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The Prehistory & History of Ceramic Kilns

Volume VII

Editor: Prudence M. Rice
Series Editor: W.D. Kingery

Proceedings of the Prehistory and History of Ceramic Kilns, held at the 98th Annual Meeting of the American Ceramic Society in Indianapolis, Indiana, April 14–17, 1996.

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Foreword

This seventh volume of the *Ceramics and Civilization* series continues the efforts of The American Ceramic Society to situate and understand its activities and programs in the broad context of culture, history, and society. Ceramic sherds make up the largest fraction of material objects recovered by archaeologists from prehistoric and historic sites. As a result there is great interest in the inferences that can be developed about design, production, distribution, use, and performance from the objects themselves.

An essential component of the very definition of ceramics is the heat treatment resulting in permanent shapes and useful properties. Thus, every site where ceramics were produced contains the remains of ceramic kilns, some simple, some complex. Many archaeologists believe that too little generally available information on kiln types, construction, and use has led to their underrepresentation in excavation reports. A principal purpose of the present meeting has been to bring together ceramic engineers, ethnographers, ceramic historians, and archaeologists familiar with the normal configurations of ceramic kilns that have been developed in a wide variety of epochs, geographies, and cultures.

The simplest ceramic pots are made with a fast, low-temperature firing accomplished in a variety of configurations with no permanent structure. For larger production and longer firing permanent kilns were constructed in many different designs appropriate for particular fuels, products, raw materials, processes, environments, cultures, and social organizations. For ceramic production at all times and all places, the kiln is an integral component.

We are fortunate that the symposium was mostly organized and this volume edited by Professor Prudence M. Rice, an eminent scholar in the field of archaeological ceramics and Chair of the Department of Anthropology at Southern Illinois University. I extend to her my thanks as Series Editor and as Chairperson of the American Ceramic Society History Committee.

W. David Kingery

TECHNOLOGY AND ORGANIZATION OF ANASAZI TRENCH KILNS

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ABSTRACT

Trench kilns were used in the production of Mesa Verde region Anasazi black-on-white pottery between at least A.D. 900 and 1250. Although first suspected in the 1940s, the kiln function was only formally recognized in the 1970s and 1980s. Many examples are in isolated settings, they often occur in clusters, some are extremely long, and none is associated with either gray- or red-ware vessel production. After 10 years of excavation and experimental research, we are close to understanding how these kilns were used to produce white-ware vessels. In addition, implications for production organization are tantalizingly complex. The emerging picture of the firing technology suggests that the large kilns represent collaborations of several potters rather simple conceptions of large scale production by a skilled individual.

INTRODUCTION

In the Southwestern United States, the Anasazi culture occupied an area that is centered today on the Four Corners, where the borders of Colorado, New Mexico, Arizona, and Utah meet (Figure 1). Although pottery is a ubiquitous aspect of Anasazi archaeology, progress in understanding ceramic production technology and organization has been relatively recent, despite a tremendous foundation laid by the work of Anna O. Shepard (1939, 1965; Bishop and Lange 1991). The major impediment has been a lack of archaeological information on Anasazi firing techniques. Without such information, archaeologists have tended to rely on ethnographic descriptions of pottery production (such as Guthe 1925)

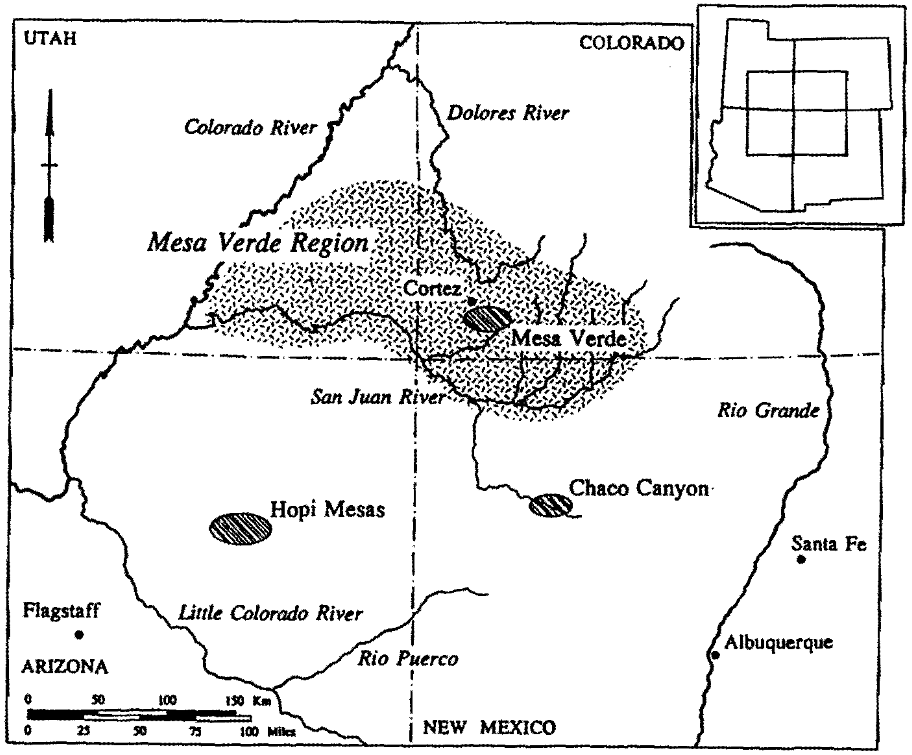


Figure 1. The Mesa Verde or Northern San Juan region of the Anasazi Culture area.

for interpretive models of production technology and organization. This situation changed in the early 1970s with the recognition of the first archaeological firing features or kilns (Helm 1973) and with the recognition of their abundance in the 1980s (Fuller 1984).

Consisting of shallow stone-lined trenches (Figure 2), these kilns were clearly different in design and scale from ethnographic and historic firing features. Interpretive models based on the firing techniques of Native American potters were no longer applicable, and new models were needed through theoretical and experimental research. In 1991, Crow Canyon Archaeological Center in Cortez, Colorado, hosted a conference of archaeologists and potters, including Native Americans. This began an informal but intense collaboration, the goal of which has been the experimental study of ancient Anasazi firing techniques. Since then, results of individual experimentation have been shared at annual Kiln

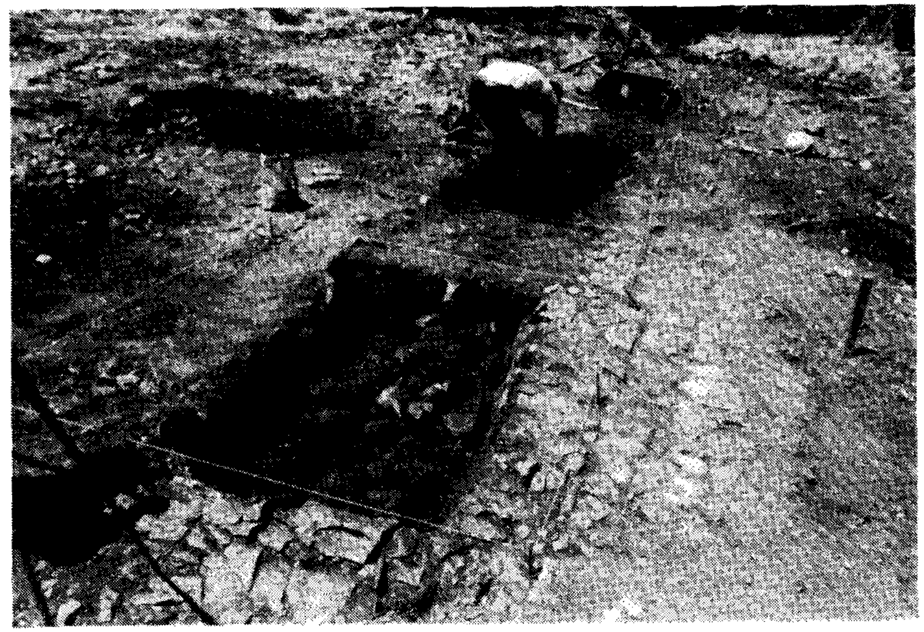


Figure 2. Trench kiln under excavation by La Plata Archaeological Consultants in 1982.

Conferences. Progress in understanding firing principles has been dramatic, both answering and raising questions concerning the prehistoric technology.

ANASAZI TRENCH KILNS

Although hundreds of possible Anasazi trench kilns now have been identified by archaeological surveys, only about 30 have been excavated. The vast majority of the kilns, and all of the excavated examples, have been located in the Mesa Verde or Northern San Juan region (see Figure 1). Other kiln types have been identified in other regions (Post and Lakatos 1995), and although the area of trench kiln distribution may enlarge with additional archaeological research, the trench kiln type appears to be a northern style.

Descriptions of 19 excavated trench kilns have been summarized by David Purcell (1993), 9 kilns have been reported in draft form from recent excavations at Mesa Verde National Park (Brisbin 1996), and several other kiln features have been described individually (Honeycutt and Fetterman 1994) or are still being studied. The excavated kilns range in age from as early as A.D. 900 through the Anasazi abandonment of the region prior to A.D. 1300. Most of those that can be firmly dated fall within the Pueblo III period (the latter third of this range), but many cannot be dated with confidence. Given the similar qualities of pottery for the entire Anasazi time span (A.D. 600-1300) it is probable that analogous if not identical features will be discovered for the pre-A.D. 900 period.

Trench characteristics show strong regularities but some variability as well. Most features are rectangular in plan, although some depart toward irregular or oval outlines. Lengths range from 1.5 to 8.5 m (Figure 3). Width is the most uniform dimension, ranging from 0.8 to 2.0 m, while depth is variable, ranging from 10 to 65 cm. With two exceptions, there is a strong correlation between increasing width and increasing depth (C. Swink 1996a). Although there are some suggestions of increasing maximum length through time, the sample of securely dated features is too small for confident interpretation, and shape and size variability is considerable even within the late examples. Also, although all kilns have a constructed length, some have clear evidence of later subdivision into smaller firing chambers, and some have areas or shelves of shallower depth, perhaps to accommodate different vessel sizes.

Stratigraphic contents of the kilns can be generalized with little qualification (Figure 4). In nearly all cases, upright slabs, usually sandstone, line the sides and ends of a shallow trench. The trench base is covered with a layer of charcoal-rich earth, often including large fragments of partially consumed fuel. On this layer is a nearly continuous but often irregular pavement of well-burned and blackened stones that fills the entire plan of the trench. Pottery, if present, overlies the stones in a matrix of charcoal and earth. Usually, a final upper layer consists of earth with distinctly less charcoal. Charcoal is dominated by woody species such as piñon pine and juniper, with only occasional preserved evidence of shrubby fuels. Although vegetation zones with scrub oak are present in the Northern San Juan region, no kilns have as yet been found in those zones, and oak has not been identified as a significant fuel component. Extremely high corn pollen content suggests that corn stalks were a secondary fuel in at least one case (Honeycutt and Fetterman 1994:22.2-7).

Pottery is surprisingly scarce in these features and falls into three categories. Usable vessels are extremely rare and are represented only by small mugs and a ladle that were found on the pavement, perhaps items that were overlooked on emptying the kilns after the last use. Slightly more common are miniature pinch pots or disks of clay that may have been potters' test pieces or children's vessels. These either were not retrieved or were discarded in the kiln after retrieval and examination. Broken pottery, partial vessels, or bloated fragments are more

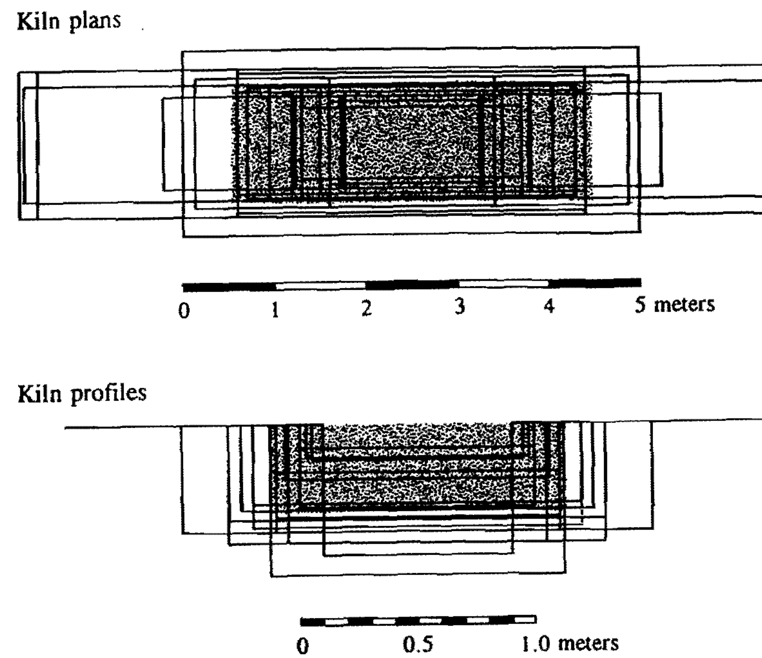


Figure 3. Schematic diagrams of kiln dimensions: length and width, and width and depth. Shapes have been simplified as rectangles, and shaded areas represent mean dimensions. Data are from Purcell (1993:Table 2).

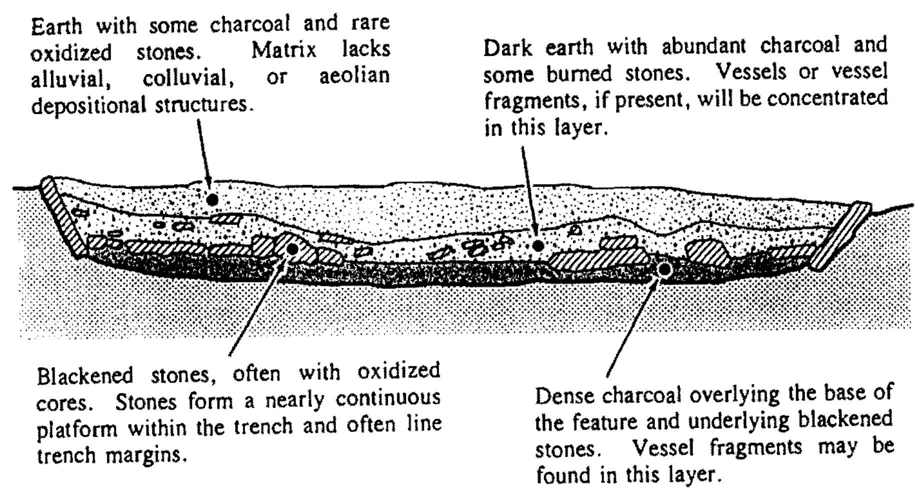


Figure 4. Representative stratigraphy of Anasazi trench kilns.

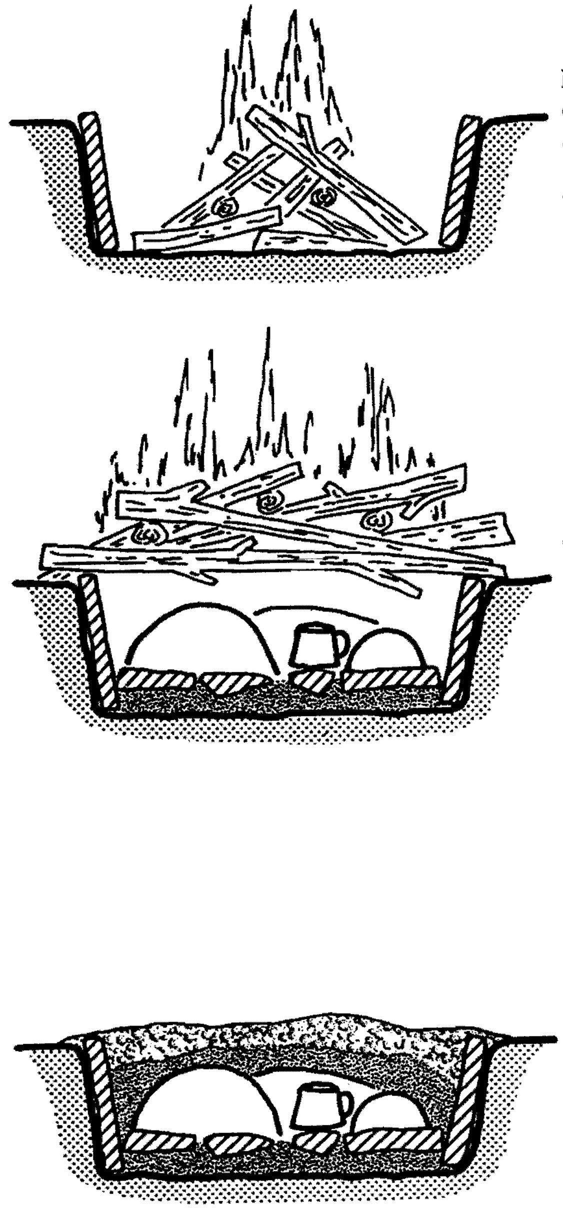
common, but significant amounts are present in only a minority of the kilns. In the most extreme case, sherds from at least 35 vessels were identified in a single kiln, but the vast majority of these were partial vessels represented by only a few fragments (Fuller 1984; C. Swink 1996b). These presumably are dominated by wasters but may include some cover sherds left behind for use in future firings. Ceramics of any kind were absent in 7 of the 28 kilns that have been described in detail.

Kilns can be located from 10s to 1000s of meters away from contemporary residential sites, and in one case the nearest known residence is more than 5 km away. Slight slopes are favored but not exclusively so, and some kilns are placed in shallow drainage bottoms or at the convergence of small and larger drainages. Feature orientation tends to be perpendicular to dip direction, suggesting that topography was not employed to encourage a draft along the kiln length. However, geographic settings are in places where morning and evening air movement up and down slope may have provided consistent light side breezes during parts of each day.

A singular locational aspect is that kilns can occur in clusters of up to six features within 10s of meters of each other. Contemporaneity is difficult to assess with the available dating techniques, and in only a few cases are kilns so close as to preclude simultaneous use.

FIRING REGIME

Without appropriate ethnographic analogues, experimental replication has been necessary to develop models of kiln function. Guidelines for the replication experiments have been the characteristics of the trench kilns, the raw materials and fuels used by the prehistoric potters, and the appearance of Anasazi pottery. These guidelines have insured a degree of authenticity, but we acknowledge that successful replication need not mean that prehistoric practices have been duplicated exactly. Experimental research from 1991 through 1996 has closely approximated most aspects of trench kiln appearance and stratigraphy, as well as the qualities and appearance of Anasazi black-on-white vessels. The greatest progress occurred through close collaboration between Clint Swink, an artist and potter, and Mesa Verde National Park archaeologists who were engaged in a series of kiln excavations (C. Swink 1996a). Although minor discrepancies in the current firing model suggest that some aspects of the Anasazi firing regime are still imperfectly understood, the structure of the current model appears to be robust (Figure 5) (C. Swink 1993).



Preliminary fire – A fire is constructed within the kiln and allowed to burn to produce a layer of charcoal across the trench base.

Secondary fire – The stone platform, vessels, and cover sherds are placed on the charcoal layer. Fuel is ignited over the setting.

Quenching – After the fuel burns to charcoal and collapses, the setting is covered with a smothering layer of earth and allowed to cool.

Figure 5. Firing sequence model based on trench kiln replication experiments.

After trench construction, a fire of coarse fuel is set within the feature. When the fuel is reduced to a layer of coals, a stone pavement is constructed on the coal bed. Vessels are placed in a single layer on this pavement, and if cover sherds are used they are arranged at this time. As the vessels heat up from the underlying coals, a dome or layer of wood fuel is built above the vessels, supported by the edges of the trench and with air space between the vessels and the fuel. Controlled ignition of the overlying fuel radiates heat downward over the vessels and encourages drafts that raise the temperature of the underlying coals (Figure 6). A reduction atmosphere is maintained in the early stages of firing by volatile gases released by the fuel and by any carbonaceous material in the clay. During this phase, some blackening or sooting of vessel surfaces can occur. As combustible gases are exhausted and charcoal alone provides both upper and lower heat, a slight oxidation atmosphere prevails, removing soot. By the time the overlying fuel collapses on the vessels, the effects of temperature are nearly complete. After short soaking near peak temperature, the firing is quenched with a layer of earth, isolating both the fuel and vessels from additional oxygen. Temperature declines steadily, and within 24 hours the vessels are usually cool enough to remove without the risk of additional oxidation that would alter vessel appearance.

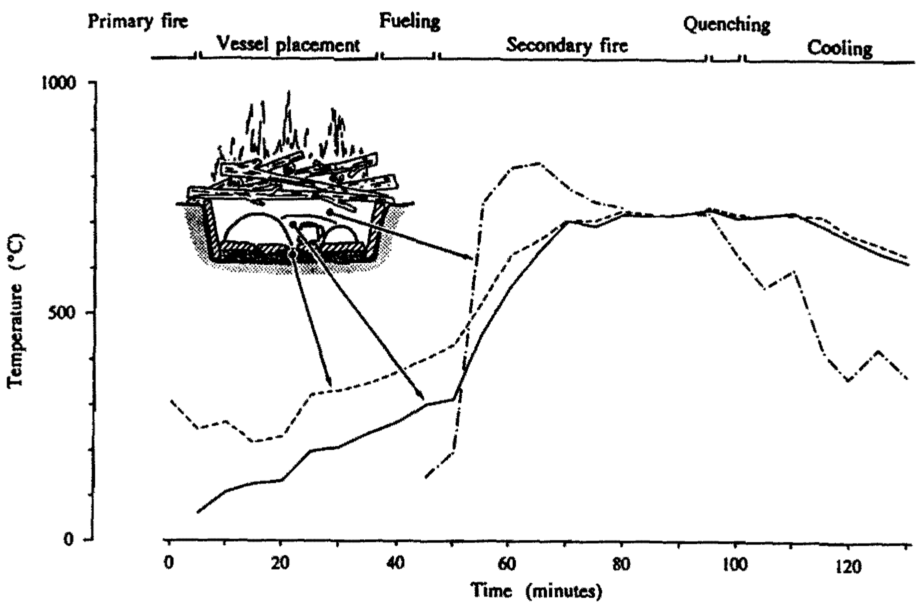


Figure 6. Experimental firing temperatures. This firing did not reach optimal temperatures (800-900° C), but it demonstrates the shape and timing of a typical firing sequence. Thermocouples were placed at different points within the setting.

Fuel selection and manipulation are key to achieving adequate temperatures and proper atmosphere control. Heat rise that is too rapid can cause vessels to shatter from differential thermal expansion and steam evolution. Over-fueling can slow combustion, lower temperatures, and subject vessels to too much reduction, resulting in soft and blackened vessels. Underfueling can also result in lower temperatures and can produce an inadequate reduction phase, resulting in soft and occasionally oxidized vessels. Impatience in waiting for the exhaustion of volatile fuel gases either before vessel loading or before quenching can cause smudging. Finally, if the late oxidation phase lasts too long before quenching or is too intense, organic-painted designs can be lightened or erased, and iron compounds in mineral paint or the clay can be oxidized. This over-oxidation results in weak designs and yellow or pink background colors, a degradation of vessel appearance that is seen on only a minority of Anasazi pottery.

Laboratory experiments currently being conducted by Lawrence Sitney at Los Alamos National Laboratory have demonstrated the importance of the reduction phase in Anasazi firing (Sitney et al. 1995). Under reducing conditions, the sintering curve for the shale clays used by Anasazi potters is effectively enhanced. Under reduction conditions, a well-fired ware can be produced at 800° C, while a temperature of closer to 1000° C would be required to produce the same degree of sintering under oxidizing conditions. In experimental trench kiln firings, temperatures of 800-900° C produce wares comparable in quality to the majority of Anasazi pottery. This staged atmosphere control of the Anasazi firing regime appears to be essential to vessel strength as well as having the secondary effect of producing the characteristic white or gray background for the painted designs.

Several points continue to be investigated through firing experiments. These include the role of cover sherds and minimization of fuel volume. The question of cover sherds is particularly intriguing. Only a few archaeological kilns contain sherds that could have been used as covers, and even these may have been wasters. Even in the large isolated kilns where retrieval of cover sherds for reuse elsewhere would have been less likely, there are insufficient sherds left in the kilns to have protected any significant portion of the setting. However, during experimental firings cover sherds effectively protect vessels from heat shock during the ignition of the overlying fuel, they can enhance temperature through draft control immediately after collapse of the upper fuel layer, and they provide vessels with some protection from the physical and atmospheric effects of both overlying fuel collapse and the subsequent earth covering. If cover sherds were used routinely, Anasazi potters must have valued them sufficiently to retrieve them after the final use of many of these trench kilns, even those at some distance from residential sites. Alternatively, the replicated firing regime may be an inaccurate characterization of the ignition and fuel collapse phases, with Anasazi potters following different procedures that minimized the risks that the experimental firings now mediate with the cover sherds.

Fuel consumption during initial experimental firings was relatively great, and with increasing experience has been reduced to an average of about 6.5 kg per vessel or about 100 kg per square meter of kiln area (C. Swink 1996a). Although current experimental fuel use patterns have been an improvement, the figure is still high. If 100 kg per meter is a reasonable approximation, fuel demand would have been a strong impetus toward moving firing locations to areas of abundant fuel availability. However, much of the heat generated by combustion is lost to upward radiation, and continuing experimentation with fuel selection and arrangement suggests that additional improvements in efficiency can be achieved. These improvements appear to hinge on fuel quality (shape and size) and arrangement. Fuel quality may prove to be as important in Anasazi kiln location decisions as fuel abundance.

IMPLICATIONS FOR PRODUCTION ORGANIZATION

Knowledge gained through replication experiments has gone beyond technical aspects of the firing regime and extends to questions of production organization. It is tempting to assume large scale production specialization based on the sheer size of the largest kilns and the tendency for facility investment to correlate with degree of specialization (Arnold 1985:219). However, the situation is far more complex.

Size does mean large numbers of vessels in each firing. Experimental firings can easily accommodate 15 vessels per square meter of kiln area, implying a range of about 25 to 200 vessels per firing for the prehistoric kilns. Estimates of the number of vessels in Anasazi households can range up to 30, including a full range of vessel forms, half or more of which would be decorated wares (Blinman 1988:152-156). Despite this large inventory, ethnographic and archaeological data on vessel breakage rates suggest that replacement of as few as five vessels per year would be a reasonable estimate (Kohler and Blinman 1987), perhaps two or three of which would be white wares in a given year. A single firing of even the smallest kiln would produce enough white-ware vessels for the annual needs of several households, and the largest kilns could produce enough replacement vessels for as many as 80 households.

Firing frequency is also an important consideration in estimating kiln production volume. This variable is impossible to determine with presently available

temporal control, but kilns were clearly used repeatedly. This is suggested by the depth of some kiln oxidation rinds, by the degree of fragmentation of some of the pavement rocks, and by episodes of kiln remodeling. However, whether firings were scheduled once or several times each year is unknown and perhaps unknowable.

Repeated use is also supported by the use of slab linings for the sides and ends of most trenches. Initial interpretation of linings included the possibility that the slabs served to reflect heat into the firing feature, enhancing the firing temperature. Experimental results suggest that fuel manipulation plays a far more important role in heat generation, and there is no significant decrease in firing temperature associated with the use of a simple earthen trench as is seen in some kilns. It is far more likely that the stone linings were designed for feature permanence. The stones would keep the sides of the kiln from collapsing during and between uses, and the lining would allow easy cleanout for the next use. This pattern of reuse is consistent with the occasional remodeling or subdivision of kilns, in which kiln size is temporarily reduced to accommodate a smaller vessel load.

The presence of multiple kilns within meters of each other also affects our interpretation of production volume. This proximity can be interpreted as simultaneous use by multiple potters with correspondingly high production volume. However, simultaneous versus sequential use of adjacent kilns is nearly impossible to differentiate archaeologically. Native American potters have suggested an alternative interpretation. Traditional potters will frequently abandon a kiln if a firing fails. Moving the firing location a few meters away is often sufficient, and the potter may or may not reuse any of the construction materials from the failed kiln. In one case where five kilns were excavated at a single site, all contained significant quantities of wasters. Unfortunately, this content could be consistent both with a simultaneous use model and with sequential use following failures.

Kiln locations provide additional points to consider in evaluating production organization. The isolated nature of many kiln locations has prompted speculation concerning fuel availability. Anasazi settlements were heavy consumers of fuel for domestic purposes, often depleting local supplies through the lifespan of villages (Kohler and Matthews 1988). Patterns of domestic fuel use appear to deplete woody species first, followed by depletion of shrubby fuels. Since the archaeological evidence and experimental firing regime suggest reliance on charcoal-producing fuels, pottery firing would require substantial quantities of high-quality dry wood. Where local supplies were depleted or scarce near residential locations, moving the firing to the fuel source may have been more efficient than moving the fuel to the firing.

However, experiments with pottery workshop participants have shown that moving unfired vessels as much as several kilometers to a kiln site poses its own problems. Unfired pottery is weak, and painted designs are tacky and can be smudged by physical contact. This fragility means that vessel transport is not without risk. Pottery production at the kiln site is possible, but there are as yet no clear suggestions of any significant residence time at the outlying kiln locations. Accessory hearths are rare, and there has been no evidence of permanent or ephemeral structures in the vicinity of the outlying kilns. Nonperishable artifactual evidence of pottery production is rare, even on sites with definite evidence of production (Blinman 1988:76-97), and although the lack of pottery production tools at kiln sites is consistent with production elsewhere, it is a weak argument.

Clay source distributions can influence the location of production facilities in some cases, including firing facilities. Informal surveys in the vicinity of some trench kilns have located clay sources within 100s of meters. However, clay sources are so common amid the dissected topography of the Colorado Plateau that few areas of the northern Anasazi landscape are outside of the resource catchments characteristic of ethnographic potters (Arnold 1985:35-57). We do not believe that clay sources are more strongly associated with kiln locations than with residential locations.

Seasonal weather patterns would have further influenced the organization of production and outlying kiln use, although the influence of these patterns would have been much less for firing features that were proximate to the potters' residences. Freezing evening temperatures can occur from September through May. Although cold does not affect the actual firing (successful experimental firings have been conducted in subfreezing temperatures), if freshly formed vessels are left unprotected and freeze while awaiting firing, they are at risk of noticeable strength reduction (T. Swink 1996). Another constraint is imposed by afternoon thunderstorms that are common from July through September. These rains need not interfere with the firing since the process can be carried through the quenching stage in the dry morning hours. However, vessels cannot be stockpiled and left unprotected at a distant firing location during the monsoon season. This would also affect production at the outlying kiln site, since many days would be required for the forming, decoration, and drying of hundreds of vessels.

Where each kiln reflects a single large-volume firing, settings do not appear to have been limited to the products of a single potter. Potential collaboration of multiple potters is difficult to evaluate, since there is no way of determining conclusively whether kiln contents (wasters or cover sherds) are cumulative remains from multiple firings or whether the associated ceramics are the consequence of the last firing only. However, since the experimental firing model requires that the trench be cleaned out before each use, it is likely that wasters (as opposed to cover sherds) are dominated by the vessels from the last firing. If this is true, then it is likely that some trench kiln firings were collaborative events. The contents of several kilns have been examined from the perspectives of both archaeologists and artists (Fuller 1984; C. Swink 1996b). Individual kilns have included ceramics with multiple and distinctive paste-slip formulations, and several kilns have included both mineral- and organic-painted vessels. These combinations are unlikely to have been the products of a single potter. Design styles in these cases have also been diverse, although this attribute is more difficult to interpret confidently.

Although the lines of evidence are not conclusive, we believe that the larger firings were collaborations of multiple potters. The argument is strongest for the large outlying kilns, since they are most affected by the risks to unfired pottery of long distance transport and weather exposure. However, we suspect that the collaborative model is applicable to the trench kilns in general.

Fuel efficiency gain in one large versus several smaller firings would encourage collaborations, but there are stronger logistical and technical arguments. Vessel quantities implied by the large kilns are not outside the conceivable range of a potter's annual production, but there is little room in Anasazi dwellings to accommodate the storage of up to 200 vessels leading up to a firing. Transporting vessels would have required considerable numbers of people, arguably stretching the abilities of a single family. Fuel gathering also represents a substantial effort, with conceivably more than a metric ton needed for the largest firings. Fuel manipulation during firing is also critical and would benefit from multiple participants. Fueling a 4-meter demonstration kiln at the 1994 Pecos Conference required the attention of four people during the most active stage of the firing. This labor demand is within the range of a family, but it is not an unskilled task and would benefit from experience. Collaborations would allow the most experienced potter to serve as firing director, having the secondary effect of transmitting knowledge through communities and generations of potters. For the large outlying firing features, the summer solstice would have been an auspicious time for firings, both in terms of weather and in minimizing scheduling conflicts with agricultural tasks.

CONCLUSION

The general consensus of archaeologists in the American Southwest is that Anasazi black-on-white pottery production was specialized at the level of a household industry (Mills and Crown 1995; Wilson and Blinman 1995). Supporting arguments have hinged on a relatively narrow range of clays used in white-ware production (Hegmon et al. 1995), widespread exchange of these wares, a few burials of women with abundant pottery production tools as grave goods (Crotty 1983), and the existence of large specialized kiln features. This production model assumes scattered skilled individuals, with slight regional concentrations or community specialization based on resource availability and quality. Increased specialization through time is suspected, in part on the basis of the many large trench kilns that date to the Pueblo III period, but still within the household industry concept (Wilson and Blinman 1995).

This late increase in apparent specialization may be overstated if the collaborative model suggested by the replication studies is correct. Other variables such as increasing community nucleation in the Pueblo III period (Lipe 1995) and fuel depletion could be contributing to an increase in the size of collaborative groups, with the consequence that the degree of specialization may be less than feature size alone would suggest.

Exchange patterns are partially consistent with this view of less extreme specialization. The detectable volume of total pottery exchange actually decreases in the Pueblo III period (Blinman and Wilson 1993). Communities within the Northern San Juan region are importing fewer vessels from outside the region, and there are fewer indications of within-region vessel distribution. There does seem to be some exportation of Northern San Juan vessels to areas such as Chaco Canyon to the south, but the volume is not extreme and from the Chacoan perspective this is a change in source area rather than necessarily a change in the volume of imports (McKenna and Toll 1991; Toll et al. 1980). The majority of pottery production from the trench kiln appears to be circulating within communities and local areas rather than over larger distances. The trench kilns appear to be indicative of large-scale firing, but not necessarily large-scale specialization.

Pottery production must be understood in terms of both technology and organization, and the prehistoric Anasazi trench kilns are graphic examples of this principle. Strictly archaeological data have been limited in the picture that can be developed of trench kiln use, and an aggressive program of replication experiments has produced valuable complementary information. Knowledge gained through replication should not be considered accurate or absolute, but it does raise important issues and provide new perspectives on the archaeological data. In this case, replication emphasizes the probable role of collaboration among groups of potters in firing white ware vessels.

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THE VARIABILITY AND EVOLUTION OF PREHISPANIC KILNS ON THE PERUVIAN COAST

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ABSTRACT

The scarcity of archaeologically documented ceramic kilns has been commented upon often and has led to the widely held opinion that prehispanic ceramics in the Andes, like ethnographically documented cases, were fired predominantly in open pits. However, the past decade has seen a series of excavations at production sites with firing structures on the Peruvian coast, particularly on the north coast. Together they span some 2500 years of prehistory and show considerable variability in regard to construction materials, size, shape, capacity and overall design. This paper describes and examines the variability found among these firing structures within the broader contexts of production sites and technologies. The observed variability seems to be in part related to the vessel formation techniques employed, exterior finish desired, scale of production, and physical and social settings.

INTRODUCTION

With the abundance of elaborately decorated pottery in the ceramic stage of Andean prehistory, archaeologists have devoted the lion's share of their attention to stylistic and iconographic studies. While there has been important advances in stylistic dating and elucidation of rituals and associated ideologies, our research on the technical and technological dimensions of these ceramics has considerably lagged behind. Since the days of Sigvald Linné's classic *The Technique of South American Ceramics* (1925), such understanding has been based largely on ethnographic analogy and visual examination, combined with the study of molds in museum collections and small-scale replicative experiments (e.g., Carmichael 1990; Donnan 1965; Tello 1938). In his synthesis of South American ceramics, Willey (1949:142) was able to summarize what was known then about the whole subject of firing and associated features in a single, short paragraph. As a whole, earlier studies that touched upon the technological dimensions of prehispanic ceramics were "retrogressive", attempting to unravel the intricacies of the manufacturing processes from their products. This approach is inherently