Aztec Elites and the Post Classic Economy: Instrumental Neutron Activation Analysis (INAA) of Museum Collections from Chiconautla, México

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Site: Chiconautla

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Introduction

With support from the Foundation for the Advancement of Mesoamerican Studies, Inc., (FAMSI) the authors analyzed ceramic material from George Vaillant's excavations at the site of Chiconautla, México housed at the American Museum of Natural History (AMNH). The results of this work shed light on outstanding questions regarding the relationship between markets, urbanism, and political development in the Basin of México and contribute to ongoing collaborative research that has created a better understanding of ceramic exchange networks emerging after the decline of the Classic Period state of Teotihuacán (Brumfiel and Hodge 1996; Charlton *et al.* 1999; Crider 2002; Crider *et al.* 2003; Hodge 1992; Hodge and Minc 1990; Hodge *et al.* 1992, 1993; Hodge and Neff, in press; Ma 2003; Minc 1994; Minc *et al.* 1994; Neff *et al.* 2000; Neff and Hodge, in press; Neff and Glascock 2000; Nichols and Charlton 2002; Nichols *et al.* 2002).

Previous work using INAA has identified six major ceramic composition groups associated with different subregions of the Basin of México–Chalco, Cerro Portezuelo, Cuauhtitlán, Otumba (Teotihuacán Valley), Tenochtitlán/Culhuacan, and Texcoco–along with several smaller groups (Figure 1) (Neff and Glascock 2000; Nichols *et al.* 2002). These studies also have obtained 185 clay samples from sources throughout the Basin for comparison with the composition groups (Neff and Glascock 1998).

The cumulative results of this research suggest that the Epi-Classic Period (A.D. 750-950) landscape, dominated by small city-states, had highly localized production and little exchange between political units (Crider *et al.* 2003; Ma 2003; Neff and Hodge, in press; Nichols *et al.* 2002). During the Early Post Classic Period (A.D. 950-1150) ceramic exchange (particularly the exchange of decorated vessels with prestige value) increased, although some limitations on exchange probably were imposed by political boundaries and, as a region, the Basin was divided into eastern and western marketing zones. In the Middle Post Classic Period (A.D. 1150-1350), the export of ceramic products from composition groups that included politically powerful city-states expanded (Minc 1994; Minc *et al.* 1994).

For example, Texcoco ceramics appear at the former city-state capital of Cerro Portezuelo, suggesting the onset of Acolhua dominance over the eastern Basin. In the Late Post Classic Period (A.D. 1350-1521), exports of Black-on-Orange pottery from the Texcoco and Tenochtitlán/Culhuacan composition groups further intensified as these imperial capitals became the largest market and craft production centers in the Basin. Greater frequencies of Black-on-Orange pottery from the Tenochtitlán/Culhuacan composition group at Chalco, an important production zone for Black-on-Orange ceramics in the Early/Middle Post Classic, may correlate with the conquest of that polity by the Aztecs around A.D. 1465 (Hodge *et al.* 1992, 1993; Nichols *et al.* 2002:69-70).

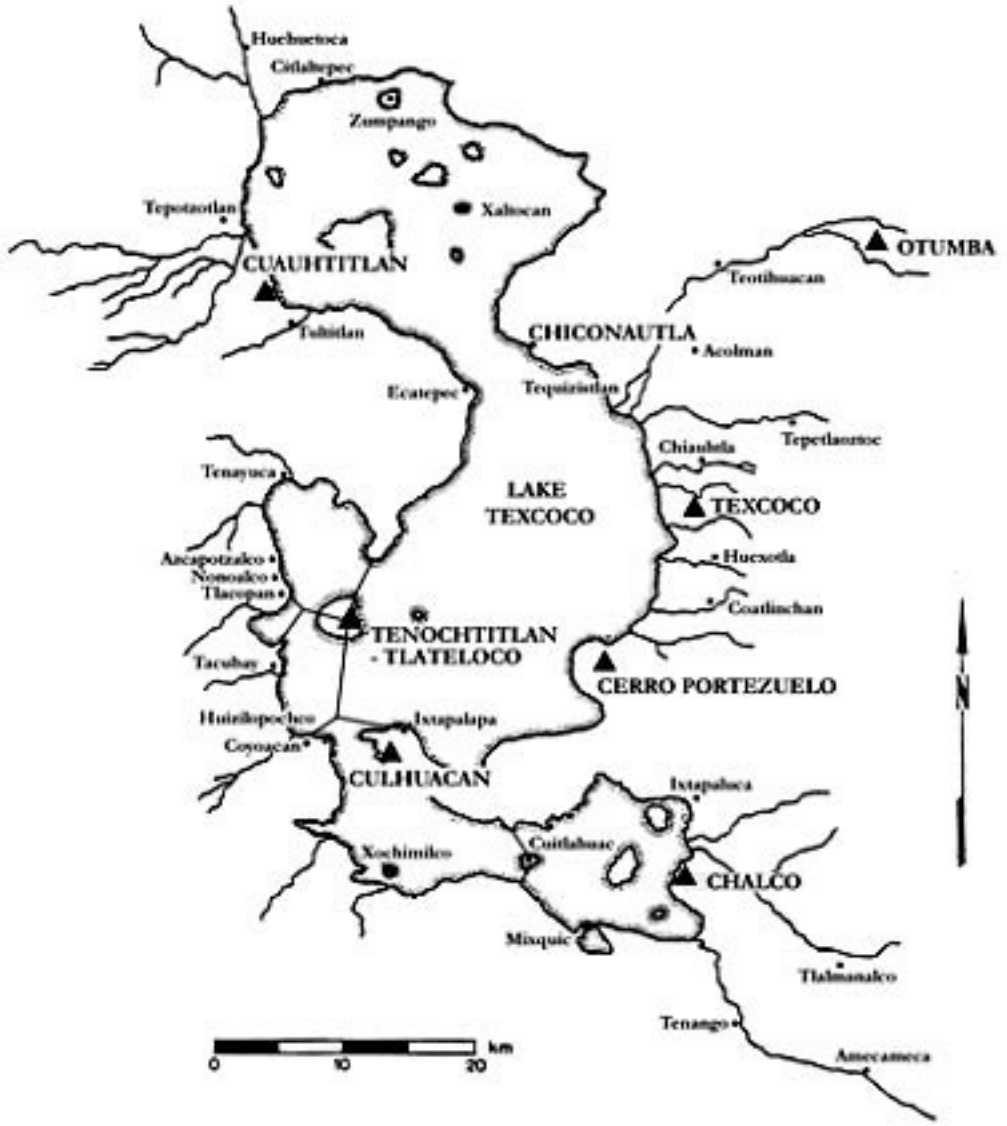

Figure 1. The Basin of México. Six major ceramic composition groups associated with different subregions of the Basin of México are identified with black triangles.

At the same time, the production and distribution of some other types is unclear. More research is needed to identify patterning in the production and distribution of Chalco-Cholula Polychromes that include a range of thin-walled, finely made vessels, which frequently occur as bowls, *pulque* vases, or copas (Neff *et al.* 1994). These fancy vessels appear less frequently and are less well-preserved in surface collections that have provided the majority of the samples analyzed by INAA to date.

Chiconautla

A brief description of Chiconautla and the research conducted there shows why the site is ideal for acquiring data that can be used to refine current ideas regarding economy and polity in the Basin of México. Chiconautla is located on the northeastern shore of Lake Texcoco and the southern edge of the Teotihuacán Valley–an important juncture for east-west exchange (Blanton and Hodge 1996; Gibson 1964:361; Hassig 1985:219; Sanders 1965:81-82). In the Classic Period, this part of the Basin was under the political domain of Teotihuacán. In the Epi-Classic Period, it is possible that the area still may have been under the control of a reduced, but still politically viable, Teotihuacán polity (Sanders *et al.* 1979; Sanders 1986). In the Middle Post Classic, regional survey shows that Chiconautla grew to be a large village, but it is unclear if it existed as a politically independent center, or was dominated by another town like Xaltocan, one of eight large regional centers in the Basin (Sanders *et al.* 1979:137-149). For the Late Post Classic, ethnohistoric documents describe Chiconaulta as a city-state capital with its own local lord who became subject to the Acolhua of Texcoco (Gibson 1964:43; Hodge 1991:134-135; Ixtlilxóchitl 1975/1977:2:88-90; Sanders and Evans 2001:948-949). Chiconautla's nobles intermarried with the Texcoco royal family; however, they also may have had a special relationship with Tenochtitlán's rulers, possibly through intermarriage (Berdan and Anawalt 1992:2:222; Evans 2001).

Working in 1935, Vaillant excavated two zones at the site. In one zone he located an Epi-Classic/Early Post Classic Period midden, while in the second zone he uncovered a well-preserved residence that he interpreted as an elite palace (Vaillant 1941). Although he was not able to finish a detailed analysis of the excavations, his careful field methods have allowed this initial work to be refined by more recent ceramic and architectural analyses, confirming that the structure he dug is best interpreted as an elite palace occupied in the Middle and Late Post Classic Periods (Elson 1999; Elson and Smith 2001).

Vaillant's pioneering methods warrant brief discussion. While in México, he carefully analyzed all the ceramics from excavation (over 100,000 sherds) and he tabulated the number of each ceramic type for each provenience unit. He brought a large sample collection of sherds (several thousand) and very likely the complete collection of other ceramic objects (such as figurines, temple models, spindle whorls, pipes, flutes, stamps) to New York. Because many of Vaillant's provenience units correspond to particular architectural units or cultural features and because he coded and described a number of previously unknown or poorly defined ceramic types now recognized as having particular temporal or cultural significance, Vaillant's Chiconautla research remains as a valuable data set that can be applied to current research questions.

Research Design

Chiconautla's critical position as an east-west point of exchange and Vaillant's acquisition of a well-documented ceramic sample from an elite residence allowed us to do two things. First, by testing samples from the Epi-Classic/Early Post Classic and the Middle/Late Post Classic house, we examined how Chiconautla fits into the current understanding of marketing and exchange patterns for the A.D. 750-1521 time period. These models suggest a shift from (1) a highly localized, solar marketing model to (2) increased movement of decorated vessels though a network of overlapping markets, perhaps also influenced by kinship, marriage, and political alliances to (3) a pattern of multi-centric production, an interlocking market system, and the growing influence of the Triple Alliance capitals of Texcoco and Tenochtitlán that reoriented city-state economies in the core of the Basin (Brumfiel 1987; Charlton et al. 2000; Nichols et al. 2002; Smith 1979, 1980, 2003a, b, c). However, the northeastern Basin, including the Teotihuacán Valley under the Acolhua, perhaps was not fully integrated into the regional system of interlocking markets (Blanton 1996; Charlton 1994; Charlton et al. 2000). The data presented here allowed us to evaluate whether or not the site's particular position at the juncture of several important exchange routes affected ceramic consumption at the site, and what the patterns say about shifting political affiliations in this critical region.

Second, because part of the Chiconautla collection comes from one of a very small number of well-documented elite Aztec residences (see also Evans 1988; Smith 1992), it provided an opportunity to sample a complete range of ceramic wares used in daily life. The sample from the Aztec residence included many forms of fancy decorated serving vessels like copas, pulque vessels, bowls, and tripod bowls; undecorated domestic vessels like jars and comals; figurines, temple models, incense burners, flutes, and pipes used in household rituals; and spindle whorls used to weave both cotton and maguey fiber cloth. The selection of ceramics from one well-defined elite household and the selection of a wide range of ceramic forms fulfilling domestic and ritual functions allowed us to address the residents' political and social affiliation with the Triple Alliance capitals of Tenochtitlán and Texcoco in the Middle and Late Post Classic and with other city-states, including Otumba, the largest city-state in the Teotihuacán Valley and an important regional craft production center (e.g., Charlton et al. 2000; Nichols 1996, in press; Otis Charlton et al. 1993).

Sample

Elson and Nichols selected a sample of 200 ceramics from Vaillant's original types and correlated these with types and variants in the current ceramic typology for the Teotihuacán Valley and eastern Basin (Charlton 1966; Hodge and Minc 1991; Nichols and McCullough 1986; Parsons 1966, 1971; M. Parsons 1972a, b; Rattray 1966, 1996; Sanders 1986, 1994-96; Sanders and Evans 2001; Whalen and Parsons 1982). The sample focused on decorated pottery types with clear designs from the Early Post

Classic (Mazapan phase), Middle Post Classic (Early Aztec) and Late Post Classic (Late Aztec) periods (Table 1, shown later in this report). We also included examples of Mazapan and Aztec figurines, Aztec pipes, whistles, flutes, and spindle whorls. The ceramics were drawn and photographed. INAA was conducted at MURR under the direction of Cecil and Glascock (2005).

Instrumental Neutron Activation Analysis (INAA)

The pottery samples from Chiconautla were compared to previously established compositional reference groups for the Basin of México and Yautepec: Texcoco, Ixtapalapa, Chalco, Cuauhtitlán, Tenochtitlán, Teotihuacán, Otumba, and Yautepec (Neff and Glascock 1998; Nichols *et al.* 2002, among others).

Sample Preparation

Pottery samples were prepared for INAA using procedures standard at MURR. Fragments of about 1cm^2 were removed from each sample and abraded using a silicon carbide burr in order to remove glaze, slip, paint, and adhering soil, thereby reducing the risk of measuring contamination. The samples were washed in deionized water and allowed to dry in the laboratory. Once dry, the individual sherds were ground to powder in an agate mortar to homogenize the samples. Archival samples were retained from each sherd (when possible) for future research.

Two analytical samples were prepared from each source specimen. Portions of approximately 150 mg of powder were weighed into clean high-density polyethylene vials used for short irradiations at MURR. At the same time, 200 mg of each sample was weighed into clean high-purity quartz vials used for long irradiations. Individual sample weights were recorded to the nearest 0.01 mg using an analytical balance. Both vials were sealed prior to irradiation. Along with the unknown samples, Standards made from National Institute of Standards and Technology (NIST) certified standard reference materials of SRM-1633a (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay (a standard developed for in-house applications).

Irradiation and Gamma-Ray Spectroscopy

Neutron activation analysis of ceramics at MURR, which consists of two irradiations and a total of three gamma counts, constitutes a superset of the procedures used at most other NAA laboratories (Glascock 1992; Neff 1992, 2000). As discussed in detail by Glascock (1992), a short irradiation is carried out through the pneumatic tube irradiation system. Samples in the polyvials are sequentially irradiated, two at a time, for five seconds by a neutron flux of 8 x 10^{13} n cm^{-2} s^{-1}. The 720-second count yields gamma spectra containing peaks for nine short-lived elements aluminum (Al), barium (Ba),

calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V). The samples are encapsulated in quartz vials and are subjected to a 24-hour irradiation at a neutron flux of 5 x 10^{13} n cm^{-2} s^{-1}. This long irradiation is analogous to the single irradiation utilized at most other laboratories. After the long irradiation, samples decay for seven days, and then are counted for 1,800 seconds (the "middle count") on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements, namely arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three- or four-week decay, a final count of 8,500 seconds is carried out on each sample. The latter measurement yields the following 17 long half-life elements: cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr).

The element concentration data from the three measurements are tabulated in parts per million using the Excel spreadsheet program. Descriptive data for the archaeological samples were appended to the concentration spreadsheet. The data are also stored in a dBase/FoxPro database file useful for organizing, sorting, and extracting sample information.

Interpreting Chemical Data

The analyses at MURR described previously produced elemental concentration values for 32 or 33 elements in most of the analyzed samples. Data for Ni in most samples was below detection limits (as is the norm for most New World ceramic analyses) and was removed from consideration during the statistical analysis. Statistical analysis was subsequently carried out on base-10 logarithms of concentrations on the remaining 32 elements. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements, such as calcium, on one hand and trace elements, such as the rare earth or lanthanide elements (REEs). Transformation to base-10 logarithms also yields a more normal distribution for many trace elements.

The interpretation of compositional data obtained from the analysis of archaeological materials is discussed in detail elsewhere (e.g., Baxter and Buck 2000; Bieber et al. 1975; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and will only be summarized here. The main goal of data analysis is to identify distinct homogeneous groups within the analytical database. Based on the provenance postulate of Weigand et al. (1977), different chemical groups may be assumed to represent geographically restricted sources. For lithic materials such as obsidian, basalt, and cryptocrystalline silicates (e.g., chert, flint, or jasper), raw material samples are frequently collected from known outcrops or secondary deposits and the compositional data obtained on the samples is used to define the source localities or boundaries. The locations of sources can also be inferred by comparing unknown specimens (i.e., ceramic artifacts) to knowns (i.e., clay samples) or by indirect methods such as the "criterion of abundance" (Bishop et al. 1992) or by arguments based on geological and sedimentological

characteristics (e.g., Steponaitis et al. 1996). The ubiquity of ceramic raw materials usually makes it impossible to sample all potential "sources" intensively enough to create groups of knowns to which unknowns can be compared. Lithic sources tend to be more localized and compositionally homogeneous in the case of obsidian or compositionally heterogeneous as is the case for most cherts.

Compositional groups can be viewed as "centers of mass" in the compositional hyperspace described by the measured elemental data. Groups are characterized by the locations of their centroids and the unique relationships (i.e., correlations) between the elements. Decisions about whether to assign a specimen to a particular compositional group are based on the overall probability that the measured concentrations for the specimen could have been obtained from that group.

Initial hypotheses about source-related subgroups in the compositional data can be derived from non-compositional information (e.g., archaeological context, decorative attributes, etc.) or from application of various pattern-recognition techniques to the multivariate chemical data. Some of the pattern recognition techniques that have been used to investigate archaeological data sets are cluster analysis (CA), principal components analysis (PCA), and discriminant analysis (DA). Each of the techniques has it own advantages and disadvantages, which may depend upon the types and quantity of data available for interpretation.

The variables (measured elements) in archaeological and geological data sets are often correlated and frequently large in number. This makes handling and interpreting patterns within the data difficult. Therefore, it is often useful to transform the original variables into a smaller set of uncorrelated variables in order to make data interpretation easier. Of the above-mentioned pattern recognition techniques, PCA is a technique that transforms the data from the original correlated variables into uncorrelated variables most easily.

PCA creates a new set of reference axes arranged in decreasing order of variance subsumed. The individual PCs are linear combinations of the original variables. The data can be displayed on combinations of the new axes, just as they can be displayed on the original elemental concentration axes. PCA can be used in a pure pattern-recognition mode, i.e., to search for subgroups in an undifferentiated data set, or in a more evaluative mode, i.e., to assess the coherence of hypothetical groups suggested by other criteria. Generally, compositional differences between specimens can be expected to be larger for specimens in different groups than for specimens in the same group, and this implies that groups should be detectable as distinct areas of high point density on plots of the first few components.

It is well known that PCA of chemical data is scale dependent (Mardia et al. 1979), and analyses tend to be dominated by those elements or isotopes for which the concentrations are relatively large. As a result, standardization methods are common to most statistical packages. A common approach is to transform the data into logarithms (e.g., base 10). As an initial step in the PCA of most chemical data at MURR, the data

are transformed into log concentrations to equalize the differences in variance between the major elements such as Al, Ca and Fe, on one hand and trace elements, such as the rare-earth elements (REEs), on the other hand. An additional advantage of the transformation is that it appears to produce more nearly normal distributions for the trace elements.

One frequently exploited strength of PCA, discussed by Baxter (1992), Baxter and Buck (2002), and Neff (1994, 2002), is that it can be applied as a simultaneous R- and Q-mode technique, with both variables (elements) and objects (individual analyzed samples) displayed on the same set of principal component reference axes. A plot using the first two principal components as axes is usually the best possible two-dimensional representation of the correlation or variance-covariance structure within the data set. Small angles between the vectors from the origin to variable coordinates indicate strong positive correlation; angles at 90 degrees indicate no correlation; and angles close to 180 degrees indicate strong negative correlation. Likewise, a plot of sample coordinates on these same axes will be the best two-dimensional representation of Euclidean relations among the samples in log-concentration space (if the PCA was based on the variance-covariance matrix) or standardized log-concentration space (if the PCA was based on the correlation matrix). Displaying both objects and variables on the same plot makes it possible to observe the contributions of specific elements to group separation and to the distinctive shapes of the various groups. Such a plot is commonly referred to as a "biplot" in reference to the simultaneous plotting of objects and variables. The variable inter-relationships inferred from a biplot can be verified directly by inspecting bivariate elemental concentration plots. [Note that a bivariate plot of elemental concentrations is not a biplot.]

Whether a group can be discriminated easily from other groups can be evaluated visually in two dimensions or statistically in multiple dimensions. A metric known as the Mahalanobis distance (or generalized distance) makes it possible to describe the separation between groups or between individual samples and groups on multiple dimensions. The Mahalanobis distance of a specimen from a group centroid (Bieber et al. 1976, Bishop and Neff 1989) is defined by:

$$D^2_{y,x} = [y - \overline{X}\,]^t I_x [y - \overline{X}\,]$$

where y is the 1 x m array of logged elemental concentrations for the specimen of interest, X is the n x m data matrix of logged concentrations for the group to which the point is being compared with $\overline{X}$ being it 1 x m centroid, and $/_x$ is the inverse of the m x m variance-covariance matrix of group X. Because Mahalanobis distance takes into account variances and covariances in the multivariate group it is analogous to expressing distance from a univariate mean in standard deviation units. Like standard deviation units, Mahalanobis distances can be converted into probabilities of group membership for individual specimens. For relatively small sample sizes, it is appropriate to base probabilities on Hotelling's T^2, which is the multivariate extension of the univariate Student's t.

When group sizes are small, Mahalanobis distance-based probabilities can fluctuate dramatically depending upon whether or not each specimen is assumed to be a member of the group to which it is being compared. Harbottle (1976) calls this phenomenon "stretchability" in reference to the tendency of an included specimen to stretch the group in the direction of its own location in elemental concentration space. This problem can be circumvented by cross-validation, that is, by removing each specimen from its presumed group before calculating its own probability of membership (Baxter 1994; Leese and Main 1994). This is a conservative approach to group evaluation that may sometimes exclude true group members.

Small sample and group sizes place further constraints on the use of Mahalanobis distance: with more elements than samples, the group variance-covariance matrix is singular thus rendering calculation of $/_x$ (and D^2 itself) impossible. Therefore, the dimensionality of the groups must somehow be reduced. One approach would be to eliminate elements considered irrelevant or redundant. The problem with this approach is that the investigator's preconceptions about which elements should be discriminate may not be valid. It also squanders the main advantage of multielement analysis, namely the capability to measure a large number of elements. An alternative approach is to calculate Mahalanobis distances with the scores on principal components extracted from the variance-covariance or correlation matrix for the complete data set. This approach entails only the assumption, entirely reasonable in light of the above discussion of PCA, that most group-separating differences should be visible on the first several PCs. Unless a data set is extremely complex, containing numerous distinct groups, using enough components to subsume at least 90% of the total variance in the data can be generally assumed to yield Mahalanobis distances that approximate Mahalanobis distances in full elemental concentration space.

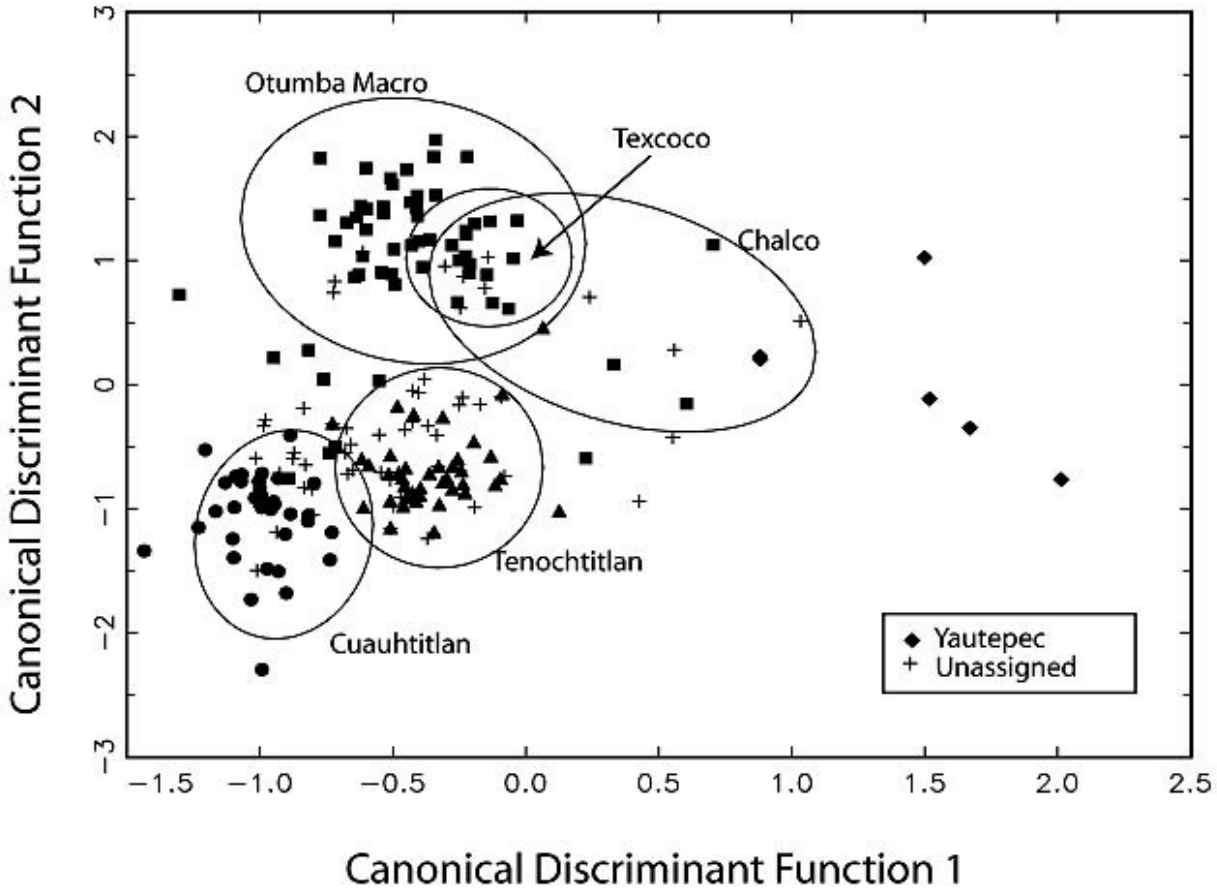

Figure 2. Ceramic samples from Chiconautla projected onto the first two discriminant function axes derived from a canonical discriminant analysis of the Cuauhtitlán, Tenochtitlán, Otumba Macro, Texcoco, Chalco, and Yautepec reference groups. Ellipses represent 90% confidence interval for group membership. The Yautepec reference group ellipse is not shown because it distorts the separation of the other reference groups.

Lastly, Mahalanobis distance calculations are also quite useful for handling missing data (Sayre 1975). When many specimens are analyzed for a large number of elements, it is almost certain that a few element concentrations will be missed for some of the specimens. This occurs most frequently when the concentration for an element is near the detection limit. Rather than eliminate the specimen or the element from consideration, it is possible to substitute a missing value by replacing it with a value that minimizes the Mahalanobis distance for the specimen from the group centroid. Thus, those few specimens that are missing a single concentration value can still be used in group calculations.

INAA Results

Compositional affiliations (when possible) of the pottery samples are listed in Table 1 (next page) and the ceramics have accompanying images. Figure 2, shown above, and Figure 3, Figure 4, Figure 5, and Figure 6, shown below, are plots of the first two discriminant function axes derived from a canonical discriminant analysis of the five main Basin of México Groups as defined by Neff et al. (2000) and used by Nichols et al. (2002) to compare ceramic source data from Cerro Portezuelo and Xaltocan. The majority of the 200 samples from Chiconautla can be assigned to three of the six reference groups for the Basin of México. In addition to the reference groups that represent the Basin of México, six samples plot within the Yautepec reference group located south of the Basin of México, in the state of Morelos. Figure 7, shown below, is a bivariate plot of elemental concentrations (hafnium and iron) of the reference groups used in this study with the samples. This figure demonstrates the overlap in groups when plotting elemental concentrations.

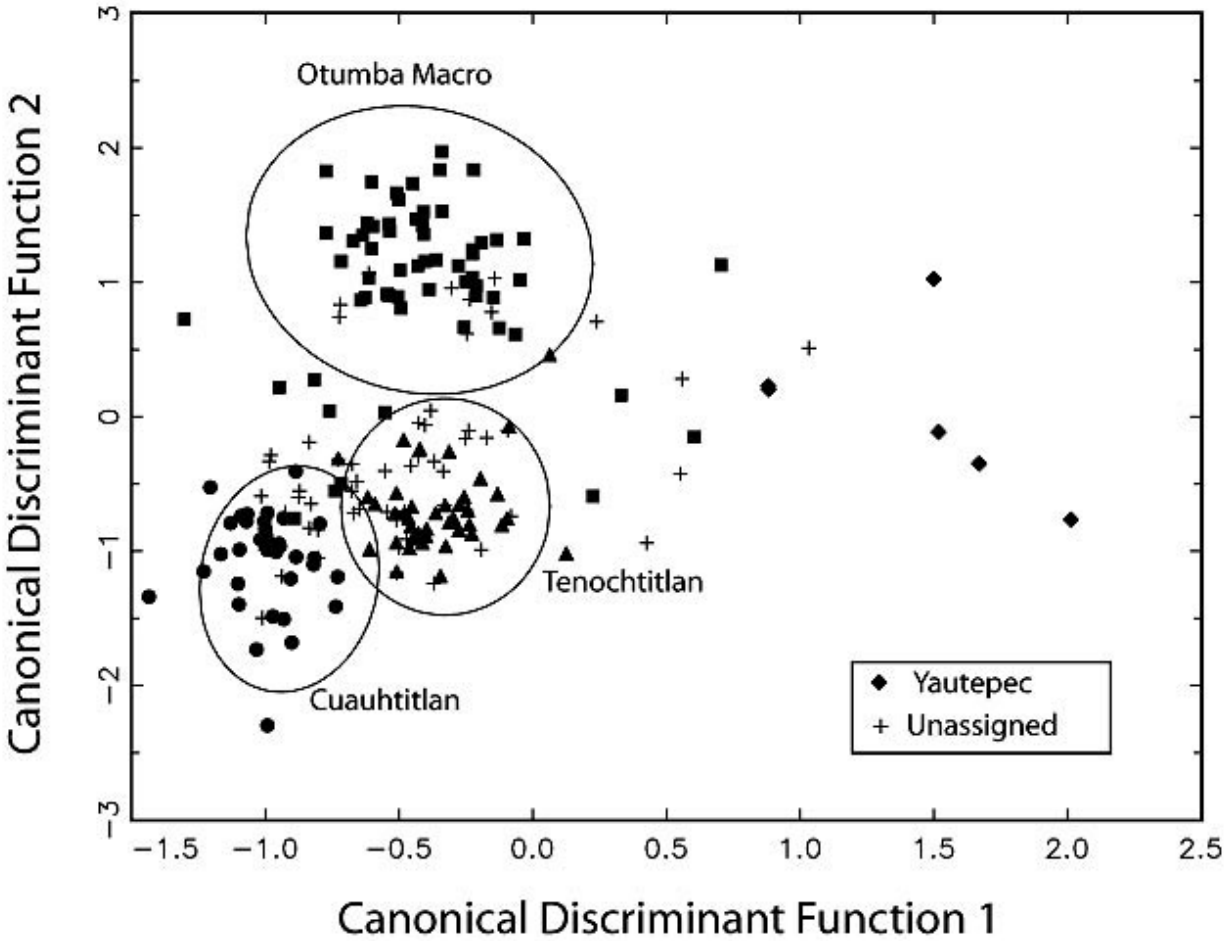

Figure 3. Ceramic samples from Chiconautla projected onto the first two discriminant function axes derived from a canonical discriminant analysis of the Cuauhtitlán, Tenochtitlán, Otumba Macro, and Yautepec reference groups. Ellipses represent 90% confidence interval for group membership. The Yautepec reference group ellipse is not shown because it distorts the separation of the other reference groups.

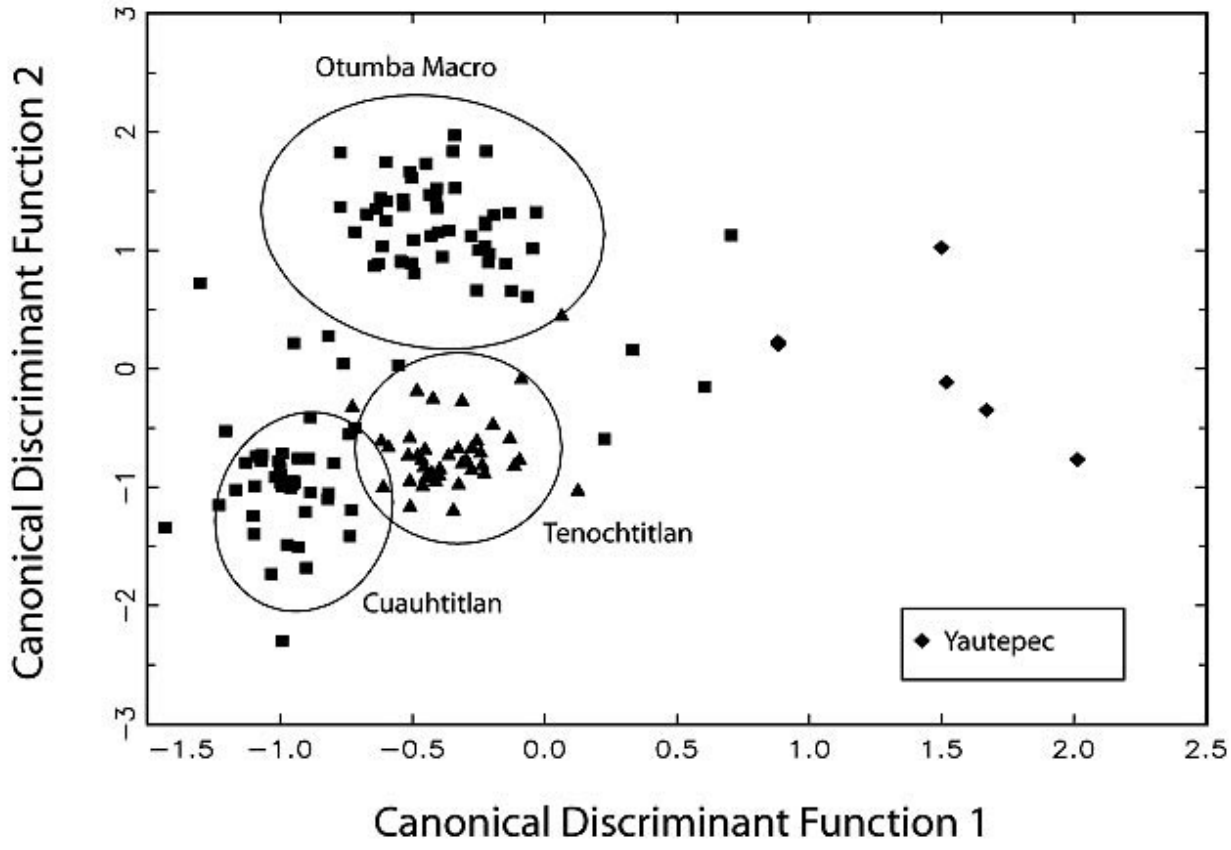

Figure 4. Ceramic samples from Chiconautla projected onto the first two discriminant function axes derived from a canonical discriminant analysis of the Cuauhtitlán, Tenochtitlán, Otumba Macro, and Yautepec reference groups (same as Figure 2 but without the unassigned samples). Ellipses represent 90% confidence interval for group membership. The Yautepec reference group ellipse is not shown because it distorts the separation of the other reference groups.

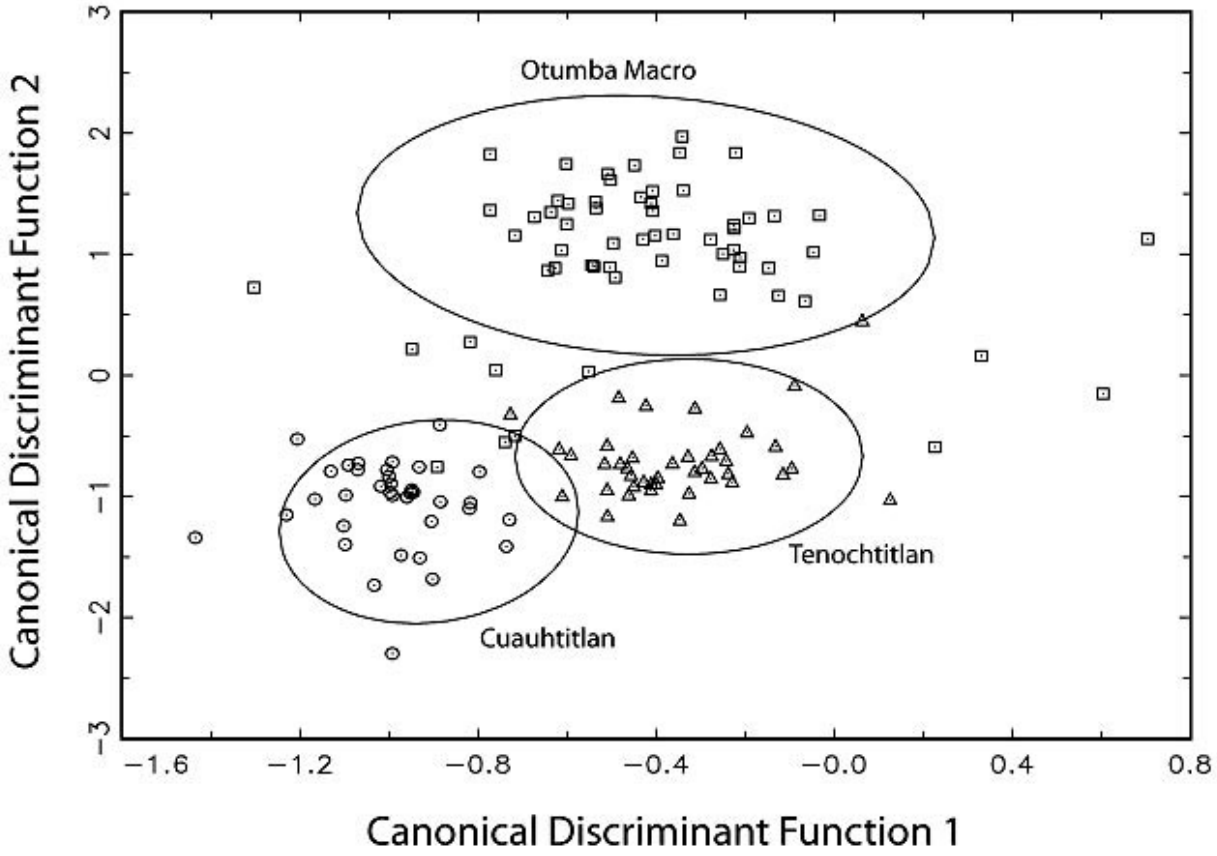

Figure 5. Ceramic samples from Chiconautla projected onto the first two discriminant function axes derived from a canonical discriminant analysis of the Cuauhtitlán, Tenochtitlán, and Otumba Macro reference groups (without the unassigned samples). Ellipses represent 90% confidence interval for group membership.

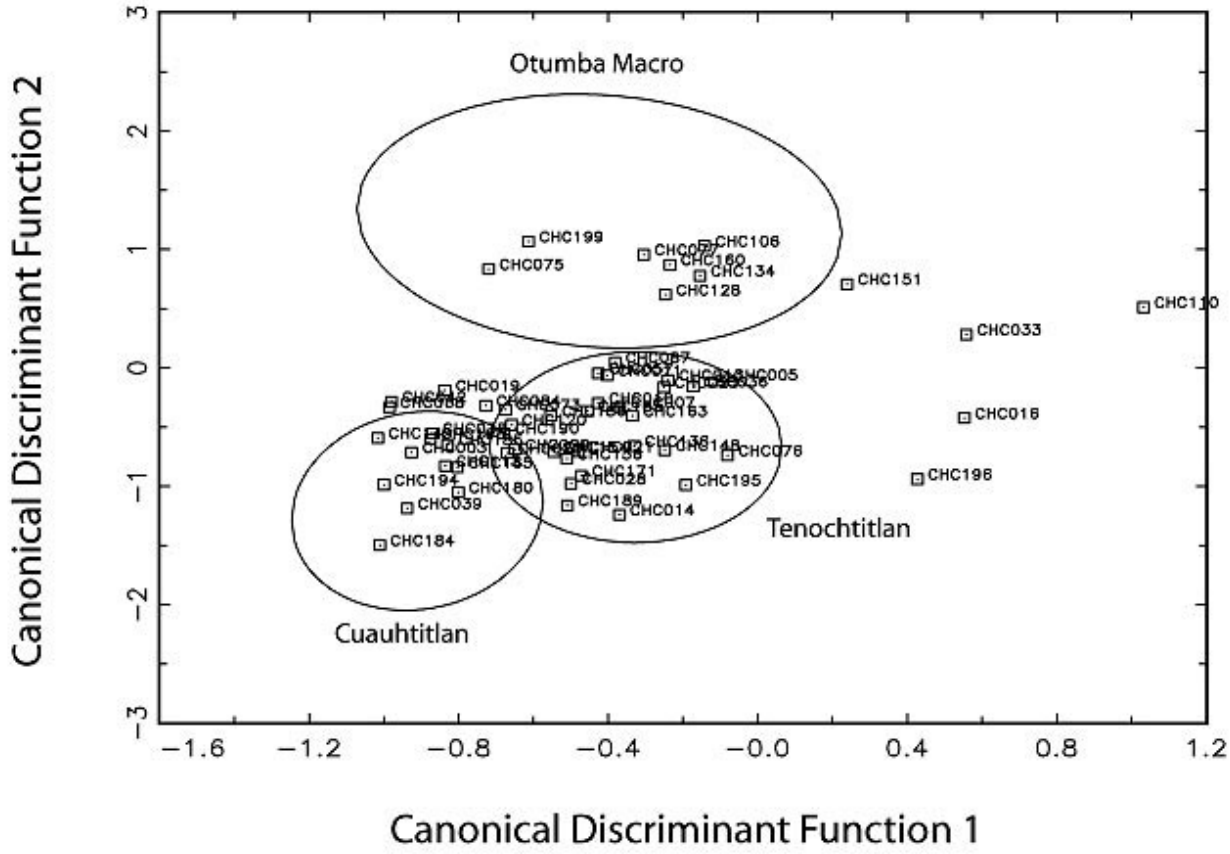

Figure 6. Unassigned Ceramic samples from Chiconautla projected onto the first two discriminant function axes derived from a canonical discriminant analysis of the Cuauhtitlán, Tenochtitlán, and Otumba Macro reference groups. Ellipses represent 90% confidence interval for group membership.

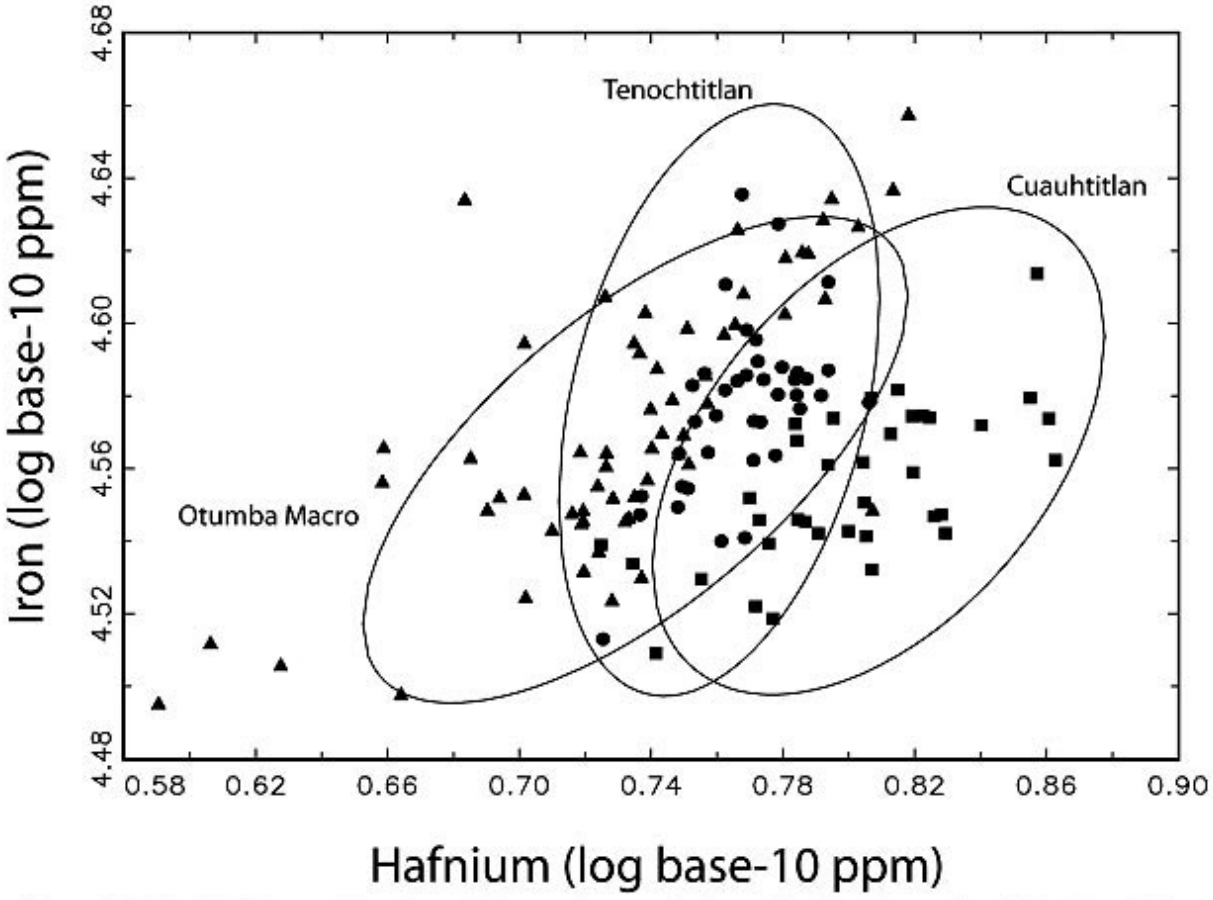

Figure 7. Plot of hafnium and iron base-10 logged concentrations showing the overlap of the Cuauhtitlán, Tenochtitlán, and Otumba Macro reference groups. Ellipses represent 90% confidence interval for group membership.

Early Post Classic (Mazapan)

The INAA sample included two Mazapan figurines imported from the Cuauhtitlán composition group (Table 1, next page) and one figurine assigned to the Otumba-Macro group. The Mazapan pottery we analyzed included several types of decorated serving bowls and jars: one incised Black-on-Brown jar, one Joroba Orange-on-Cream bowl, one Red and Black-on-Buff jar, a Red-on-Cream (white) slipped flat bottom bowl with nubbin supports, two Toltec Red-on-Buff bowls, a stamped cream-slipped bowl, and five Mazapan Wavy-Line bowls. Only one import was identified, a Mazapan Wavy-Line bowl assigned to the nearby Cuauhtitlán composition group. The majority of the Mazapan ceramics (57.1%) are assigned to the local Otumba-Macro group. Four sherds, including one Incised Black-on-brown jar, one Red and Black-on-Buff jar, one stamped cream slipped bowl, and one Mazapan Wavy-Line Red-on-Buff bowl are unassigned.

Middle Post Classic (Early Aztec)

The Middle Post Classic sample of Early Aztec pottery includes both decorated orange wares and red wares. About one-third (30.8%) of the Aztec II Black-on-Orange bowls and molcajetes were made in the Teotihuacán Valley and assigned to the Otumba-Macro group. Black-on-Orange bowls and molcajetes from the Cuauhtitlán composition group are nearly as common (26.9%). This is the first time that ceramic imports from the Tenochtitlán composition group are represented in the INAA sample from Chiconautla and all are Black-on-Orange, both bowls and molcajetes. Thus, Black-on-Orange vessels made outside the Teotihuacán Valley were more common by this time than those from the local Otumba-Macro composition group. The INAA sample included only three Early Aztec Red wares: a Black-on-Red bowl imported from Morelos, one Black and White-on-Red bowl assigned to the Otumba-Macro group and one Black and White-on-Red bowl that is unassigned.

The Aztec II-III Black-on-Orange specimens show a similar distribution to Aztec II with both bowls and molcajetes assigned to the Cuauhtitlán (40%) and Otumba Macro (20%) groups and one Black-on-Orange bowl imported from the Tenochtitlán group. The Early-Late transitional Black-on-Red bowls include one import from the Tenochtitlán group, one bowl imported from Morelos, and one bowl that is unassigned, along with an incised Black-on-Red bowl from Otumba Macro and one incised bowl that is unassigned. The only Early-Late Aztec Black and White-on-Red bowl is not assigned to a composition group.

Late Post Classic (Late Aztec)

Imports of Aztec III Black-on-Orange serving wares from the Tenochtitlán composition group jump to 42.1% in the Late Post Classic, more than double the frequency of Black-on-Orange serving wares from the local Otumba-Macro group (17.5%) or the Cuauhtitlán group from across the lake (15.8%). The only Aztec III Black-on-Orange basins in the INAA sample both come from the Cuauhtitlán group. Imports from Morelos continue in low frequencies (1.8%). Four miniature Aztec III bowls for spinning cotton were included in the INAA sample: one from the Cuauhtitlán group, two from the Tenochtitlán group, and one spinning bowl is unassigned. One Aztec III Black-on-Orange copa for drinking chocolate was imported from Tenochtitlán. Five Aztec III Black on-Orange molcajetes and two bowls are unassigned.

Chiconautla's elites used a wide variety of Late Aztec red wares. Black-on-Red serving wares show a similar distribution pattern to decorated orange wares, both are dominated by the Tenochtitlán composition group (40%). Otumba Macro and Cuauhtitlán each account for 10 percent of the Black-on-Red. The single Black-on-Red copa was a Tenochtitlán composition group import. Four Black-on-Red bowls are unassigned.

The Black and White-on-Red examples include seven hour-glass shaped vessels used by elites to drink *pulque*; five are imports from the Tenochtitlán composition group and

two are unassigned. In contrast, four or 50% of the Black and White-on-Red bowls are assigned to the Otumba-Macro group, one bowl is from the Cuauhtitlán group and three Black and White-on-Red bowls are unassigned.

Most of the remaining red wares consisting of bowls and copas of various color combinations were made in the Teotihuacán Valley and assigned to the Otumba-Macro group. Four elaborately decorated Black and White and Orange-on-Red bowls came from the Cuauhtitlán group and one Black and Brown and Yellow-on-Red bowl was imported from Morelos. Four miscellaneous red ware bowls are unassigned.

Aztec Incense Burners and Censers

Fragments from 13 incense burners were analyzed and over half (seven) were assigned to the Otumba Macro group. Incense burners were made at Otumba, a city-state capital to the northeast in the Teotihuacán Valley (Charlton *et al.* 2000). Handles (one serpent-shaped) from two incense burners assigned to the Cuauhtitlán group and one incense burner was imported from Tenochtitlán. Three incense burner fragments are unassigned.

Spindle Whorls

The sample also included six spindle whorls. Even though both small whorls used to spin cotton and large whorls used to spin *maguey* were mass-produced in workshops at Otumba, none of the spindle whorls from Chiconautla are assigned to the Otumba. Of the three cotton whorls one was imported for Morelos and two are unassigned. Of the three *maguey* whorls one was imported from Morelos, one came from the Cuauhtitlán composition group, and one is unassigned.

Figurines

Workshops at Otumba to the northeast of Chiconautla mass-produced Late Aztec figurines and 25% of the figurine sample from Chiconautla likely was made at those workshops (Charlton *et al.* 1991, 2000). One Aztec figurine with an elaborate headdress (CHC012 or 30.2/175; see Table 1, next page) was imported from the Tenochtitlán group. The remaining eight figurines are unassigned. The INAA sample also included two pipe fragments, both unassigned. Of the two flutes, one was imported from Tenochtitlán and one from Cuauhtitlán. One of the two whistles also was imported from Tenochtitlán, while the other whistle is unassigned.

To view individual ceramic samples, click on AMNH catalogue numbers within the table. Or for thumbnail images by ceramic composition groups, click here:

Table 1. Chemical assignations for 200 ceramic samples from Chiconautla

The objects were assigned a number at the Missouri University Research Reactor (MURR number) apart from their original American Museum of Natural History (AMNH) catalogue number.

Chemical Group	MURR Analytical ID	AMNH Catalogue Number	Ceramic Ware	Ceramic Type	Form	Period
Cuauhtitlán	CHC002	30.1/9958 A			Figurine	Mazapan
Cuauhtitlán	CHC006	30.2/1040	Aztec Orangeware	Black-on-Orange	spinning bowl	Late Aztec
Cuauhtitlán	CHC020	30.2/2481 A01	Aztec Redware	Black/white-on-Red	bowl	Late Aztec
Cuauhtitlán	CHC026	30.2/2506 A01	Aztec Redware	Black/white-on-Red	hourglass form/pulque	Late Aztec
Cuauhtitlán	CHC027	30.2/2506 A02	Aztec Redware	Black/white-on-Red	hourglass form/pulque	Late Aztec
Cuauhtitlán	CHC040	30.2/2531 A01	Aztec Redware	Black-on-Red	bowl	Late Aztec
Cuauhtitlán	CHC059	30.2/2564 A01	Aztec Redware	Black/white-on-Red	hourglass form/pulque	Late Aztec
Cuauhtitlán	CHC060	30.2/2564 A02	Aztec Redware	Black/white-on-Red	hourglass form/pulque	Late Aztec
Cuauhtitlán	CHC061	30.2/2564 A03	Aztec Redware	Black/white-on-Red	hourglass form/pulque	Late Aztec
Cuauhtitlán	CHC062	30.2/2565 A01	Aztec Redware	Black/white/orange-on-Red	bowl	Late Aztec
Cuauhtitlán	CHC063	30.2/2565 A02	Aztec Redware	Black/white/orange-on-Red	bowl	Late Aztec
Cuauhtitlán	CHC064	30.2/2565 A03	Aztec Redware	Black/white/orange-on-Red	bowl	Late Aztec
Cuauhtitlán	CHC065	30.2/2565 A04	Aztec Redware	Black/white/orange-on-Red	bowl	Late Aztec
Cuauhtitlán	CHC079	30.2/2643 A04	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Cuauhtitlán	CHC082	30.2/2643 A07	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Cuauhtitlán	CHC085	30.2/2643 A10	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Cuauhtitlán	CHC089	30.2/2643 A14	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early/Late Aztec
Cuauhtitlán	CHC090	30.2/2643 A15	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Cuauhtitlán	CHC095	30.2/2649 A01	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec

Cuauhtitlán	CHC097	30.2/2649 A03	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early/Late Aztec
Cuauhtitlán	CHC100	30.2/2649 A06	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Cuauhtitlán	CHC104	30.2/2654 A02	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Cuauhtitlán	CHC138	30.2/2688 A01	Aztec Orangeware	Black-on-Orange	bowl–pointed foot	Late Aztec
Cuauhtitlán	CHC141	30.2/2688 A04	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Cuauhtitlán	CHC144	30.2/2691 A03	Aztec Orangeware	Black-on-Orange	bowl–pointed foot	Late Aztec
Cuauhtitlán	CHC147	30.2/2691 A06	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Cuauhtitlán	CHC150	30.2/2691 A09	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Cuauhtitlán	CHC152	30.2/2691 A11	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Cuauhtitlán	CHC157	30.2/2711 A01	Aztec Orangeware	Black-on-Orange	basin	Late Aztec
Cuauhtitlán	CHC158	30.2/2711 A02	Aztec Orangeware	Black-on-Orange	basin	Late Aztec
Cuauhtitlán	CHC159	30.2/2711 A03	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec?
Cuauhtitlán	CHC161	30.2/2728 A01			Incense burner–handled	Aztec
Cuauhtitlán	CHC162	30.2/2731 A01			Incense burner–handled	Aztec
Cuauhtitlán	CHC179	30.2/2802 A01	Toltec Buffware	Wavy line Red-on-Buff	bowl	Mazapan
Cuauhtitlán	CHC191	30.2/630			Flute	Aztec
Cuauhtitlán	CHC198	30.2/901			Spindle whorl	Aztec
Otumba Macro	CHC001	30.1/9654			Figurine	Mazapan
Otumba Macro	CHC004	30.1/9998			Figurine	Aztec
Otumba Macro	CHC015	30.2/2469 A01	Aztec Redware	Black/white-on-Red	bowl	Early Aztec
Otumba Macro	CHC018	30.2/2480 A01	Aztec Redware	Black/white-on-Red	bowl	Late Aztec
Otumba Macro	CHC022	30.2/2490 A01	Aztec Redware	Black/white-on-Red	bowl	Late Aztec
Otumba Macro	CHC024	30.2/2501 A02	Aztec Redware	Black/white-on-Red	bowl	Late Aztec
Otumba	CHC032	30.2/2515 A01	Aztec Redware	Black-on-Red	bowl	Early/Late

Macro						Aztec
Otumba Macro	CHC034	30.2/2524 A01	Aztec Redware	Black-on-Red	bowl	Early/Late Aztec
Otumba Macro	CHC043	30.2/2536 A04	Aztec Redware	Black-on-Red	bowl	Late Aztec
Otumba Macro	CHC047	30.2/2544 A01	Aztec Redware	Black/white/orange-on-Red	bowl	Late Aztec
Otumba Macro	CHC048	30.2/2546 A02	Aztec Redware	Black/white-on-Red	bowl	Late Aztec
Otumba Macro	CHC049	30.2/2548	Aztec Redware	Black/white/orange-on-Red	bowl	Late Aztec
Otumba Macro	CHC050	30.2/2549 A01	Aztec Redware	Black/white/orange-on-Red	bowl	Late Aztec
Otumba Macro	CHC051	30.2/2552 A01	Aztec Redware	Black/white/orange-on-Red	bowl	Late Aztec
Otumba Macro	CHC052	30.2/2554 A02	Aztec Redware	Black/white/orange-on-Red	copa	Late Aztec
Otumba Macro	CHC053	30.2/2555	Aztec Redware	Orange/brown-on-Red	bowl	Late Aztec
Otumba Macro	CHC054	30.2/2556 A01	Aztec Redware	Orange/brown-on-Red	bowl	Late Aztec
Otumba Macro	CHC055	30.2/2557	Aztec Redware	Black/brown-on-Red	copa	Late Aztec
Otumba Macro	CHC056	30.2/2558	Aztec Redware	Black/orange-on-Red	copa	Late Aztec
Otumba Macro	CHC058	30.2/2561 A04	Aztec Redware	Black/brown-on-Red	copa	Late Aztec
Otumba Macro	CHC066	30.2/2566 A01	Aztec Redware	White/black/yellow-on-Red	copa	Late Aztec
Otumba Macro	CHC067	30.2/2566 A02	Aztec Redware	Orange/black-on-Red	bowl	Late Aztec
Otumba Macro	CHC069	30.2/2569	Aztec Redware	Black/white/orange/brown-on-Red	copa	Late Aztec
Otumba Macro	CHC070	30.2/2570	Aztec Redware	Black/orange/brown-on-Red	copa	Late Aztec
Otumba Macro	CHC071	30.2/2574 A01	Aztec Redware	Black/orange/brown-on-Red	bowl	Late Aztec
Otumba Macro	CHC072	30.2/2574 A02	Aztec Redware	Black/orange/brown-on-Red	bowl	Late Aztec
Otumba Macro	CHC091	30.2/2643 A16	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Otumba Macro	CHC092	30.2/2643 A17	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early/Late Aztec
Otumba	CHC093	30.2/2643 A18	Aztec Orangeware	Black-on-Orange	bowl–	Early

Macro					molcajete	Aztec
Otumba Macro	CHC094	30.2/2643 A19	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Otumba Macro	CHC096	30.2/2649 A02	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Otumba Macro	CHC098	30.2/2649 A04	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Otumba Macro	CHC099	30.2/2649 A05	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Otumba Macro	CHC101	30.2/2649 A07	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Otumba Macro	CHC102	30.2/2649 A08	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Otumba Macro	CHC108	30.2/2658	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Otumba Macro	CHC109	30.2/2665 A01	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Otumba Macro	CHC118	30.2/2665 A11	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Otumba Macro	CHC125	30.2/2666 A02	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Otumba Macro	CHC129	30.2/2667 A04	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Otumba Macro	CHC131	30.2/2667 A06	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Otumba Macro	CHC132	30.2/2667 A07	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Otumba Macro	CHC133	30.2/2667 A08	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Otumba Macro	CHC142	30.2/2691 A01	Aztec Orangeware	Black-on-Orange	plate	Late Aztec
Otumba Macro	CHC151	30.2/2691 A10	Aztec Orangeware	Black-on-Orange	bowl–molcajete w/slab foot	Late Aztec
Otumba Macro	CHC164	30.2/2740 A02			Incense burner–lobed	Aztec
Otumba Macro	CHC165	30.2/2742			Incense burner–basin	Aztec
Otumba Macro	CHC166	30.2/2743 A01			Incense burner–basin	Aztec
Otumba Macro	CHC167	30.2/2743 A02			Incense burner–basin	Aztec
Otumba Macro	CHC168	30.2/2743 A03			Incense burner–basin	Aztec

Otumba Macro	CHC169	30.2/2744 A01			Incense burner–basin	Aztec
Otumba Macro	CHC170	30.2/2745			Incense burner–basin	Aztec
Otumba Macro	CHC174	30.2/2790 A01	Toltec Buffware	Wavy line Red-on-Buff	bowl	Mazapan
Otumba Macro	CHC175	30.2/2790 A02	Toltec Buffware	Wavy line Red-on-Buff	bowl	Mazapan
Otumba Macro	CHC176	30.2/2790 A03	Toltec Buffware	Wavy line Red-on-Buff	bowl	Mazapan
Otumba Macro	CHC177	30.2/2796 A01	Toltec Buffware	Toltec Red-on-Buff	bowl	Mazapan
Otumba Macro	CHC178	30.2/2796 A02	Toltec Buffware	Toltec Red-on-Buff	bowl	Mazapan
Otumba Macro	CHC181	30.2/2805	Toltec Buffware	Red/white-on-Buff	bowl	Mazapan
Otumba Macro	CHC182	30.2/2806 A01	Toltec Buffware	Joroba Orange-on-Cream	bowl	Mazapan
Otumba Macro	CHC187	30.2/412			Figurine	Aztec
Otumba Macro	CHC188	30.2/518			Figurine	Aztec
Tenochtitlán	CHC008	30.2/1049	Aztec Orangeware	Black-on-Orange	spinning bowl	Late Aztec
Tenochtitlán	CHC009	30.2/1052	Aztec Orangeware	Black-on-Orange	spinning bowl	Late Aztec
Tenochtitlán	CHC012	30.2/175			Figurine	Aztec
Tenochtitlán	CHC037	30.2/2525 A02	Aztec Redware	Black-on-Red	bowl	Early/Late Aztec
Tenochtitlán	CHC041	30.2/2534	Aztec Redware	Black-on-Red	bowl	Late Aztec
Tenochtitlán	CHC044	30.2/2540 A01	Aztec Redware	Black-on-Red	copa	Late Aztec
Tenochtitlán	CHC045	30.2/2540 A02	Aztec Redware	Black-on-Red	bowl	Late Aztec
Tenochtitlán	CHC046	30.2/2540 A03	Aztec Redware	Black-on-Red	bowl	Late Aztec
Tenochtitlán	CHC078	30.2/2643 A03	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Tenochtitlán	CHC080	30.2/2643 A05	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Tenochtitlán	CHC081	30.2/2643 A06	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Tenochtitlán	CHC083	30.2/2643 A08	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Tenochtitlán	CHC086	30.2/2643 A11	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC088	30.2/2643 A13	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec

Tenochtitlán	CHC105	30.2/2654 A03	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Tenochtitlán	CHC111	30.2/2665 A03	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC112	30.2/2665 A04	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC114	30.2/2665 A07	Aztec Orangeware	Black-on-Orange	bowl	Early/Late Aztec
Tenochtitlán	CHC115	30.2/2665 A08	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC116	30.2/2665 A09	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC117	30.2/2665 A10	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC119	30.2/2665 A12	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC121	30.2/2665 A14	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC122	30.2/2665 A15	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC123	30.2/2665 A16	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC126	30.2/2667 A01	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Tenochtitlán	CHC127	30.2/2667 A02	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Tenochtitlán	CHC130	30.2/2667 A05	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Tenochtitlán	CHC135	30.2/2667 A10	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC137	30.2/2682	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Tenochtitlán	CHC139	30.2/2688 A02	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Tenochtitlán	CHC140	30.2/2688 A03	Aztec Orangeware	Black-on-Orange	bowl–pointed foot	Late Aztec
Tenochtitlán	CHC143	30.2/2691 A02	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Tenochtitlán	CHC145	30.2/2691 A04	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Tenochtitlán	CHC153	30.2/2692	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Tenochtitlán	CHC172	30.2/2755 A02			Incense burner–handled	Aztec
Tenochtitlán	CHC173	30.2/2762	Aztec Orangeware	Black-on-Orange	copa	Late Aztec
Tenochtitlán	CHC189	30.2/540			Whistle	Aztec
Tenochtitlán	CHC192	30.2/632			Flute	Aztec
Unassigned	CHC003	30.1/9987			Figurine	Aztec
Unassigned	CHC005	30.2/102			Figurine	Aztec
Unassigned	CHC007	30.2/1048	Aztec Orangeware	Black-on-Orange	spinning bowl	Late Aztec
Unassigned	CHC010	30.2/113			Figurine	Aztec

Unassigned	CHC011	30.2/138			Figurine	Aztec
Unassigned	CHC013	30.2/188			Figurine	Aztec
Unassigned	CHC014	30.2/21			Figurine	Aztec
Unassigned	CHC016	30.2/2469 A02	Aztec Redware	Black/white-on-Red	bowl	Early/Late Aztec
Unassigned	CHC017	30.2/2473 A02	Aztec Redware	Black/white-on-Red	bowl	Early Aztec
Unassigned	CHC019	30.2/2480 A02	Aztec Redware	Black/white/orange-on-Red	bowl	Late Aztec
Unassigned	CHC021	30.2/2485 A01	Aztec Redware	Black/white-on-Red	bowl	Late Aztec
Unassigned	CHC023	30.2/2501 A01	Aztec Redware	Black/white-on-Red	bowl	Late Aztec
Unassigned	CHC025	30.2/2501 A03	Aztec Redware	Black/white-on-Red	bowl	Late Aztec
Unassigned	CHC028	30.2/2507 A01	Aztec Redware	Black/white-on-Red	hourglass form/pulque	Late Aztec
Unassigned	CHC029	30.2/2507 A02	Aztec Redware	Black/white-on-Red	hourglass form/pulque	Late Aztec
Unassigned	CHC030	30.2/2514 A01	Aztec Redware	Black-on-Red	bowl	Late Aztec
Unassigned	CHC033	30.2/2515 A02	Aztec Redware	Black-on-Red	bowl	Early/Late Aztec
Unassigned	CHC036	30.2/2525 A01	Aztec Redware	Black-on-Red	bowl	Early/Late Aztec
Unassigned	CHC038	30.2/2528 A01	Aztec Redware	Black-on-Red	bowl	Late Aztec
Unassigned	CHC039	30.2/2528 A02	Aztec Redware	Black-on-Red	bowl	Late Aztec
Unassigned	CHC042	30.2/2535	Aztec Redware	Black-on-Red	bowl	Late Aztec
Unassigned	CHC057	30.2/256			Figurine	Aztec
Unassigned	CHC068	30.2/2568	Aztec Redware	White/black-on-Red	bowl	Late Aztec
Unassigned	CHC073	30.2/2574 A03	Aztec Redware	Gray-on-Red	bowl	Late Aztec
Unassigned	CHC075	30.2/2575 A01		White-on-Buff	jar	Aztec
Unassigned	CHC076	30.2/2643 A01	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Early Aztec
Unassigned	CHC077	30.2/2643 A02	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Unassigned	CHC084	30.2/2643 A09	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Unassigned	CHC087	30.2/2643 A12	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Unassigned	CHC103	30.2/2654 A01	Aztec Orangeware	Black-on-Orange	bowl	Early/Late Aztec
Unassigned	CHC106	30.2/2654 A04	Aztec Orangeware	Black-on-Orange	bowl	Early Aztec
Unassigned	CHC107	30.2/2654 A05	Aztec Orangeware	Black-on-Orange	bowl	Early

						Aztec
Unassigned	CHC110	30.2/2665 A02	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Unassigned	CHC113	30.2/2665 A05	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Unassigned	CHC120	30.2/2665 A13	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Unassigned	CHC124	30.2/2666 A01	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Unassigned	CHC128	30.2/2667 A03	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Unassigned	CHC134	30.2/2667 A09	Aztec Orangeware	Black-on-Orange	bowl–slab foot	Late Aztec
Unassigned	CHC136	30.2/2667 A11	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Unassigned	CHC148	30.2/2691 A07	Aztec Orangeware	Black-on-Orange	bowl	Late Aztec
Unassigned	CHC149	30.2/2691 A08	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Unassigned	CHC154	30.2/2693 A01	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Unassigned	CHC155	30.2/2693 A02	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Unassigned	CHC156	30.2/2693 A03	Aztec Orangeware	Black-on-Orange	bowl–molcajete	Late Aztec
Unassigned	CHC160	30.2/2727 A01			Incense burner–handled	Aztec
Unassigned	CHC163	30.2/2740 A01			Incense burner–lobed	Aztec
Unassigned	CHC171	30.2/2755 A01			Incense burner–handled	Aztec
Unassigned	CHC180	30.2/2802 A01	Toltec Buffware	Wavy line Red-on-Buff	bowl	Mazapan
Unassigned	CHC183	30.2/2807	Toltec Orangeware		bowl	Mazapan
Unassigned	CHC184	30.2/2812	Black/Brown Ware		jar	Mazapan
Unassigned	CHC185	30.2/2819 A01	Toltec Buffware	Red/black-on-Buff	jar	Mazapan
Unassigned	CHC186	30.2/405			Figurine	Aztec
Unassigned	CHC190	30.2/574			Whistle	Aztec
Unassigned	CHC193	30.2/680			Pipe	Aztec
Unassigned	CHC194	30.2/682			Pipe	Aztec
Unassigned	CHC195	30.2/746			Spindle whorl	Aztec
Unassigned	CHC196	30.2/779			Spindle whorl	Aztec
Unassigned	CHC199	30.2/924			Spindle whorl	Aztec

Yautepec Ref.	CHC031	30.2/2514 A02	Aztec Redware	Black-on-Red	bowl	Early Aztec
Yautepec Ref.	CHC035	30.2/2524 A02	Aztec Redware	Black-on-Red	bowl	Early/Late Aztec
Yautepec Ref.	CHC074	30.2/2574 A04	Aztec Redware	Black/brown/yellow-on-Red	bowl	Late Aztec
Yautepec Ref.	CHC146	30.2/2691 A05	Aztec Orangeware	Black-on-Orange	bow	Late Aztec
Yautepec Ref.	CHC197	30.2/870			Spindle whorl	Aztec
Yautepec Ref.	CHC200	30.2/934			Spindle whorl	Aztec

Discussion

Our analysis has allowed us to develop ideas about Chiconautla's political and social affiliation with the Triple Alliance capitals of Tenochtitlán and Texcoco in the Middle and Late Post Classic and with other city-states, including Otumba, the largest city-state in the Teotihuacán Valley and an important regional craft production center. The Mazapan ceramics that Vaillant recovered from his excavations at Chiconautla are part of an Early Post Classic ceramic complex found throughout the Teotihuacán Valley. Sanders (1986) suggests that the Mazapan Wavy-Line Red-on-Buff style may have originated at Teotihuacán, the largest Early Post Classic settlement in the Teotihuacán Valley. People at Chiconautla mostly consumed ceramics made in the Teotihuacán Valley suggesting limited market exchange of pottery and figurines between the subregions of the Basin of México in the Early Post Classic. This is consistent with consumption patterns at rural sites in the Teotihuacán Valley (Crider *et al.*, in press). There is evidence of minor amounts of imported pottery from the Cuauhtitlán composition group.

Sanders (1986) argues that Toltec orange and cream slipped wares belong to a late subphase of the Early Post Classic that he calls Atlatongo. He thinks the adoption of these styles of pottery marks the incorporation of the Teotihuacán Valley into the Early Post Classic state centered at Tula in Hidalgo. No imports of Early Post Classic orange or cream-slipped pottery from a composition group outside the Teotihuacán Valley were identified in our Chiconautla INAA sample. However, MURR has not yet defined a Tula composition group and this is an important problem that needs to be addressed.

The presence of Mazapan ceramics suggests some continuity of occupation at Chiconautla from the Early to Middle Post Classic when Aztec city-states are first identifiable in the archaeological records (Hodge 1984, 1997; Charlton and Nichols 1997). The Mazapan ceramics were found with Aztec II pottery in an early structure (West House Rooms) that was sealed by the later building of the Aztec palace. It is not

clear if this association of Mazapan and Early Aztec (Aztec II) pottery was caused by intermixing or indicates chronological overlap.

Market exchange of ceramics intensifies with the appearance of Aztec II orange wares and Early Aztec red wares in the Middle Post Classic. At this time the Basin of México was divided into series of city-states in a volatile political environment of competition, shifting alliances, and conflicts. The Cuauhtitlán composition group became a major supplier of Aztec II Black-on-Orange pottery to Chiconautla, nearly equaling the percentage of locally made Black-on-orange serving wares. This pattern persisted with Aztec II-III transitional types. The Tenochtitlán composition group also became an important supplier of Aztec II/II-III Black-on-Orange pottery to Chiconautla.

No Early Aztec red wares from the Cuauhtitlán composition group appear in our INAA sample. However, in addition to red wares made in the Teotihuacán Valley, perhaps in workshops at Otumba to the northeast (Charlton *et al.* 1991, 2000), the Tenochtitlán composition group supplied Chiconautla with Early Aztec red ware pottery. The palace's occupants imported Black-on-Red bowls from Morelos in the Middle Post Classic, the first time imports from this region of Central México appear at Chiconautla.

By the Middle Post Classic substantial amounts of pottery were moving through market networks in the Basin, and in the case of Chiconautla, these exchange networks crossed confederation boundaries. Perhaps half of the Aztec II Black-on-Orange pottery consumed at Chiconautla came from outside the Teotihuacán Valley. The fact that pottery could be transported by canoe to Chiconautla from the western Basin facilitated such trade but this possibility also existed in the Early Post Classic when most villagers consumed pottery from the "local" composition group. Even before the emergence of Tenochtitlán as the political capital of the Aztec Triple Alliance empire in the early fifteenth century, the Tenochtitlán composition group had become a major pottery exporter to Chiconautla, along with the Cuauhtitlán composition group. Cuauhtitlán was a major pottery manufacturing center in the 16th century and our INAA results indicate that its ceramic industry was well established by the Middle Post Classic (see also Nichols and Charlton 2001).

In the Late Post Classic, Chiconautla's elites showed a marked preference for eating and drinking with pottery from the Tenochtitlán composition group that dominates both Aztec III Black-on-Orange and Late Aztec red wares. The popularity of decorated bowls, dishes, molcajetes, and plates from the Tenochtitlán composition group mirrors the growth of Tenochtitlán and surrounding settlements as the capital of the Aztec empire. Chiconautla's elites clearly preferred to drink pulque in vessels from the Tenochtitlán region. The political importance of ceramic production zones influenced the appeal of their products. The higher proportion of Late Aztec red wares that are unassigned probably reflects a pattern of more localized manufacturing for the lower-fired red wares (Nichols and Charlton 2002).

Hodge and Minc (Hodge 1992, Hodge and Minc 1990, Hodge et al. 1993, Minc et al. 1994) suggested the presence of multiple subregional market systems in the Middle

Post Classic that coincided with the boundaries of city-state confederations. They concluded that political boundaries of confederations within the Basin continued to constrain market exchanges of decorated pottery in the Late Post Classic. Other archaeologists argue that by the Late Post Classic a complex interlocking market system had developed in the Basin (Blanton et al. 1993; Smith 2003). The INAA results for the Middle Post Classic from Chiconautla demonstrate a trend of market intensification and the presence of multiple subregional market systems, with Chiconautla consuming ceramics made in the Teotihuacán Valley and also importing them from the Cuauhtitlán region on the opposite shore of Lake Texcoco. By the Middle Post Classic Chiconautla also imported decorated orange and red wares from the Tenochtitlán composition group. The persistent regionalism seen in the Otumba city-state and elsewhere in the northeastern periphery of the Basin (Charlton and Nichols 1991, 2001) is not as evident at Chiconautla because of its lakeshore location at a trading crossroads.

However, despite the increased market exchange, a striking finding of the INAA results is the absence of pottery from the well-established Texcoco composition group even during the Middle Post Classic prior to the historically documented start of the Triple Alliance and Tenochtitlán's assent as the Aztec imperial capital. Chiconautla was first incorporated into the Acolhua confederation of the eastern Basin. After the early 1430s descent and marriage ties linked Chiconautla's ruling dynasty to Texcoco's ruler. In addition to being the capital of the Acolhua confederation and the second largest Late Post Classic city in the Basin, Texcoco was an important pottery manufacturing center. In a large study of source analysis of Aztec pottery by Nichols and Charlton (2002) from sites distributed throughout the Teotihuacán Valley, the Texcoco composition group accounted for one-fifth of the Aztec II Black-on-Orange pottery and about one-quarter of the Aztec III Black-on-Orange pottery.

In contrast, not a single specimen of decorated pottery in our INAA sample from Chiconautla was assigned to the Texcoco composition group. This probably is not just due to sampling as we selected decorated types commonly found throughout the eastern Basin. Nichols and Charlton's (2001) INAA of Aztec pottery in surface collections from Chiconautla followed a similar pattern. Of the 23 specimens they analyzed, only an Aztec III Black-on-Orange dish and an Aztec IV Black-on-Orange dish were assigned to the Texcoco composition group. After the Spanish conquest and destruction of Tenochtitlán, the Texcoco composition group emerged as a major center of Aztec IV Black-on-Orange pottery manufacturing.

Despite their incorporation into the Acolhua confederation, Chiconautla's elites showed little interest in purchasing pottery from the Texcoco area. Their economic allegiances to Tenochtitlán were stronger. Elson (1999:153) notes that the gloss on the depiction of Motecuhzoma's palace in the Codex Mendoza (Berdan and Anawalt 1992:3:f69r) lists Chiconautla as one of three polities called "friends of Motecuhzoma," suggesting that perhaps Chiconautla's nobility had kinship ties to Tenochtitlán (Berdan and Anawalt 1992:2:222). In a study of Aztec plain ware pottery, Christopher Garraty (personal communication, 2006) reports identifying undecorated orange ware pottery at

Chiconautla from the Texcoco composition group. This also suggests that the political landscape shaped the preferences of Chiconautla's elites in buying decorated serving wares.

Our findings indicate a shift from a pattern of restricted subregional markets for ceramics in the Early Post Classic to increased market exchange with substantial amounts of decorated serving wares being traded beginning in the Middle Post Classic. However, the flow of pottery and choices of consumers, such as the elites who lived at the Casas Reales, also was influenced by the political status and power of urban centers. Much research has focused on comparing changes between the Middle and Late Post Classic associated with the development of the Aztec empire. Although the sample of Early Post Classic pottery analyzed from Chiconautla is small, the findings are consistent with other studies indicating that equally substantial economic changes took place from the Early to Middle Post Classic that have not yet been fully explored or explained.

List of Figures

Tenochtitlán, and Otumba Macro reference groups (without the unassigned samples). Ellipses represent 90% confidence interval for group membership.

Figure 6. Unassigned Ceramic samples from Chiconautla projected onto the first two discriminant function axes derived from a canonical discriminant analysis of the Cuauhtitlán, Tenochtitlán, and Otumba Macro reference groups. Ellipses represent 90% confidence interval for group membership.

Figure 7. Plot of hafnium and iron base-10 logged concentrations showing the overlap of the Cuauhtitlán, Tenochtitlán, and Otumba Macro reference groups. Ellipses represent 90% confidence interval for group membership.

Images by Ceramic Composition Group

Cuauhtitlán

Otumba Macro

Tenochtitlán

Unassigned

Yautepec

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exterior

interior


30.2
2643


30.2/2469 A01
ST/3B


30.2
2460


ST/12

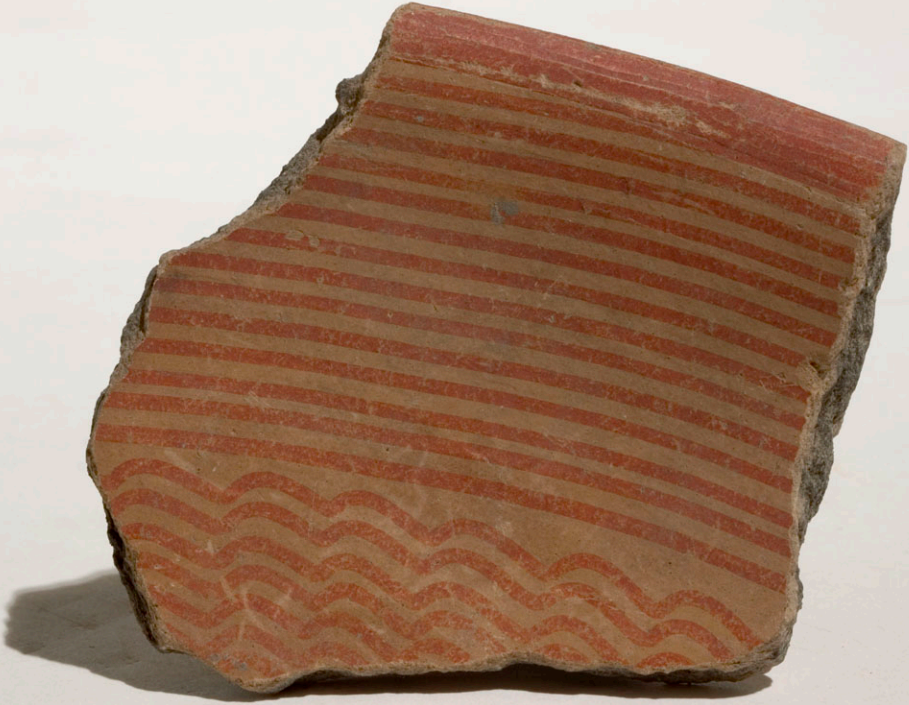
exterior

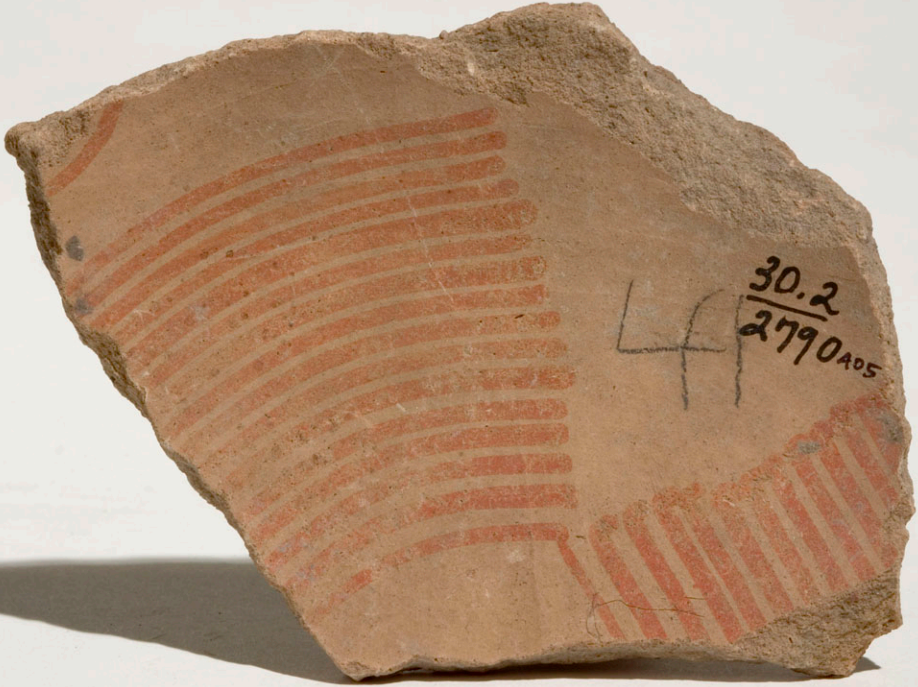
interior


7267
30,2
2566

exterior

interior




30.2
2790 AD5


30.2
2805

exterior

interior

exterior

interior


B7


58


30.2/4169 A03


30:2/2485

exterior

interior


ST/13


41


30.2
2727

exterior

interior