4].

The Guangala phase, one of the late Pre-Columbian cultures of the coast of Ecuador, is one example of these ancient societies (500 BC – AD 800) [2]. Archaeologists and students from Drew University have been excavating Guangala sites (Fig. 1) in the El Azúcar Valley within the coastal region, where they have uncovered artifacts with textile impressions. The goal of this project is to refine the methods for analysis of textile impressions and apply them to five of the artifacts recovered from the El Azúcar Valley in order to gain insight into the Guangala culture.

Figure 1: The Guangala Area

BACKGROUND

The Guangala culture existed on the southwest Ecuadorian coast for nearly a full millennium, and yet very little is known about it. There are no written records of their culture. Based on the artifacts recovered, archaeologists have evidence that textiles were being produced and used at Guangala settlements [2]. Textile impressions offer the only detail of the actual textiles produced.

Figure 2: An example of a figure with possible textile impressions.

Textile impressions are left behind during the production of ceramics. Artisans formed ceramic vessels on pieces of textiles, which served as a non-adhesive surface. Impressions of the textiles were then left on the bases of the vessels. In other cases, the textiles prevented the clay from sticking to molds used to create ceramic figurines (Fig. 2), leaving behind impressions on the interior surfaces. Modern potters also often store wet clay in textile bags which can leave textile impressions on unused clay [5]. During excavations, clay lumps have been found with impressions, suggesting that Guangala potters may have followed the same custom [2].

All of the current evidence suggests that the Guangala culture was a domestically-centered one, with small and dispersed communities lacking social or political hierarchy [6]. However, there is evidence that the Guangala traded with cultures as far north as Mexico and into the southern part of the South American coast as well. Based on colonial period Ecuadorian coastal trade and evidence of textile production at the Guangala sites, textiles could have been among the trade items.

TEXTILES

Pre-Columbian societies of the Andes placed a high value on quality textiles. The production and use of textiles appears to have been ubiquitous. Unfortunately, because of the extremely hot and moist climate, few textiles remain. Therefore, for this region, information about textiles must be deduced from a combination of indirect sources such as weaving implements and textile impressions.

Although no textiles have been found during archeological digs of the Guangala region, spindle whorls, other weaving instruments and cotton seeds have been found at all sites [2]. Based on accounts made by the Spanish upon landing in the area and on analysis of the weaving artifacts, it is thought that the textiles were woven mainly on two-bar vertical looms, also known as heddle looms, which hang in front of the weaver and keep the warps taught by affixing them to two vertical bars. Such looms are still used in that area today in combination with the Spanish shuttle loom, introduced during the colonial era [7]. Information on the structure of the textiles cannot be deduced from information on the production technology. Without actual textiles, impressions on ceramics are the only source for weave structure.

Figure 3: Cotton Saddlebag

Figure 4: Cabuya Purse

Figure 5: Alpaca Poncho

Only one study has attempted to analyze impressions for the Guangala phase, and this analysis suggests that the vast majority of Guangala textiles were simple plain weaves [4]. Other analysts have studied textiles from this time and have concluded that cotton fibers were primarily used on the coast [5], although the evidence for this is very weak. Indigenous cotton was domesticated in the region and is used today in modern textile production (Fig. 3). Alpaca wool imported from the highland plain, as well as local plant fibers such as cabuya, was also used in pre-Columbian and modern weaving (Figs. 4 and 5). Manufactured alpaca wool textiles may also have been available through trade with the Andean region [8].

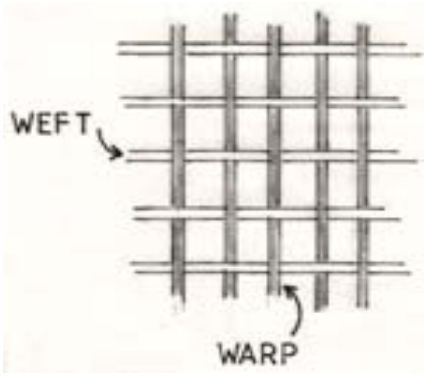

Figure 6: Warp and Weft

It is important in the analysis of textiles to understand the distinction between warp and weft (Fig. 6). The warp of a fabric refers to the tightly stretched, parallel vertical threads that are held in place by a loom. Before weaving begins, the warp is laid down as the foundation of the textile. The weft is the series of threads that are entwined through the fixed warp strands [2, 9].

Different techniques are used to manipulate the warp and the weft to create various types of weaves. In a plain weave, as in the majority of pre-Columbian Ecuadorian textiles, each weft is guided over and under the warp elements in an alternating over-one-under-one fashion. Simple weave is constructed with single, unpaired warp and weft threads [2, 9].

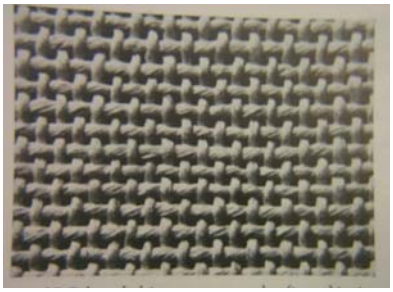

Figure 7: Balanced plain weave

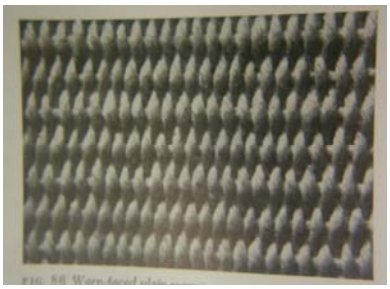

Figure 8: warp-faced

Figure 9: weft-faced

In addition to these characteristics, textiles are also balanced, warp-dominant, or weft-dominant. Balanced weave is characterized by a balance of warp and weft elements (threads) - both the warp and the weft are clearly visible and evenly spaced (Fig. 7). In warp-faced weave, the warp is more plainly visible, while weft-faced weave features the weft packed closely, hiding the warp (Figs. 8 and 9).

Weaves can be loose or compact, depending on the skill of the weaver, the design of a textile, and its intended use. Looser weaves have more spacing between elements, while compact weaves are pulled more tightly to eliminate spaces. It is important to note that the looseness of a weave may be affected by the amount of use a fabric has seen. With use, the threads tend to separate and stretch. Measurements for these characteristics are given in threads per centimeter in either direction [9].

Threads and weaving can be either regular or irregular. Regular weaving is characterized by an even, repeated weave pattern, using threads of similar sizes. Regular threads are spun evenly with uniform thickness throughout their lengths. Irregular textiles lack either one or both of these characteristics. The regularity and fineness of the textile affects its worth – threads of smaller diameter required more skill to weave and were more valuable. Both comparative regularities and fineness are often clearly visible in textile impressions [9]. With only a small area of the original textile visible in an impression, it can be difficult to determine its entire structure.

SAMPLES

Five artifacts, all drawn from excavations in the El Azúcar Valley of coastal Ecuador were analyzed in this study [2]. These five artifacts offered seven distinct textile impressions. Artifacts 1 and 3 are the most recent of the five pottery sherds and were created during the Late Guangala cultural phase (AD 500 to 800). Artifact 1 was recovered from the surface, in the remains of midden from a domestic occupation. It was originally thought that there was no evidence that a house once stood at this site. Similarly, Artifact 3 was found in surface midden

material. Both of these sherds have an impression on one face [2]. The uses of these artifacts were originally unknown.

Artifacts 2 and 4 are from the Middle Guangala cultural phase (AD 200 to 500). Like Artifact 1, Artifact 2 is from a site that preserved only midden and was found among the remains of daily domestic activities. This sherd appears to be part of a thick plate which once sat on a pedestal base. Two decorative ridges characterize this sherd, which appears to be part of the outer rim of the bowl. Two different textile impressions are found in the rough band between these ridges [2].

Artifact 4 was also found to be from the Middle Guangala cultural phase. It appears to be the face of a pottery figurine. This type of figurine was more difficult to create, since it had detailed sculpting and required a careful control of firing required to obtain the desired color. The textile imprint lies on the inside surface of the figurine [2].

Artifact 5 was the oldest of the five artifacts. This artifact is one of the most intriguing for two reasons. One, it does not appear to be a pottery sherd at all. Its shape is irregular, and although its surfaces are coarse, its edges do not show any apparent breakages that would indicate that it was once part of a larger pottery object. The second reason that this artifact is so interesting is that it is the only one with imprints on both sides. Additionally, the textile imprints on each side differ drastically in thread characteristics and weave pattern [2]. The use of this artifact was not immediately known.

The focus of the analysis of each artifact was on the textile impressions. Nevertheless, the observations on the artifacts themselves can contribute to an understanding of their possible functions and give further insight into the Guangala culture.

METHOD

Without the actual textiles to study and minimal knowledge of Guangala fabrics available, this study had to be carried out very differently from the normal archaeological textile analysis. Such analyses are carried out on actual textiles and can include detailed study of weave structures, designs, fibers, and dyes. Textile impressions offer a negative mold of textile weaves and depending on the depth and detail of the impression information on weave patterns, threads and fibers. The texture and grainy nature of the artifacts available for this study made it hard to isolate and follow weave patterns or individual fibers in the impression even under a dissecting microscope. Thus, the first portion of the method centered on creating detailed representations of the textile impressions, which were easier to analyze. Previous analyses have utilized dental impression material (vinyl polysiloxane) to make casts of textile impressions [3, 4]. These casts were thus positives of the original textiles and were also extremely detailed due to the nature of the dental material.

This study implemented some innovative procedures to aid in the analysis. Casts were made with forensic impression material in addition to the dental material. Most distinctively, a set of comparative molds and casts of modern textiles from Ecuador and the surrounding countries was analyzed. These experimental groups represented a variety of different weaves,

weaving techniques, and thread compositions which could be used for comparative analysis. Scanning Electron Microscopy was also part of the original plan of analysis. The most success was reached, however, using dissecting microscopes, which became the primary mode of magnification for this study. Under this magnification (0.7x and 10.5-45x) both individual threads and the overall pattern of the weave could be simultaneously viewed in great detail.

Another important decision in formulating our procedure was the quantitative and qualitative data which could be collected from the textile impressions and casts. Based on similar studies [4, 8] and the nature of our impressions, a standard set of characteristics were selected for analysis. The characteristics uniformly studied for each textile impression were: warp versus weft, type of weave, thread (element) diameter, number of threads per centimeter, and regularity – both for threads and overall weave. Where possible, hypotheses were made as to thread composition and quality of fabric.

Casts

Taking casts of the seven textile impressions to obtain positive images of the ancient textiles was essential to analysis. Crime scene investigation casting material (vinyl polysiloxane – low viscosity and light body) was used first on the artifacts. The impression material was loaded into a gun with a thin, long tip for making precise molds. The material hardened quickly, and its composition was conducive to shaping itself into the sherds' most detailed crevices. Multiple application techniques were used. After the first few molds retained air bubbles, the wet mold material was pressed to pick up the details of smaller grooves. However, this in turn produced thinner molds, which were too thin to retain a full impression. Also tried was a dental molding material (also vinyl polysiloxane – low viscosity and light body) that was more viscous than the CSI material. Each material seemed to have some advantages and disadvantages. For example, the duller flesh color of the CSI material made analysis easier than did the bright yellow color of the Dental material. In order to keep the material from running, the desired imprint areas were bordered with dental wax. Most importantly, the wax allowed for deeper molds which generated enough weight to fill the small grooves and crevices of the sherds without needing to apply pressure. In the end, a majority of the molds were of the thick, dental impression type.

Two molds were made of each experimental clay mold. One mold was cut into a smaller portion to mount on the stage of the SEM for surface boundary analysis, while the other was used for digital photography and dissecting microscope analysis. Unfortunately, both the CSI and dental materials left a noticeable residue on the artifacts, but the residue was fairly easily removed with gentle scrubbing and acetone.

In order to try to determine the type, pattern, and possible use of the textiles imprinted on the artifacts, experimental clay molds were made of fabrics from modern-day Ecuador (or similar pieces from neighboring South American countries) for comparison. The different experimental textiles used were an alpaca poncho, a cotton towel, a sheep wool bag, a cabuya purse, a cabuya coaster, a cotton saddlebag, and a panama hat (which was made from the pleated leaves of the toquilla palm). The impressions were prepared by pressing a small amount of wet clay into the fabric to pick up the textile's pattern and texture. Several clay impressions were made of each

experimental fabric in order to achieve a wide range of patterns. After drying overnight, the negative impressions were then fired in a kiln to expunge all the moisture and prevent softening of the clay.

Impressions were made of the clay molds with the two types of liquid impression materials used on the artifacts. The same overall method as on the sherds was used to obtain positive molds of our clay experimental pieces to compare weave styles.

Photography

Photographs were taken of the artifacts, experimental fabrics and all the molds for both documentation of the method and further analysis of the textile patterns. A camera with a magnifying lens was mounted over a translucent stage to create sharp and detailed pictures. In order to emphasize the patterns of the textile imprints, a fiber-optic illuminator with a bendable neck was used to cast shadows on an angle over the ridges of the textile impressions. The brightness and color contrast in some of the photographs were altered in Adobe Photoshop® to make the patterns more visible.

Microscope Analysis

The examination of the textile impressions was conducted largely through the use of the dissecting microscope. The purpose of the magnification was to allow a fiber-to-fiber analysis of the imprint to ensure a more comprehensive and precise analysis than could be afforded with the naked eye. The major aspects of the textiles impressions that were analyzed were: warp and weft; the specific type of weave, element width and elements per centimeter; and regularity of individual threads as well as in the overall weave.

The dissecting microscope was critical in making such an analysis. The positive textile impressions were placed underneath the dissecting scope which clarified the individual indentations of the weave and allowed for the recording of quantitative and qualitative data. Warp and weft could often be determined due to the relative straightness of the elements (warp is usually more linear because it is fastened to a loom and then the weft is woven around the warp fibers). For more complicated warp and weft patterns, other sources including textbooks and the experimental samples were consulted for identification. The separate elements (threads of the warp and weft) of the textile along with the number of elements present per centimeter were measured underneath the microscope using rulers and calipers. In some cases, information about the elements' width, in conjunction with a comparison to the experimental group fabrics, helped identify the type of thread. The textiles' weaves were deduced by comparing the magnified artifacts' impressions to those of the controls as well as to the images collected from other sources [9]. The dissecting microscope elucidated the differences in width along each fiber and so allowed for an analysis of the regularity and uniformity of the weave pattern. Knobs in the individual threads indicate an irregularly spun thread (and often a course fabric). Regularity in weave could also be determined by comparing the spacing between elements throughout the impression [9].

SEM was employed in an attempt to analyze the details of the impression. It was hoped that this detail would allow for the identification of fiber types used to construct each textile that had made an imprint. While the SEM did provide great surface detail, the "noise" of the dental/CSI material interfered with the ability to observe the actual impressions. Without actual fiber samples from the Guangalan textiles that made the artifacts' impressions, the images generated by the SEM proved largely inconclusive.

DATA AND RESULTS

Figure 10: Artifact 1 under the Dissecting Microscope
Field of View: 6 mm

The most conclusive results regarding Artifact 1 were obtained through a naked eye analysis of the artifact. The artifact was very thick, and looks more like a rock than a piece of pottery. Also, the clay used to make this artifact was very coarse, and contained several air pockets. When analyzed under the dissecting microscope, various mineral deposits were visible. The impression on the rock is irregular in that it is thicker in some places than in others, and it appears to have never been fired. Also, the site at which Artifact 1 was found was the bottom of a midden site, which was previously the site of a Guangala village. Fiber type was inconclusive. Though the analysis of Artifact 1 under the dissecting microscope was less conclusive than was hoped (Fig. 10), a quantitative summary of the artifact is summarized in Table 1-1 (Appendix B).

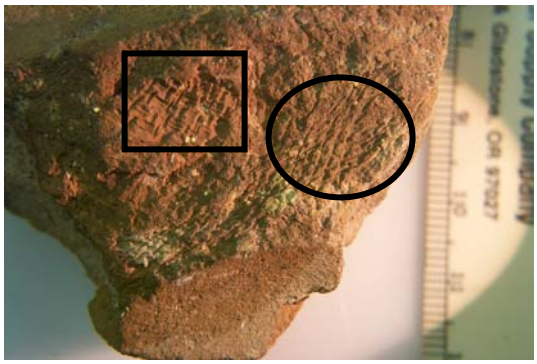

Figure 11: Artifact 2
Two types of textiles indicated by the square and the oval

A naked eye analysis of Artifact 2 reveals impressions of two distinct textiles (Fig. 11). Although the two patterns are very different, it is unclear whether they came from the same textile (which would have consisted of two different patterns) or from two separate textiles. The thickness of the fibers matches that of the cotton control sample, though a deeper impression would have yielded more conclusive results. The pattern of warp and weft of the section indicated by the square (Fig. 11) is much more complicated than on any other artifact. The design has a double weft with thicker threads than those of the warp. The warp is arranged in a pattern in which every third strand is significantly thicker than the others. Also, the textile impression was fairly regular – no knobs were observed on the section indicated by the square (Fig. 11), which means that neither the warp nor the weft was raised very much on the textile. Analysis of both textiles on Artifact 2 is summarized in Table 1-1 (Appendix B*).*

A naked eye analysis of Artifact 3 matched the textbook image of a balanced plain weave pattern (Figs. 15 and 16), which was fairly regular apart from some variation in the tautness of

the fibers. Also, the artifact appears to have been a piece of pottery because the clay had been fired, and one side was polished. The fiber type may have been alpaca based on the relative thinness of the fiber, but the impression was not preserved well enough to draw any definitive conclusions. Analysis of Artifact 3 is summarized in Table 1-1 (Appendix B*)*.

Observation by the naked eye revealed that Artifact 4 is a piece of a figurine. The front of the artifact is smooth, indicating that this object was very carefully crafted, and the clay used to make this object was much more finely-grained than the clay used to make any of the other artifacts. Special care seems to have been taken in the firing of the clay because color differences on the face are distinct and appear deliberate.

Analysis under the dissecting microscope of Artifact 4 yielded more quantitative results, which are summarized in Table 1-1. Though it was determined that the weave type was not balanced, whether the weave was warp-dominant or weft-dominant is impossible to determine because it is impossible to establish from the impression in which direction the textile was made.

Also, though the dissecting microscope revealed that the thread diameter of this artifact is 0.8 mm (which is, in general, considered to be a medium-large diameter [8]), the textile was woven more finely than any of the other textiles analyzed. Additionally, while most of the other textile impressions analyzed had balanced plain weaves with some irregularity, the textile impression on Artifact 4 had a more complicated weave pattern (either warp- or weft-faced plain weave) with little to no irregularities.

Through careful comparison, it was determined that Artifact 4 matched the experimental mold of alpaca fibers almost perfectly (Figs. 12 and 13), though a deeper impression would have yielded more conclusive results because it would have shown the fibers characteristic of alpaca wool under large magnification. While it generally has been accepted that the Guangala people used only cotton (based on the sizes of the looms found [2]), Artifact 4 seems to have been made of Alpaca fibers. Analysis of Artifact 4 is summarized in Table 1-1 (Appendix B*)*.

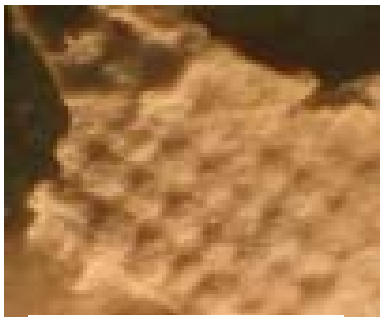

Figure 12: Artifact 4 under the Dissecting Microscope
Field of View: 6 mm

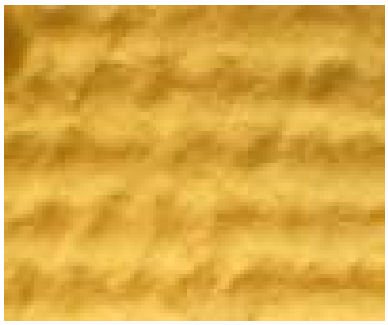

Figure 13: Alpaca impression under the Dissecting Microscope
Field of View: 6 mm

When Artifact 5 was analyzed with the naked eye, it was observed that both sides of the artifact were covered in prominent impressions of two very different textiles and patterns. Also, the clay that comprised the artifact was not very coarse but had small stones clearly visible. The clay did not appear to have been fired. Also, some textile impression exists on the edges of the artifact, so it seems as though the artifact was a fragment of clay rather than a pottery sherd. The textile impression of Side A matched the textbook image of a balanced plain weave nearly perfectly (Figs. 14 and 15). Though the weave pattern on Side B of the artifact is very

complicated and difficult to identify, it seems to consist of a ridge or seam. Analysis of Artifact 5 is summarized in Table 1-1 (Appendix B).

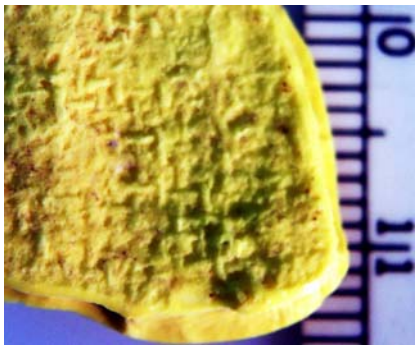

Figure 14: Artifact 5, Side A

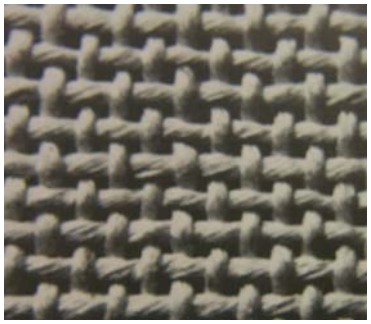

Figure 15: Balanced Plain Weave

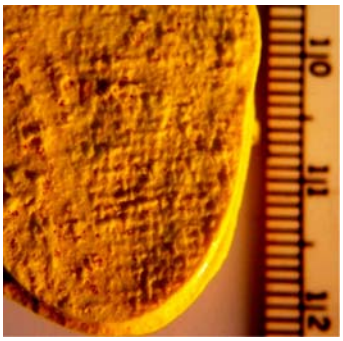

Figure 16: Artifact 3

CONCLUSION

The project gave information on Guangala phase textile production and structure, appropriate methods for analysis of textile impressions and surprising new details on Guangala life. The data and observations can be used to make hypotheses about the identity of the artifacts. Although the SEM was hypothesized to have yielded detailed information, it actually was largely ineffective for revealing any details about the fibers of the textile. None of the impressions preserved the details of the individual fibers. The SEM magnified the molds so deeply that all that could be analyzed were the details in the matrix of the vinyl polysiloxane. The dissecting microscopes generated surprisingly conclusive results. Because of the dissecting microscopes, it was possible to count the number of threads per centimeter, the thread diameter, and analyze the complexities in the warp/weft patterns on each of the textile impressions. A naked eye analysis was also surprisingly helpful, especially in creating a useful interpretation of the data collected from images produced by the dissecting microscopes. Also, a surprising amount of detail was observed using pictures taken at various magnifications. If a project similar to this one were to be conducted, less time should be spent on SEM preparations and observations, and more time and attention should be spent on analysis with the naked eye and with the dissecting microscopes. These methods yielded more substantial conclusions regarding each of the artifacts.

The data and observations made regarding Artifact 1 suggested that, although it was originally thought that there were no houses at the site, the artifact is a piece of floor from a Guangalan home (Fig. 17). Also, because the thread diameter is so thick (1.5 mm) and the impression is thicker in some places than others, the textile may have been from a rug or a mat that was placed on the floor. The deeper impressions may correspond to either the edges of the mat or the places on which people often stepped.

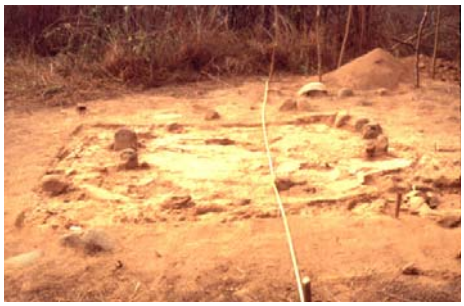

Figure 17: an example of the floor that Artifact 1 may have come from

As indicated by the square in Figure 11, Artifact 2

has an intricate warp pattern. Thus, it may be posited that at least this section contained some type of decoration or color. The identity of the section indicated by the oval (Fig. 11) is unclear.

Artifact 3 was observed to have large spaces between each thread. To account for these spaces, it was hypothesized that the textile was a crude weave and/or a well-used cloth. Additionally, the artifact's shape seems to suggest that it came from a larger plate or bowl, a hypothesis supported by evidence that the artifact was fired.

Based on the observations of Artifact 4, it seems likely that this artifact was part of some type of sacred statue or figurine. This hypothesis is supported not only by observations of shape and color of the artifact but also by the observations made regarding the actual textile impression. As was previously explained, the textile on Artifact 4 matched the experimental mold of alpaca fibers very well. However, there is no evidence for llama or alpaca herds in the coastal region during the Guangala phase. Llamas were native to the Andean Mountain range. This means that the Guangala people likely traded for the textile or the fibers used on Artifact 4. A traded wool textile would probably be more valuable to the Guangala culture than would be a cotton textile produced locally. This fits the hypothesis that Artifact 4 was some type of sacred figure because the Guangala people would likely have used valuable textiles on important pottery rather than everyday items, such as bowls and plates.

The appearance of Artifact 5 suggested that this artifact was not a piece of a ceramic vessel. Based on the observation that both sides of the artifact are covered in textile impressions, it has been hypothesized that Artifact 5 is a piece of clay that was stuck and thus accidentally fired or sun-baked between two different textiles (the impressions on each side of the artifact were clearly from different textiles). The impression on one side of the artifact (Side A) was clearly a balanced weave, but the pattern on the other side (Side B) was not large enough to make any conclusions regarding the textile pattern. Nonetheless, the pattern on Side B was clearly intricate and complex, leading to the hypothesis that the textile was made to be decorative or colorful.

Data and observations can be used not only to generate conclusions about each individual artifact, but also to compile new details of the Guangala culture into a picture that may explain more about the people who lived in this region. For instance, two out of five artifacts analyzed had a weave more complicated than the standard balanced simple plain weave. Two out of five artifacts analyzed were also hypothesized to have consisted of some type of design or color pattern. These two seemingly simple hypotheses imply that the Guangala culture was, to a certain degree, sophisticated in the way that they crafted their textiles or had access through trade to decorated textiles. Nevertheless, the occurrence of spindle whorls and weaving implements at all Guangala sites supports the model of local Guangala textile production. Moreover, this sophistication and the scarcity of irregularities found in four out of seven impressions analyzed indicate some degree of skillfulness in weaving among the people of the Guangala region.

General conclusions can be applied not only to the people who made these ancient textiles, but also to the culture of the people in this region. Because two of the artifacts analyzed likely came from alpaca fibers, the people of the Guangala region must have had some sort of trading system in place. Furthermore, to have traded with cultures surrounding them, they must

either have had the same economic system as their surrounding cultures, or have crafted their own system to be compatible with those of their neighboring cultures.

Although prima facie it may seem as though five artifacts are not enough to draw conclusions about an entire way of life, from an analysis of these five artifacts it was possible to make conclusions not only about Guangala textiles, but also about the culture of the people who lived in the Guangala Region. Thus, by drawing conclusions about an entire culture through experiments that allow for physical observations to be combined with background information and history, this project has epitomized the goal of archaeology.

APPENDIX A: IMAGES

Artifact 1

Figure 18: Artifact 1

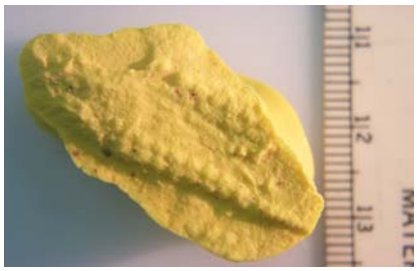

Figure 19: Cast of Artifact 1

Artifact 2

Figure 20: Artifact 2

Figure 21: Artifact 2

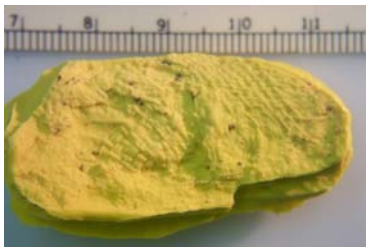

Figure 22: Cast of Artifact 2

Artifact 3

Figure 23: Artifact 3

Figure 24: Cast of Artifact 3

Artifact 4

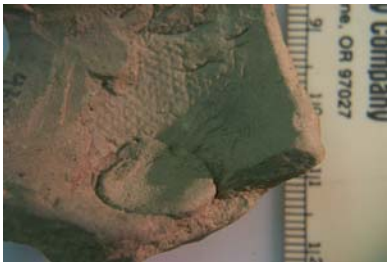

Figure 25: Artifact 4

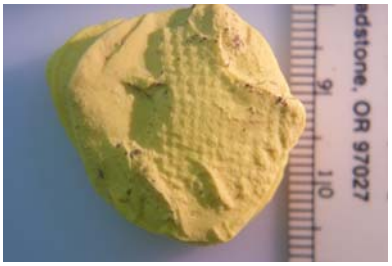

Figure 26: Cast of Artifact 4

Artifact 5

Figure 27: Artifact 5, Side A

Figure 28: Artifact 5, Side B

Figure 29: Cast of Artifact 5, Side A

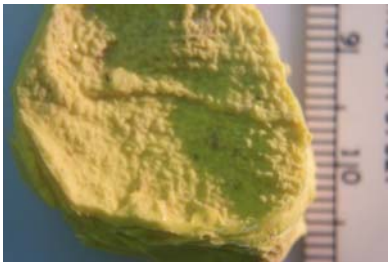

Figure 30: Cast of Artifact 5, Side B

Controls

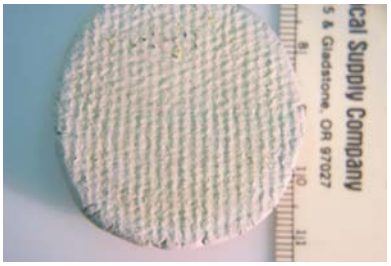

Figure 31: Mold of Alpaca Fibers

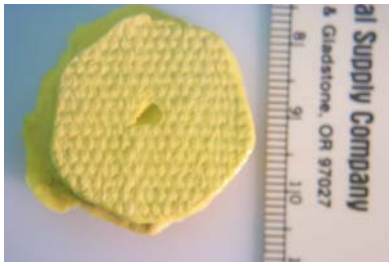

Figure 32: Cast of Alpaca Fibers

Figure 33: Cotton Saddlebag

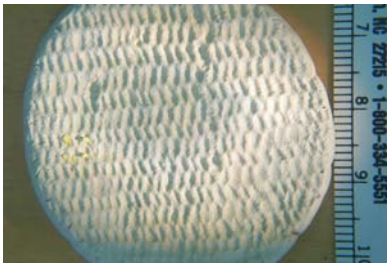

Figure 34: Mold of a Cotton Saddlebag

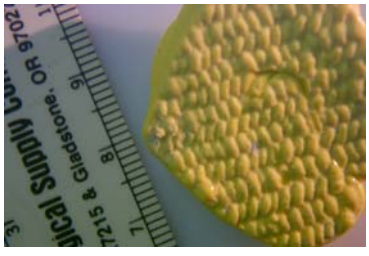

Figure 35: Cast of Cotton Saddlebag

Figure 36: Cotton Towel

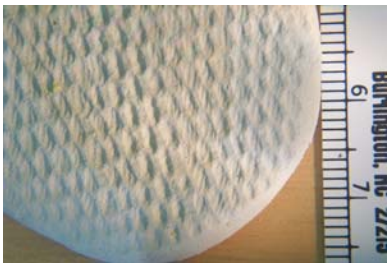

Figure 37: Mold of Cotton Towel

Figure 38: Cast of Cotton Towel

Figure 39: Panama Hat

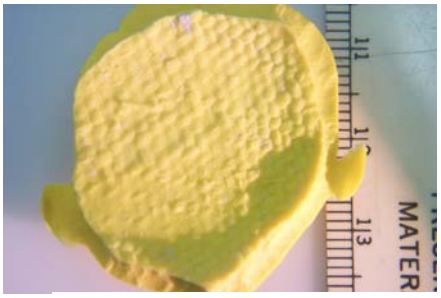

Figure 40: Cast of Panama Hat

Figure 41: Sheep Wool Bag

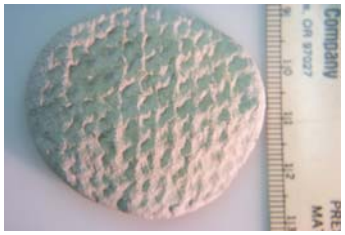

Figure 42: Mold of Sheep Wool Bag

Figure 43: Cast of Sheep Wool Bag

Figure 44: Cabuya Coaster

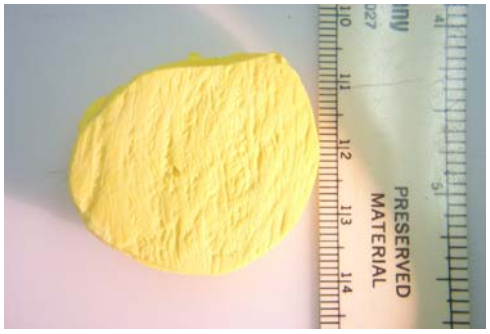

Figure 45: Cast of Cabuya Coaster

Figure 46: Cabuya Bag

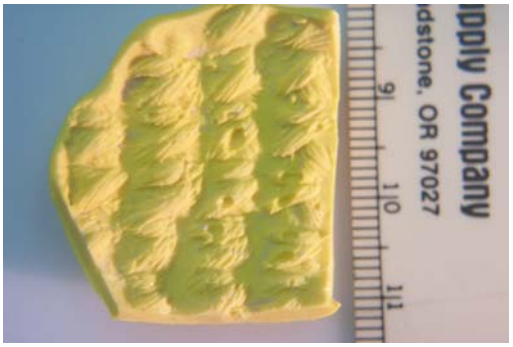

Figure 47: Cast of Cabuya Bag

APPENDIX B: DATA TABLE 1-1

Artifact Observed	Warp	Weft	Weavetype	Spin z/s	Fiber Type	Thread Diameter (mm)	# Threads/cm	Regularity
1	Indeterminate	Indeterminate	Indeterminate	----------	Indeterminate	1.5	6	slight variation in thickness
2 (square)	1 thick, 2 thin (repeating)	double	Balanced Plain	----------	Probably Cotton	.25 (thick), .2 (thin)	12 warp, 16 weft	slight variation in thickness, no knobs
2 (oval)	Indeterminate	Indeterminate	Plain (loose)	----------	Indeterminate	.1 - .4	10 warp, 14 weft	Irregular spacing and diameter
3	Single	Single	Balanced Plain	----------	Probably Alpaca	0.5	11	fairly regular; gradually becomes looser
4	Single	Single	warp/weft (?) faced plain	----------	Probably Alpaca	0.8	8	balanced
5A	Single	Single	Balanced Plain	----------	Indeterminate	0.2	12	slight variation in thickness, no knobs
5B	Indeterminate	Indeterminate	Intricate and inconsistent	----------	Indeterminate	0.2	12 one way, 20 the other (warp/weft indeterminate)	Indeterminate

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