Archaeological Ceramics

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17. Kilns and Ceramic Technology of Ancient Mesoamerica

WILLIAM O. PAYNE

Abstract

Microscopic and chemical analyses were made of specimens recovered from excavations in the Valley of Oaxaca, Mexico, to determine the geologic origins. Field studies were conducted to find the pottery materials for comparison. Contemporary potters were subjected to close scrutiny of their preparation, forming, and firing practices to learn what to look for in ancient wares and to compare the technologies. Kiln structures were examined very closely, resulting in the identification of kilns and kiln sites of approximately 600 A.D.

Introduction

These studies were begun in 1958 in the Valley of Oaxaca and adjacent terrain, in southern Mexico, and are continuing to the present day. The primary object was to reveal as much as possible regarding the technology of pre-Columbian pottery making. First was a thorough study of the geology of the valley. Second, samples were taken of soils suitable for the production of ceramic bodies. (NOTE: The author uses the ceramist's term "body," rather than the limited, and inaccurate, word "paste.") Suitable materials were found in situ where they were formed by the disintegration of rock formations and in places such as alluvial fans, river banks, and flood plains. Third, modern village potters were studied to determine present methods of preparation of bodies and formation of wares. This work revealed clues as to the techniques of ancient potters. Fourth, modern village kilns were examined for clues in the search for ancient firing technologies. As a result, two kilns were recognized from the period of ca. 600 A.D. Fifth, various firing methods of the present day were studied and experimented with in an attempt to duplicate atmospheres and temperatures used for ancient ware.

Raw Materials

Collection of soils and minerals from many formations was made. Alluvial fans were found to produce suitable bodies originating by decomposition of tertiary rocks, such as rhyolite, andesite, and acid granites. The plastic component was supplied largely by decomposed feldspars. The angular shapes of the granular components indicated nearby sources of the above rocks. Cretaceous formations produced compositions of clayslates, limestones, and metamorphic sandstones. Extensive flood plains are made up of mixtures of the above residues in varying amounts depending upon the distances transported and the hydrological history. Most of these soils exhibit deoxygenation resulting in light to dark gray colors. Many of them carry small amounts of angular pyroclastic ash, similar to the fallout produced by Mount St. Helens, Washington. Another source of coarse body is from the decomposition of Precambrian gneisses and schists. These are among the most ancient rocks on the North American continent and are found on the surface only in southern Mexico.

A deposit of high quality kaolinite was found near Mitla, Oaxaca. It is probably a source of the off-white body used in the valley in ancient times. It was formed by the percolation of hot volcanic waters through a very large feldspar dike. Levigation produced a very fine slip clay. A commercial deposit of fine white kaolin is presently producing clay for local factories. It occurs near Nochistlan and may be the source of the white slip clay used on Mixtec polychrome decoration.

Mineral oxides are found in many places in and near the valley. Red iron oxides are common, and the dioxide of manganese occurs as veins at San Pedro el Alto. These along with the white kaolin were the principal colorants for washes and slip painting.

The ratio of plastic components (i.e., clays) to nonplastics (quartz, feldspars, micas) measured by dry weight, after levigation and decanting, was clustered around 50:50, or half and half. That ratio is common today for the industrial production of commercial ceramic bodies.

Samples of soils and lightly crushed fragments of pottery were glued side by side for microscopic determination of mineral content regardless of the color of the specimens. A rubber-tipped pestle was used in a porcelain mortar to avoid crushing of nonplastics. Most of the complicated classifications of Oaxacan pottery have, in the past, been based upon color changes due to firing conditions, rather than upon mineral composition. Of the some eighteen to twenty thousand sherds and fired bodies examined microscopically, not one was found to contain crushed fired pottery as the nonplastic component.

The excavation of Tomb 2 at Lambityeco produced a large quantity of unfired ceramics. Some pieces were made of the coarse red Precambrian material, but most were formed of the gray valley floor soil. The former was found in nearby ravines and the latter was found within a half kilometer of the tomb site. Much of the material had been removed in ancient times, leaving mounds topped by very old trees held up by clusters of roots. Sherds formerly used as scrapers were common in the clay pits.

The author has observed (over many months of field studies of many sites) that almost 100% of the pottery at a given site was made within a 2-kilometer radius of that location. A search within that range will usually reveal the body source, as well as a source of water and of fuel. If the area has not been plowed or covered by vegetation, it may be possible to find old kiln structures.

Body Preparation

Preparation of the material for use is a homogenizing process called "wedging," a method of kneading the wet body. The material is crushed to speed wetting, and rocks, if present, are picked out by hand. Several cones of prepared body were found in Tomb 2 at Lambityeco. These had been shaped in the same way that Oriental potters today prepare body for use in the village potteries.

Forming of Ware

Many clues as to forming methods may be found in ancient ware. "Ropes" of body were laid up in concentric rings for the walls. This technique has been miscalled "coiling" for many years. One may observe the evidence often, on the inside or outside of the ware. The rings are pinched up to thin out the walls which are subsequently scraped and/or burnished on the outside of jars and the inside of bowls and dishes. Some pieces from the Early and Middle Formative periods showed evidence of the lower half of large jars being formed over an existing pot, then finished by adding concentric rings for the upper half. That wood ash was used to prevent sticking is proven by observing pockmarks left by burned-out charcoal fragments. Ash is used today by many potters for the same purpose. Imprints of matting are occasionally seen, showing that slabs were patted out before laying up on the mold. Many large figures were molded entirely by hand, while smaller, mass-produced pieces were partially hand-formed, with mold-made additions. Many of these molds have been found.

Kilns

Extensive studies were made of contemporary village pottery kiln structures. Some potters simply pile the ware loosely, in the open, place fuels under and over the pots, set the mound afire, then wait until combustion is complete. Others make a ring of large pots on open ground, place fuel on the ground, stack the pots on that, cover the pile with more fuel and fire it off. Some build much more elaborate structures for more controlled temperature and atmosphere control. Two pits are dug in the ground about a half meter apart with a hearth tunnel joining them at the bottom. A perforated floor of adobe bricks is made in one pit at the level of the top of the tunnel. The other pit is used for fuel storage and stoking of the fire. In other villages a large cylinder is laid up of rocks and mud mortar on the surface with a covered hearth on one side. The floor of the firing chamber is made in the same way as the subterranean models.

Figure 1. Consolidated remains of a pottery kiln found in a habitation site on the slopes of Monte Alban, Oaxaca, Mexico. Diameter of the ware chamber is 1.40 M (4'7"). Rocks which formed the cylindrical wall were dispersed downhill to form farming terraces. The kiln was in use ca. 600 A.D.

Measurements made of the firing aperture were found in square area to equal the total area of the perforations in the firing floor. This formula is that used by contemporary Western potters for their up-draft and down-draft kilns. This research led to the identification of two kilns in a residential site on the slopes of Monte Alban (Fig. 1). They were thought to be storage pits until recognized as pottery kilns built about 600 A.D. The larger kiln was semisubsurface with the firing chamber excavated in the bed rock and the ware chamber built on the surface of laid-up local rocks. A very small kiln was cut in a bank of bed rock, but was in such poor condition that its total structure was conjectural in details.

Firing Methods: Fuels, Atmospheres, and Temperatures

Owing to the absence of known kilns suitable for the production of the reduced black ware of the Oaxaca region, reference was made to the methods employed by the Pueblo potters of New Mexico. Experiments were conducted and resulted in duplicate gray-black color of the wares fired and smothered. Since the discovery of the Monte Alban kilns, it is now known that the pre-Columbian potters were using the iron oxide reduction technique. For pots to be fired in the open area, pot-wall techniques were given a "bon voyage" blessing with a burning twig before being packed inside the kiln wall on dried maguey leaves. More leaves were piled on top of the load and it was set alight on the downwind side. More fuel was placed on top to even the burning as it progressed. A thermocouple stuck inside one of the pots recorded a temperature of 700 °C, about 1300 °F, in 50 minutes. The ware was allowed to cool to 300 °C before drawing of the ware began.

The subterranean kilns are loaded to the top of the chamber and laid over with sherds of broken ware. A very low fire is lighted and allowed to burn for about 3 hours to drive off the hygroscopic water; then the principal fuel of oak is added for about 8 hours until the ware seen through the sherds glows a dull red. More fuel is added, often including resinous pine. When the fire is at peak heat, the kiln is sealed quickly with mud on the top over the sherds, an adobe brick is placed in the fire door, and the seal is made air-tight with mud mortar. This technique causes the ware to burn black because of oxygen starvation. The kiln is allowed to cool for about 8 hours, when the chamber is opened for removal of the ware. Recorded temperature was 750 °C, or about 1400 °F.

A large pot was recovered in pieces and reconstructed. The pieces had apparently been used as covering sherds, in different firings. There are varying degrees of reduction of the iron content; some of the fragments are a light brown and others are shaded in values of gray to almost black.

Summary

The application of disciplines in geology, mineralogy, physical chemistry, and a knowledge of the art and craft of the potter have led to some significant revelations in an area hitherto ignored. The truism "it takes one to know one" has never been more applicable than in this research. The author is a potter, not a scientist, and as such relates directly to the craft upon which so much archaeological "evidentia" depends.

It is hoped that this brief review stimulates field archaeologists to depend upon an exhaustive study of the simple, physical evidence of the potters' art, before resorting to expensive and sophisticated analytical processes. Comparative studies, of course, are only useful where there is a probable continuum of cultural pattern. The situation in the Oaxaca Valley is such that it may be used as a pattern for research—the living potters are using the technology developed by their ancestors. Modern ceramic technology has made definite inroads on their craft, but the fundamentals are still there.

The result of these intensive studies of the crafts of the modern potters has led to the presently expanding discoveries of kilns and kiln sites for the making of pottery of earlier times. Without the indispensable device of the kiln, there is no way in which pottery could have been made of the quality found throughout Mesoamerica. The kilns excavated at Monte Alban are presumably identified as the first permanent structures for firing pottery in Mesoamerica. In the past month [9-1-80] another large pottery kiln has been uncovered in the Monte Alban zone; *see* M. Winter, field notes, INAH Regional Center, Oaxaca, Mexico, personal communication.

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18. Ceramic Technology and Problems and Prospects of Provenience in Specific Ceramics from Mexico and Afghanistan

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Abstract

The theme of this research follows Frederick R. Matson's statement in *Ceramics and Man* that "unless ceramics studies lead to a better understanding of the cultural context in which the objects were made and used, they form a sterile record of limited worth" (1965a, p. 202). The ultimate goal of ongoing technological investigations of Mesoamerican "Thin Orange" ceramics from central Mexico, and Central Asian "Red Streak-Burnished" ware from northern Afghanistan is to identify the loci of manufacture and determine the sociocultural mechanisms whereby these ceramics were distributed in their respective culture areas. The results of my technological, mineralogical, and petrographic investigations are summarized, and the suggested cultural mechanisms of distribution elaborated. The Mesoamerican ceramic (150 B.C.–A.D. 850) has numerous variants based on aplastic analysis, and was manufactured primarily outside of the Basin of Mexico but also at the metropolis of Teotihuacan, in the main during the Classic Teotihuacan period. The Afghan ware (A.D. 140–550) was apparently made in Baluchistan and transported northward, ultimately destined for the market centers of Central Asia. The results of these studies are discussed, and analytical problems and interpretational difficulties are noted at this interface between archaeological and physical scientific investigations.

Introduction

Recent publications in archaeology have stressed the processual analytical approach as contrasted with a strictly historical analytical approach (Wetherington 1978). Although both viewpoints are valid, the intellectual stimulation derived from their interaction demonstrates the need for archaeologists to become more proficient in relating their own research to ethnographic, ethnohistoric, and archaeological problems. The archaeologist's goal should be to explicate archaeological data within a framework of the social and behavioral sciences as well as the arts and humanities. At the same time the archaeological investigator is reliant upon analytical techniques that derive from the physical sciences, especially chemistry and physics. Therefore the sites, artifacts, and contexts are analyzed and initially interpreted within the physical sciences, yet the ultimate interpretations are social and humanistic. As a result, the archaeologist is present at the interface between these realms, and with a "foot in each camp" attempts to resolve the interface problems whereby both physical scientists and archaeologists benefit from one another's specializations and research interests.