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Making and Firing Hopewell Pottery

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Introduction

Between 200 BCE and 500 CE, a cultural horizon was flourishing across much of Northeastern North America. The people living at this time were living in dispersed sedentary households, and engaged in low-level food production [1]; however, they are best known for building the large conglomerations of earthworks and mounds that are all over the Ohio Valley. Their impressive mounds have been excavated and documented, but not much is known about the domestic lives of these people. As archaeologists have started excavating the domestic sites of the Hopewell, they have noticed that pottery is not only important in their burials, but also plays an important role in their daily lives. The features associated with their dwellings have many broken pieces of pottery within them. The pottery from both the domestic sites and the mounds has been classified, but archaeologists have not tried to recreate Hopewell pottery-making methods.

The objective of this research project was to determine the likely temperature range that the Hopewell used to fire their pottery. No kilns have been found associated with Hopewell domestic sites, so it is likely that they were using a type of outdoor fire. This project focused on two sets of variables with two options; a covered fire compared to an uncovered fire, and a pit fire compared to a ground fire. A comparison of colors between the experimental pottery and the Hopewell pottery will hopefully determine the likely temperature range that the Hopewell used to fire their pottery.

Ceramic Background

Before going on to my methodology, I would first like to address some issues inherent in this project that must be accepted, for the situation does not allow for us to work around them. These would be the challenges of re-creating ceramics, which include differences in the type of clay, and differences in the amount of inclusions.

Clay is formed by the gradual weathering of rocks; this means that the location where clay is formed leads to different types of clay [2]. If the clay has been formed in an area and has not been moved from that area prior to human collection, it is called primary clay. However, most clays are secondary clays – they were formed in one location via natural processes, and then transported from their location of formation to another location. Clay that is moved in this way picks up particles along the way, so the amount of carbonic acid and other diluted solvents is different in different clay deposits [2]. The clay that the Hopewell were using to create their pottery was likely found in the river, in a secondary clay deposit. This problem is compounded when we factor in time's affect on the situation; because rivers change their courses slowly over time, there is no way to get exactly the same clay as the Hopewell used. The different type of clay would affect the firing temperature, and it might affect the firing temperatures significantly. It is something we will have to accept as an assumption in this study.

Inclusions are mixed into clay to control the shrinkage of the clay – the change in size that occurs during water loss and firing [2]. They prevent the pottery from breaking in the creation process. However, the amount of inclusions in clay does not affect firing temperature; it only affects the functionality of the end product.

Methodology

All of the previous information was taken into consideration when I was selecting my materials; the focus of this study is a color comparison between the artifacts and experimental vessels, so it is incredibly important to obtain similar materials. In general, I tried to find as many materials as

possible from as similar a source as the Hopewell would have used. This way, the extent of the ceramic problems would be lessened.

The clay used in this project came from the banks of the Scioto River, which is the river that runs close to Brown's Bottom [1]. The exact location that the clay was acquired at was unknown. The inclusions used came from crushed local granite, which would have been plentiful near the Hopewell. In order to make the granite easier to crush, it was heated first.

Pottery Creation

The first step of vessel creation was to mix the clay and the inclusions together. This was done by breaking a larger chunk of clay into four smaller sections. Inclusions were then added to these smaller sections, and the smaller sections were recombined into the large chunk. This large chunk was continuously kneaded until the inclusions were evenly distributed throughout the clay. The distribution was observed by cutting the clay chunk in half occasionally throughout the kneading process. This combination of clay and inclusions was then used to make the coils for vessel creation.

Pottery vessels can be created many different ways; archaeological evidence supports the hypothesis that the Hopewell used a coil method to construct their vessels. The most substantial evidence supporting this hypothesis is seen in the breakage patterns of the vessels that are excavated; oftentimes, they break along the neck in a fairly straight line, which would be right along the space between two coils. Based on this evidence, this experiment used the coil technique.

The combination of clay and inclusions, after being thoroughly mixed, is rolled into logs. These logs are stacked on top of each other in the desired shape of the vessel. The coils are then worked into each other on both sides to form the walls of the vessel. Next, tools were used to refine the vessel's shape, and increase its functionality.

Archaeological excavations of Hopewell sites have shown that they used some tools in their pottery production. They hit the sides of the pottery with paddles wrapped with lengths of hemp. This tool would help to better integrate the coils, which would produce a sturdier, more durable vessel. It was also likely used to regulate the surface of the pottery; the Hopewell had large vessels, so this paddle would allow them to better balance the pot. On the insides of their pots, they used smooth stones to smooth the sides and bottom. They found these rocks in the nearby river. Only these two tools were used to reconstruct the vessels used in this study.

Firing

Before firing could begin, there had to be research on a few factors such as type of wood, method of measuring temperature, and the effect of environmental factors on fire temperature.

The fires in this study were fed primarily with hardwoods. Hardwoods are denser than softwoods, which makes them release more energy when they are burned. This makes them produce hotter fires than softwoods [3]. I assumed that since the Hopewell were making fires every day of their lives, they would have noticed that some woods burn hotter than others, and they would have used

these woods for firing their pottery. The wood used for the firing was mainly birch, with some other local hardwoods; these types of trees were found in forests near the Hopewell.

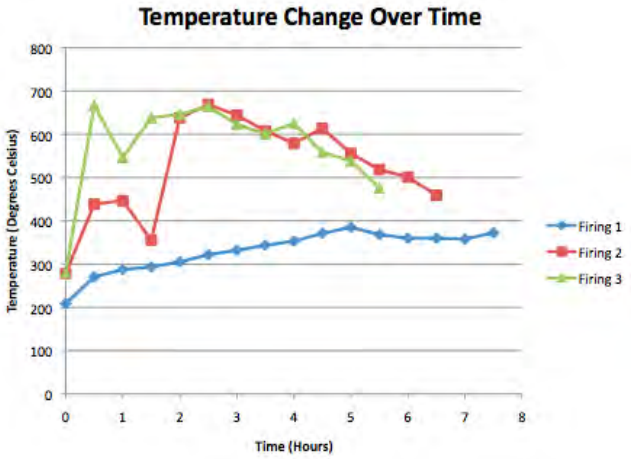
Research was also conducted on whether external environmental factors, specifically temperature, would have an effect on the temperature of the fire. No data or studies could be found on this subject, so it was assumed that the external temperature would not affect the fire's temperature. Moisture content in the wood would affect the fire's temperature and fuel efficiency, so all of the firewood was thoroughly dried beforehand.

The method of temperature recording used was a thermocouple probe. This device is used for measuring very high temperatures, and also would ensure fire safety. The probe is at the end of a two-foot long heat-resistant metal shaft; this shaft could be placed so that the sensor was in the center of the fire, while the handle at the other end would be safely out of reach of the fire. This sensor plugged into the thermocouple controller, and the controller would display the temperature of the area in both Fahrenheit and Celsius. Measurements were taken every half hour for the duration of the fire, and the first measurement was taken a half-hour after lighting the fire.

This experiment consisted of three different firings. The purpose of these three firings was to compare the changes in temperature in relation to two sets of variables: buried and unburied fires, and pit and ground fires. For the pit fires, the pit was 3-4 inches deep. The first firing was a buried pit fire, the second was an open pit fire, and the third was an open ground fire. These three firings allowed us to compare these two sets of variables and find out what variables have an effect on firing temperature. This would allow us to acquire a better understanding of the temperature range that the Hopewell used to fire their pottery.

Results

The data from all three fires was collected, and graphed on the same figure for the purposes of comparing the three fires. The graph is included below:



Some informal observations of the three fires should be noted here. The fuel ran out towards the end of the third firing, which caused the rapid decrease in temperature at the end of that firing. Temperature fluctuations were difficult to avoid for the second and third firings, because adding wood would cause the temperature to rise quickly, and then after a while the temperature would rapidly decrease. Also, the size of the wood placed on the fire seemed to have an effect on the temperature of the fire for the next half hour, causing more temperature fluctuations. These temperature fluctuations are unavoidable, and likely no attempt should be made to avoid them, because it is unlikely that the Hopewell would have evenly divided all their wood before adding them to the fire. The steadiness of the first firing was because it was buried; no additional fuel was being added, and the dirt acted as an insulation, therefore helping to maintain the temperature of the fire. It should also be noted that the temperature readings between the measurements for the third firing were significantly higher than the readings in the second firing; oftentimes, Firing 3's temperature would rise into the low seven hundreds. This would certainly affect the outcome of the ceramics from these two firings. The last notable point about the firing temperatures is that according to modern ceramics charts used by artists, none of these fires attained temperatures that would be hot enough to fully transform the pottery into ceramics [4].

After the experimental pottery was removed from the fire, it was brought to the lab so it could be broken and the colors could be compared to the Hopewell ceramics. The pottery from the first firing did not match any of the colors from the Hopewell pottery; in fact, there was little difference in color between the unfired pot and the fired pot. It was an orange/tan color. This pottery was also incredibly brittle. There are two possible explanations for why

this pot did not match any Hopewell pottery. The first explanation is that it is possible that the Hopewell were not using the pottery that was fired at a similar temperature range. Or, it is possible that the Hopewell did use pottery that was fired at this temperature range, but because the pottery is so brittle, none of the potsherds survived to be recognized during excavation. The vessels from the other two firings changed color significantly, and were also compared to Hopewell potsherds.
The colors of the pots from the second and third firings did match some of the colors of the Hopewell ceramics. The pot from the second firing was a red/tan color, and the pot from the third firing was a red/dark gray color. Also, the third pot was the most difficult to break; however, all of these pots could be broken with less force than expected of ceramics. The pattern of color change seems to advance from low to high temperatures in this order: orange, tan, red, dark gray.

As the experimental pottery was being compared to the Hopewell pottery, it became apparent that the profiles of the experimental pottery changed color drastically. The color of the bases was a dark red, while the tops were a dark gray-black color; so the bases were exposed to a lower temperature range than the tops of all three of the vessels. It is possible that this color discrepancy is only due to pottery placement in the fire, because all the vessels were placed top-up in the fire.

Discussion

These results give us some more information on the two variables' effect on firing temperature. For the comparison of the pit and ground fires, we can infer from the graph that the two pit firings did not get as hot as the ground firing. This phenomenon is likely occurring because the pit is reducing the amount of air circulating through the fire, even if it is a shallow pit. This reduction of air circulation would reduce the maximum temperature of the fire, and also reduce the fuel efficiency of the fire. The unburied pit fire consumed far more fuel than the ground fire, and left multiple large pieces of wood unconsumed. On the other hand, the ground fire reached significantly higher temperatures. This study suggests that it is likely that the Hopewell used a ground fire rather than a pit fire for ceramics firing.

We can also interpret the effect of burying a fire on its temperature. The buried fire did maintain a very steady temperature, but it did not come close to approaching the temperature of the unburied fires. This low temperature was produced insufficient pottery; it did not change color much, and it was also very brittle. The two unburied fires achieved higher temperatures, but the temperatures did fluctuate a lot. There is evidence that significant temperature fluctuations weaken pottery, however, there is currently no archaeological evidence that would help us to figure out how much the Hopewell fires fluctuated as they made their pottery.

The last interesting subject is the brittleness of the experimental pottery. This may be connected to the size of the pottery found at the sites. During excavations, only incredibly small potsherds are found, and complete vessels are never found. It could be that the Hopewell pottery was very brittle, like the experimental pieces, and broke easily both before and after becoming a part of the archaeological record.

Conclusion

The findings from this study lead us to two possible conclusions. The first possible conclusion is that the color matching was not significant enough to conclude that the correct temperatures were achieved, and the Hopewell were likely using higher temperatures to fire their pottery. The

second possible conclusion is that the color matching was significant, which means the likely temperature range was determined, and that the Hopewell were not fully firing their ceramics. More research is needed to determine which of these conclusions will be better supported.

Further research is certainly needed, and this further research could take many different approaches. More tests could focus on the effects of burying a hotter fire, to see if that fire would maintain stable, high temperatures, and therefore fire the pottery more thoroughly. Or, possibly a bigger fire would achieve higher temperatures. It would also be wise to see if changing the orientation of the pot in the fire – such as placing the top down on the ground – would address the problem with the bases reaching lower temperature ranges than the tops of the pots. Also, performing studies of the virtrification of Hopewell pottery would help determine how much of the clay was converted to ceramics, which would give us a better idea of the likely temperature range used to fire their pottery.

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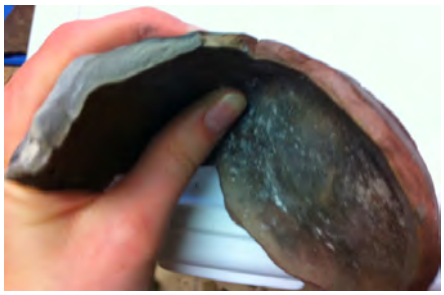

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