A Pilot Study Examining Ceramic Paste Fabrics at the Ancient Maya Site of Hun Tun in Northwestern Belize

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Abstract

This article is a pilot study applying a petrographic analysis to ceramic body sherds from the ancient Maya site of Hun Tun, a hinterland site in northwestern Belize. The goal is to understand if there are multiple producer groups at the site, and determine what, if any, trade, and exchange are taking place at the site. The study revealed two distinct paste fabrics, being the Sand-Carbonate, and Carbonate fabrics. The Sand-Carbonate fabric is distinguished by well-sorted and rounded to well-rounded sand sized calcite grains, while the Carbonate fabric is distinguished by poor sorting, angular calcite grains, and large amounts of voids. The results of the study show the validity of the method at a small site, while also serving as the basis for future research.

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Introduction

Previous research has noted the benefit of using petrography to analyze paste fabrics among ceramics in the ancient Maya lowlands, a place where bedrock has the potential to interfere with chemical analysis (Brennan et al., 2013). As noted in the work of Quinn (2013), ceramic producers can have their own "signatures" hidden within the clay used to produce their vessels, where individual choices made by craftspeople have the potential to affect the function of vessels (Rice, 1987). Lechtman (1977) has noted how the process in which ceramics are manufactured are constrained in certain ways due to specific forms that are determined by cultural norms that still leave room for craftspeople to express their own agency through variations in production methods, referred to as technological style, such as temper of ceramics. By studying these variations, producer groups within and between archaeological sites can be distinguished from one another based purely on choices involving paste fabrics.

Ceramics are primarily produced for two main purposes: Internal consumption, and distribution. As Hirth (1998) notes, if ceramics are produced internally, a limited set of technological styles will be found; whereas a site where ceramics are imported will find a much greater mix of paste fabrics, occasionally with inclusions that cannot be found in the local area (i.e., volcanic ash, marine shell). Understanding ceramic production can further sub-divide vessels in ways that cannot by understood with purely type-variety, an analytical technique where ceramics are classified broadly, then divided into groups based on surface treatment (i.e., slips), then divided again into types as determined by decorations on the surface, and then into varieties (Rice, 1987). Combining type-variety with petrography allows variations to be linked to specific varieties to discriminate between technological styles that may be taken by craftspeople at a given site, or between sites.

This study is focused on an ancient hinterland Maya site called Hun Tun, located in the Rio Bravo Conservation and Management Area (RBCMA) of northwestern Belize, and managed by the Programme for Belize Archaeological Project (PfBAP). Research at Hun Tun by its site director, Dr. Robyn Dodge, has focused on understanding social stratification through household studies (Dodge, 2016). Through this research into households, questions about how craftspeople fit into communities start to arise. The goal of this pilot work is to understand how many, if any, producer groups are responsible for the ceramics present at Hun Tun, and to serve as a basis for future research in ceramics at the site.

Background

PfBAP was established in 1992 and has focused on collaboration between a large collective of scholars, each bringing their own skillsets and expertise to the project, while also doubling as a host for a major collective of field schools that train students in archaeological excavation and lab methods (Adams et al., 2004). Due to the size of the RBCMA and PfBAP, research goals have focused on understanding regional interactions between major centers, and their smaller counterparts, as well as specifically researching smaller sites (Lohse et al., 2004).

One such example of these interactions is between the large site of La Milpa, and the smaller site of Hun Tun. Hinterland sites such as Hun Tun or the nearby Medicinal Trail make up the vast majority of sites in the region. These sites were made up of everyday people including craftspeople, farmers, as well as other laborers, among others, and are commonly referred to in literature as “commoners” (Robin, 2003). Authors such as Scarborough et al. (2003) have noted how hinterland sites may also be specialized communities, that provide specific resources to other communities, or even produce goods for export. By studying hinterland sites, PfBAP helps put people back into archaeology through studies of everyday life and interactions.

While PfBAP studies small sites, the research area is home to several major sites, such as La Milpa, Wari Camp, Dos Hombres, Great Savanna, Grand Cacao, and Ma’ax Na, among others that have potentially not been identified yet (Adams et al., 2004; Levi, 2012; Sullivan & Valdez, 2004, 2015). Dodge (2016) notes how studies into commoners developed as a challenge to more binary “elite” and “commoner” relationships. Due to visibility, major centers were commonly the primary target of earlier archaeological studies, leading to small sites being pushed aside as insignificant. Such ignorance led to a very limited understanding of the lives of the ancient Maya, where the lives of the few outweighed the lives of the many. As a response, scholars began to create a shift in focus from temples to households. Hun Tun is one such example of household studies, as the site is a perfect example of how social complexity can be studied at a site that retains ties to major sites, as well as some nearby smaller sites, such as Medicinal Trail (Dodge, 2016). To address this complexity, research at Hun Tun has focused on understanding how the interactions of relationships of inequalities between large and small sites can be understood archaeologically through distributions of material goods and resources (Dodge, 2016).

Kent Flannery, one of the leading experts into household studies in Mesoamerica noted how clusters of households exist in settlements, appearing in the forms of residences, storage areas, or other features that are separated by open areas (1976). Such clusters allow for households to be related to specific groups, which may themselves be nested in other larger groups within sites. Flannery’s work has been useful in the study of settlement at Hun Tun, as it allows households to be viewed as distinct from the rest of their community. Each cluster has their own function that distinguishes them from the rest of the site, where some residences can focus on agriculture, while others can be groups of craftspeople. Because groups can be separate from their communities, the materials produced by craftspeople can vary based on how those people interact with the spaces around them (Wilke & Rathjhe, 1982). This understanding of how variations can exist within communities is the basis of this study into ceramics at Hun Tun.

While excavations at Hun Tun have revealed a diverse set of resources and trade goods, such as obsidian, jade, and marine shell, among others, this pilot study focuses purely on the production and exchange of ceramics. Within PfBAP, ceramics have been well documented and studied by various ceramicists within the collective (Adams et al., 2004; Sullivan & Valdez, 2004). Broadly, ceramics range from the Middle Preclassic period (800-400 B.C.E.) through the Terminal Classic period (800-900 C.E.). Sullivan and Valdez (2004); (Sullivan & Valdez, 2015) note how that there is a dramatic increase in the number of small hinterland sites, as well as a dramatic increase in quality of utilitarian ceramics. The Late Classic (600-800 C.E.) and Terminal Classic (800-900 C.E.) periods at PfBAP sites are identified as the Tepeu sphere, which is divided into three phases. The majority of ceramics at Hun Tun are from the Tepeu 2-3 phases, and are made up of a large variety of types (Dodge, 2016). Due to the short occupation of Hun Tun, the site presents a fantastic opportunity to study variation in craft production among households in the ancient Maya.

Following the work of Rice (1987), if ceramics are being produced for trade, an obvious mass-produced standardized form or type will be present. Craft specialization among the Maya allows communities to grow their relationships through interdependence between various sites (Valdez, 2012). Most Maya households were not sufficiently able to produce all of the material goods necessary while maintaining a food supply, and as such, had to rely on trade and exchange of goods (Masson & Freidel, 2012). As Hirth (1998) explains, due to exchange playing such a massive role in the lives of the Maya, all households should see some degree of homogeneity among their artifacts. Eckert et al. (2015) explains how variation in ceramics can exist due to ideological beliefs, or as a result of export. When understanding variation due to ideological beliefs, the potential for de-centralized production has the potential for even further difference among stylistic intentions, especially compared to the functional choices of individuals when tempering ceramics. Due to time constraints involved with making ceramics, the possibility exists that craftspeople could be made up entirely of part-time actors, who spend most of their time focused on food production or providing other services to nearby sites. This study aims to understand if ceramics at Hun Tun are being produced for export, if there is any standardization among craftspeople, and if the actors producing ceramics are full-time specialists, or part-time producers.

Methodology

Borrowing from geological sciences, petrographic analysis was first applied to Mesoamerican ceramics by Sigvald Linné (Bishop, 2014) on ceramics from the ancient Aztec site of Teotihuacan, and later in the Maya lowlands by Anna Shepard in her research (Shepard, 1942, 1948, 1958, 1967). The use of petrography allows thin sections of ceramics to be viewed under a polarizing microscope to identify inclusions present in the ceramic sherd (Rice, 1987). One of the major benefits of petrography is the ability to distinguish between whether or not inclusions were intentionally ground for temper, as well as the sorting and maturity of inclusions in the vessel (Quinn, 2013). Another benefit is the cost-saving nature, as petrography requires less samples at a lower cost when compared to something like neutron activation analysis (NAA) or laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), both of which require a large amount of samples, and have dramatically higher costs than petrography. At the same time, petrography shows the intentionality of craftspeople, which is understood through distinguishing inclusions from the clay matrix, as well as potentially non-local inclusions (i.e., volcanic ash, marine shell), as compared to something like grog (crushed pottery). Due to limitations in funding and the destructive nature of NAA and LA-ICP-MS, this study sticks to petrography, as the research questions at hand are based on identifying producer groups and exchange.

Twenty-three thin sections were sent to National Petrographic Service Inc. in Rosenburg, Texas for processing. In processing, the ceramics are trimmed to size with a wet saw before being impregnated with epoxy. The sample is then ground to a thickness of 0.03 mm before being mounted on a glass slide (Quinn, 2013). After the finished samples were returned, they were viewed at the University of Texas at Austin's Jackson School of Geosciences Graduate Microscopy Lab on a Zeiss Axioskop 40 polarizing microscope, where point counts were taken to calculate inclusion percentages and to aid in grouping paste fabrics. As Quinn (2013) discusses, petrography is able to indicate firing temperature of ceramics, as the mineral dolomite begins to disintegrate at temperatures above 800℃, whereas calcite will remain until temperatures reach 900℃.

Petrography has three main elements to it that are studied, which are the clay matrix, the inclusions, and the voids that are found in the paste of a vessel. Clay is the main actor in a vessel, and almost always makes up most of the paste (Quinn, 2013). Clay is understood as a naturally occurring mineral that is easy to work and shape into form for firing (Rice, 1987). Some craftspeople may elect to mix two or more sources of clay for their vessels, which petrography is able to reveal. Clays can also have their own naturally occurring inclusions, which are not usually bigger than 0.10 mm (Quinn, 2013). The color and composition of a clay matrix reveals information about clay sourcing and firing environment, something which can help distinguish local and non-local ceramics based purely of the clay used in production.

Inclusions are particulate materials which are distinct from the clay matrix (Quinn, 2013). These are the most distinct actor in ceramics, and typically reveal some of the most important information, such as intentionality, trade, or even meaning when inclusions such as volcanic ash or marine shell are found (Quinn, 2013). As a result, inclusions are the most commonly studied component in ceramic petrography. Examples of inclusions are seemingly endless, but most commonly found are minerals, grog, bone, shell, plants, among a long list of others (Rice, 1987).

Finally, petrography also studies voids. Voids, as the name suggests, are empty spaces in ceramics, and are understood as the absence of materials (Quinn, 2013). Voids themselves play a major role in ceramics, as they influence the weight, strength, permeability, insulation, and thermal conductivity of a vessel (Quinn, 2013). These can occur naturally in the clay, or even be created during processing by having air be trapped in the clay during kneading. While naturally occurring voids are very small, 0.05 mm and below, other voids created during processing and firing can be dramatically larger (Quinn, 2013). During the firing process, new voids are created primarily in four different ways: shrinking rates of clay, organic or plant materials burning away, or the decomposition of inclusions (ex: dolomite), or even in through shock in the post firing. Voids are also able to be created through weathering or decomposition after they are deposited in their resting place before excavation (Quinn, 2013). To assist in the classification of voids, the samples from Hun Tun were impregnated with a blue epoxy to aid in identification.

The clay matrix can be described through its color under plane polarized light (PPL) and optical activity, such as isotropic or anisotropic clay. Anisotropic clay has different, and much more active visual properties when viewed from different angles in cross-polarized light (XPL), whereas isotropic clay lacks these features (Zhang et al., 2019). Samples were classified with either an anisotropic, or isotropic clay matrix.

Inclusions are characterized here through percentage estimation, angularity, sorting, and a list of minerals present. Percentage estimations are based off of point counts from a single thin section and are used to roughly determine the number of inclusions in the remainder of the vessel. Angularity is broken down into four categories: angular, subangular, subrounded, and rounded. Figure 1 shows a chart used to aid in determining the angularity of inclusions. Sorting is characterized as: well sorted, moderately sorted, poorly sorted, and very poorly sorted. Figure 2 shows a chart used to help estimate the sorting of the paste and its inclusions.

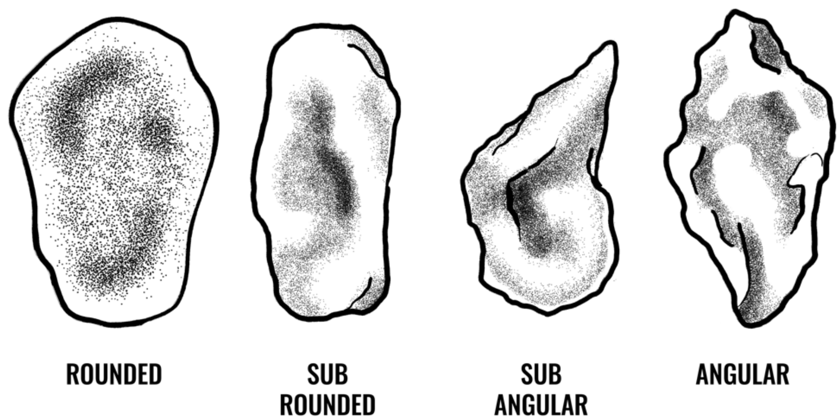

Figure 1: Inclusion Angularity Chart

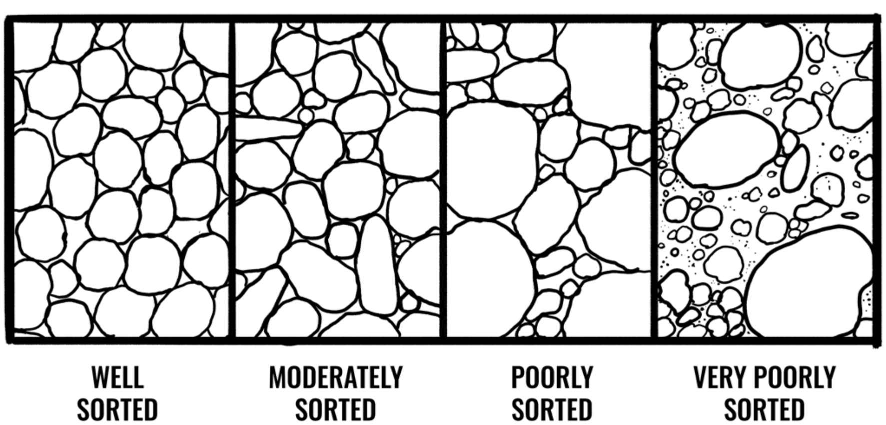

Figure 2: Grain Sorting Chart

Point counts are a quantitative form of analysis which is completed by moving a thin section along an x-axis and y-axis at a set interval. The interval used here is 0.3 mm, and 150 point counts were taken. Each time that the slide is moved on an interval, whatever is targeted by the crosshairs is either counted as clay matrix, or as inclusions or voids. The decision was made to collect 150 points due to the high number of inclusions in some of the samples. Rather than adjust the point counts to fit some samples where the sherd may be bigger than others, having a standard from which inclusions were calculated made for more meaningful comparisons.

Firing is one of the final steps in the processing of ceramics. Rice (1987) describes three main variables that affect the results of how ceramics leave the firing process, which are: time, temperature, and atmosphere. Since all three of these factors play major roles, all three must be examined, rather than just temperature. While the list of outcomes is numerous, the factors relevant here are the presence, absence, and alteration of minerals which are used to understand temperature, and the color of the paste of the sherd when viewed with the naked eye, which suggests time and atmosphere.

The lowest temperature at which ceramics can be fired with no major changes to minerals is between 600-700°C (Cultrone et al., 2001). Above 700°C, dolomite begins to decompose, or alters into other minerals, typically into calcite and periclase with the equation given by Trindade et al. (2009).

$$CaMg(CO3)2 \text{ (dolomite)} \rightarrow CaCo3 \text{ (calcite)} + MgO \text{ (periclase)} + CO2$$

Once temperatures reach upwards of 800°C, dolomite is fully decomposed, whereas calcite remains until temperatures of 900°C (Cultrone et al., 2001; Trindade et al., 2009).

The color of the clay matrix can also be used to understand firing temperatures. When ceramics are fired at high temperatures, iron contents in clays can tint the clay matrix into a red shade (Rice, 1987). When ceramics are fired at high temperatures in an environment where oxygen is restricted, the clay matrix will change from red or brown to black (Rice, 1987).

When ceramics are viewed with the naked eye, they can occasionally have a black strip in the center of their core. This is caused by ceramics containing organic material, such as plants not being fired long enough and hot enough to fully burn off all of the organics. If organic material is fully burned off, a homogenous color will be present, whereas if ceramics are not fired long enough or hot enough, they will have dark cores. This also requires a free flow of oxygen being constant during the firing (Rice, 1987).

Similar to time, atmosphere performs the same way, where a flow of oxygen and proper temperatures are needed to fully burn off organic material. Rice (1987) discusses two main atmospheric conditions that affect ceramics, which are oxidizing atmospheres, and reducing atmospheres. An oxidizing atmosphere is one with free circulation of large amounts of air, a reducing atmosphere is one with limited amounts of airflow that is likely restricted. Dark cores are a result of a reducing atmosphere (Rice, 1987)

Because petrography is destructive in nature, and the limited number of ceramics recovered from some contexts at Hun Tun, the ceramics chosen consist of unidentifiable body sherds with no distinguishable characteristics. This was done to avoid destroying any rim sherds, or elaborately decorated ceramics, such as polychromes, due to their scarcity at the site.

Results of Petrographic Analysis

The results of the pilot study have revealed more than one paste recipe present at Hun Tun. The most common inclusion by far is calcite, followed by lower amounts of dolomite, grog, hematite, and quartz, among others in more trace amounts. Table 1 shows the percentages of inclusions compared to voids present in each of the samples.

Two major paste fabrics were noted among the samples. The first is the Carbonate fabric (n=9), which is characterized by poor sorting, subangular to angular grains, and abundant voids (Figure 3). The next is the Sand-Carbonate fabric (n=12), which is characterized by moderate to well sorting of sand sized grains (number from Quinn), subrounded to rounded grains, and less abundant voids (Figure 4). There was a total of two sherds which could not be placed into either group, due to the scarcity of calcite inclusions, and the large amount of grog present in one sample (HT4).

Sherd ID	Context	Calcite	Dolomite	Grog	Quartz	Hematite	Mica (Muscovite)	Voids	Fabric
HT1	7-CX-3	49	0	0	0	22	0	29	Ungrouped
HT2	7-CX-3	29	43	0	1	2	1	24	Sand-Carbonate
HT3	7-CX-3	24	40	0	0	8	1	45	Sand-Carbonate
HT4	7-CY-3	11	0	39	1	4	0	47	Ungrouped
HT5	7-CY-3	51	0	0	0	2	0	47	Carbonate
HT6	7-CY-3	17	48	1	0	1	10	23	Sand-Carbonate
HT7	7-DA-6	50	0	0	1	2	0	47	Carbonate
HT8	7-DA-6	50	0	0	3	11	0	36	Carbonate
HT9	7-DA-9	82	1	3	0	1	0	23	Sand-Carbonate
HT10	7-DA-9	81	1	1	0	1	0	26	Sand-Carbonate
HT11	7-DA-9	60	0	0	0	1	0	49	Sand-Carbonate
HT12	7-DB-2	10	56	0	1	1	0	32	Sand-Carbonate
HT13	7-DB-2	54	0	0	0	2	0	44	Sand-Carbonate
HT14	7-DB-2	51	0	0	0	5	0	44	Sand-Carbonate
HT15	7-DB-3	7	56	0	3	6	0	28	Carbonate
HT16	7-DB-3	64	0	0	1	1	0	34	Carbonate
HT17	7-DB-3	74	0	0	1	1	1	23	Sand-Carbonate
HT18	7-DD-2	60	0	0	2	1	0	37	Sand-Carbonate
HT19	7-DD-2	50	0	0	2	10	0	38	Carbonate
HT20	7-DD-2	9	58	0	1	1	1	30	Carbonate
HT21	7-DG-2	60	0	0	1	1	0	28	Sand-Carbonate
HT22	7-DG-2	31	0	1	8	2	0	58	Carbonate
HT23	7-DG-2	32	1	0	1	2	0	64	Carbonate

Table 1: Percentages of Inclusions per Sample

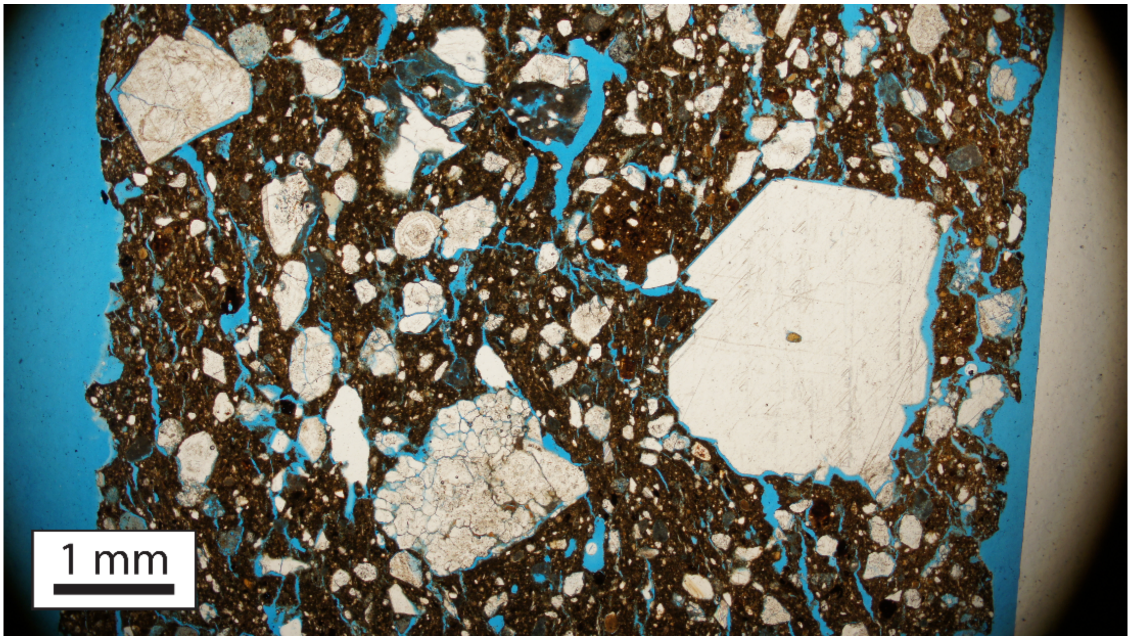

Figure 3: Example of Carbonate Fabric (HT22)

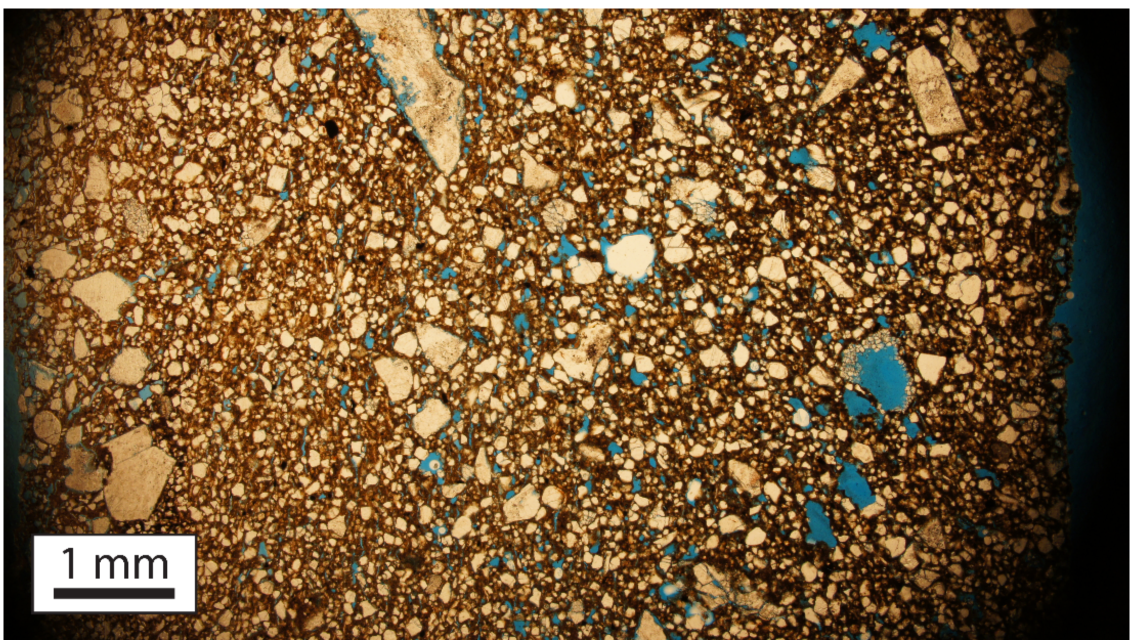

Figure 4: Example of Sand-Carbonate fabric (HT10)

The total number of samples containing grog (n=6) suggests the inclusion was not intentionally added, simply due to the small amounts in five of the six samples, with the sixth being in an ungrouped category. This suggests the possibility that there was not enough grog available to use for temper, that craftspeople elected to use other tempers instead, or that the clay being used had no need for more tempers, as might be the case with the Sand-Carbonate fabric.

There also exists variation within the Sand-Carbonate and Carbonate fabrics. Dolomite dominates the inclusions in a total of six samples. Within the Sand-Carbonate fabric (n=4), only one sherd contains grog, and in small amounts, while the Carbonate fabric (n=2) has no grog inclusions. This suggests two different clay sources, one dominated by calcite, and one dominated by dolomite, but still retaining the scarcity of grog that most other samples display.

For anisotropic clay matrixes, there are a total of three samples, all of which are dominated by dolomite. This suggests a possibility that these were either imported from another site with a clay source containing anisotropic clay dominated by dolomite, or a group of craftspeople at Hun Tun traveled to a different area to collect their clay for pottery production.

As for matrix colors, all but one sample (HT14) display some variety of brown matrix, suggesting a similar origin and firing environments for all samples. At same time, this suggests a lack of long-distance trade, where ceramics were produced in a region with a different bedrock than is local to Hun Tun and PfBAP, which is dominated by limestone.

Interpretations

The result of the petrographic analysis leads to an argument that Hun Tun had two or more paste fabrics local to the region, if ceramics were being produced at the site. For ceramics placed into the Sand-Carbonate fabric, the samples which show both primarily dolomite inclusions and an anisotropic matrix (n=2), they may have been imported from another site, potentially made by another group preparing ceramics in a different way than those producing the other two main fabrics at Hun Tun, or even experimentation with a new clay source. Each of these possibilities creates the potential for innovation within Hun Tun, as their craftspeople may have changed where they collected their clay based on differences in plasticity or durability through firing.

There is a possibility that due to the Sand-Carbonate containing rounded to well-rounded grains, the calcite may or may not have been intentionally added as a temper. Rice (1987) notes how similar to quartz, calcite is also a major component of sand. While it is possible that the craftspeople that produced those vessels were collecting and storing unground sand to use as a temper, it is also possible that the calcite could have been found naturally in the clay, and little to no temper was needed in processing ceramics. In more recent ethnographic accounts, modern Maya potters collect and store sand or calcite to use as a temper (Deal, 1998).

It is difficult to make a definitive interpretation on whether the sand was intentionally added or was naturally included. The best argument for intentionality is the angularity of grains, which is missing in these samples. While angularity is a result of crushing inclusions for processing, rounded grains are caused naturally by weathering, most commonly by streams or rivers transporting and then depositing the sand. Due to these factors, the sand could have been natural, added intentionally, or perhaps both.

As for the Carbonate fabric, there is a clear answer for the intentionality of craftspeople. For samples dominated by calcite (n=7), grains are all subangular to angular, suggesting that calcite was likely intentionally ground to be used as a temper for samples. As for samples dominated by dolomite (n=2), the grains are subangular to subrounded, suggesting the possibility that some grains, whether or not they were dolomite or calcite, were intentionally ground as temper, while others may have been natural within the vessel. While calcite and dolomite are both common in most carbonate clays, the presence or lack of dolomite has implications for the firing temperature of ceramics.

Among calcite, dolomite, quartz, and grog, muscovite mica (n=5) and hematite (n=23) also appear in small amounts. These grains are typically well rounded and not associated with any specific fabric, and as such, do not offer much to discussions of differences among producers.

As discussed above in the methodology section, the presence and absence of dolomite gives leads to determining the firing temperature of the samples. Just over 60% (n=14) of the samples contained calcite, but no dolomite, suggesting that an almost even split of ceramics were fired between 800-900°C, while the other half was fired below those temperatures.

The color of the clay matrix played almost no role in determining the firing temperature of ceramics. There was only one sample (HT14) with a tan matrix that was likely fired at a low temperature, whereas the others are almost impossible to distinguish, as they are all various but still similar shades of brown. This compliments the previous mention of the presence and absence of dolomite inclusions, as both produced similar results.

A total of almost 35% (n=8) of the samples contained dark cores. This suggests that the environment in which those ceramics were fired, failed to burn at high enough temperatures for long enough to burn out all organic materials, and likely did not have proper circulation to the ceramics. The black cores are not associated with any specific fabric, as there is an almost even split among the Sand-Carbonate and Carbonate fabrics.

By understanding the temperature at which the samples were fired, we can reconstruct how craftspeople at Hun Tun, or even another site if ceramics were imported were producing their ceramics. Since around 40% of the samples (n=9) contained dolomite, and 35% contained dark cores (n=8), it is safe to say that the ceramics were fired at moderate to high temperatures, likely with restricted airflows in some cases.

Conclusion

Based on the petrographic analysis, it seems likely that there were multiple producers of the ceramics found at Hun Tun. Whether or not they were produced locally is not able to be determined with the results of the study. Two main fabrics were identified. The Sand-Carbonate fabric is characterized by moderately sorted to well-sorted inclusions, rounded to well-rounded grains of calcite sand and less abundant voids. Whereas the Carbonate fabric is characterized by poor sorting, subangular to angular grains, and abundant voids. The two fabrics both contain their own variation, with the Sand-Carbonate fabric showing the most signs of difference with two samples containing anisotropic clay and a lack of grog. Grog was not likely used as a temper in the majority of ceramics, as sample (HT4) was the only one that was likely intentionally tempered.

In short, the results of this pilot study show the validity of applying petrography to ceramics at hinterland sites that might be limited in variation. Even with such a small sample size and two fabrics, multiple producers and sources were revealed. These results would benefit from other forms of analysis, such as NAA and LA-ICP-MS, as well as a larger sample size and comparisons to other nearby sites.

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