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A NEW BAYESIAN CHRONOLOGY FOR POSTCLASSIC AND COLONIAL OCCUPATION AT XALTOCAN, MEXICO

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ABSTRACT. This article proposes a new four-phase chronology for Postclassic and colonial occupation at Xaltocan, Mexico, using Bayesian statistical modeling of a suite of 54 radiometric dates. Of these, 46 samples come from recent extensive excavations of sealed, stratified household deposits, facilitating improved understanding of sample context and resulting in a more accurate chronology. The timing of the adoption of major ceramic wares at the site and intrasite level is outlined and contextualized within broad, regional phases. These results are particularly valuable given recent research that repudiates a uniform chronological framework for the Basin of Mexico in the Postclassic period, and indicates instead a significant amount of chronological overlap and regional variation in the use of distinct ceramic types.

INTRODUCTION

Despite the vast and detailed knowledge available for the Postclassic period in the Basin of Mexico, archaeological chronologies for that occupation—specifically ones that do not rely on monumental inscriptions or colonial historical documents—remain poorly defined. As Jeffrey Parsons, Elizabeth Brumfiel, and Mary Hodge (Parsons et al. 1996:228) concluded in the most recent treatment of Coyotlatelco and Aztec I ceramic wares, "We are still a long way from understanding the spatial-temporal distribution of [these types] in central Mexico, much less the sociopolitical and socioeconomic implications of this distribution." This meager grasp is partially due to the apparent complexity of these distributions, as well as the small number of existing radiocarbon determinations and a lack of detailed contextual information for those dates. This situation is exemplified at the site of Xaltocan, capital of the pre-Aztec Otomí city-state, and subsequently subject to the successive Aztec and Spanish colonial empires. With over 20 years of archaeological research at Xaltocan, the site chronology is better understood than most, and yet the existing chronological framework relies on 10 ^{14}C determinations from test pits excavated in 10-cm arbitrary levels for the delineation of four phases spanning nearly a millennium. Fortunately, investigators have now carried out sufficiently extensive and detailed excavations of stratified household contexts at Xaltocan to support the elaboration of an improved chronology. This article uses Bayesian statistical modeling of a suite of 45 new radiometric dates from these excavations, as well as nine previously reported radiometric dates from test pit excavations, to propose a new chronology for the site.

Postclassic and Colonial Ceramic Chronologies in Central Mexico and Xaltocan

Between the 1930s and 1950s, a typology of seriated ceramic types for the Basin of Mexico was first created based on the Aztec I-IV Black-on-Orange wares (Vaillant 1938; Franco 1945, 1949, 1957; Griffin and Espejo 1947, 1950; Tolstoy 1958) (Figure 1). This framework emphasized a single evolutionary trajectory between types with the exception of some colonial Aztec IV motifs that showed obvious European influence.

This relative chronology was correlated with absolute dates, refined, and expanded to include other central Mexican regions associated with the Aztec Empire as a result of major regional survey and excavation projects beginning in the 1960s (Charlton 1966; Parsons 1966; Blanton and Parsons 1971; Whalen and Parsons 1982; Smith and Doershuk 1991; Evans and Freter 1996; Hare and Smith 1996; Nichols and Charlton 1996; Parsons et al. 1996; Hodge 1998; Brumfiel 2005b). Sanders et al. (1979) argued that Aztec I and II ceramics were roughly contemporaneous, regional variants used in the Basin of Mexico between AD 1150 and 1350. Aztec I ceramics were used predominantly in the southern Basin, with the northern Basin island of Xaltocan standing out as a marked exception,

while Aztec II ceramics were popular in the northern Basin. In stratigraphic excavations at sites where both Aztec I and II were used, such as Chalco and Culhuacan (O'Neill 1962; Sejourne 1970), Whalen and Parsons (1982) found that Aztec I pottery was used exclusively for some time before Aztec II was adopted, suggesting some degree of temporal variation. Aztec III ceramics were considered to be the hallmark of the period AD 1350–1519 (Sanders et al. 1979). However, Charlton (1968, 1972) demonstrated that in many rural areas, European-influenced ceramics did not appear until approximately AD 1650, and Aztec III pottery continued to be produced in the colonial period alongside Aztec IV pottery.

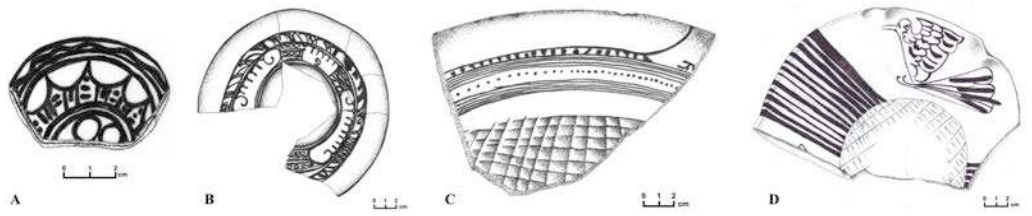

Figure 1 Aztec I–IV Black-on-Orange diagnostic ceramic types: a. Aztec I bowl; b. Aztec II plate; c. Aztec III molcajete; and d. Aztec IV molcajete.

More recent Basin of Mexico chronologies have replaced a model of unilinear change with a more complex framework in which stylistic differences are both spatial and temporal, significant chronological overlap exists for several types, and chronological overlap varies geographically. Investigations by Brumfiel and colleagues (Parsons et al. 1996; Brumfiel 2005a) placed Aztec I pottery earlier, beginning in the 10th century, and thus partially contemporaneous with the other regional ceramic complexes, Coyotlatelco and Mazapan. Their research indicated a period during which Aztec I pottery was used exclusively followed by a significant period during which both Aztec I and II ceramic types were used at some sites (like Xaltocan), while others (like those in the southeastern Basin) were characterized by continued use of Aztec I pottery and a delay in the use of Aztec II. Thus, as Nichols and Charlton (1996:242) suggest, we must move beyond problematic assumptions "of a uniform chronological framework for the entire basin during the Postclassic period." This conclusion presented challenges and exciting potential for research exploring spatial and temporal variation in ceramic traditions related to Postclassic ethnicities and city-state confederations. It also demonstrated the need for the development of detailed local chronologies within broad regional phases, a need that this article addresses (Hodge 1998:203).

Local chronologies for the site of Xaltocan, located on a human-made island in the northern Basin of Mexico (Figure 2), were first established by Brumfiel (2005a). Using stratigraphic evidence, multidimensional scaling of ceramic variants, and 10 ^{14}C dates from twenty-four 2 × 2 m test pits (Operations) excavated in arbitrary 10-cm levels in 1990 and 1991, Brumfiel proposed four phases of occupation at the site. These four phases were based on the following stratigraphic sequence of diagnostic Aztec Black-on-Orange ceramics: pure Aztec I contexts lie underneath mixed Aztec I and II deposits, which lie underneath Aztec II ceramics, which in turn lie beneath Aztec III and IV ceramics (Brumfiel 2005a:117–8).

A ^{14}C sample from the vegetation underlying the human-made island provided an early boundary estimate for site construction; this date had a median of cal AD 660. The first occupation phase was associated with pure deposits of Aztec I Black-on-Orange pottery and Chalco Polychrome. Phase 1 had four ^{14}C dates with medians of cal AD 880, 960, 970, and 990 and represents occupation during the Early Postclassic period.

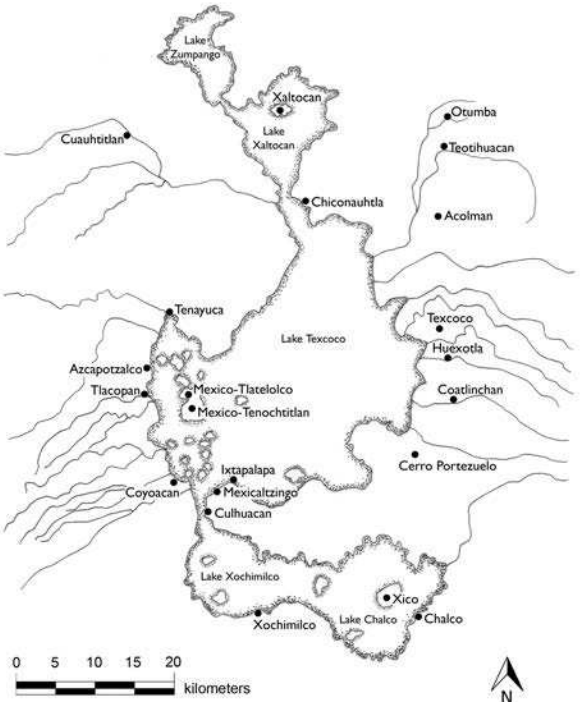

Figure 2 Map of the Basin of Mexico

Brumfiel's research (2005a) indicated a period of overlap between Aztec I and II pottery types, called Phase 2, that confirmed the gradual shift first suggested by Whalen and Parsons (1982). In addition to mixed Aztec I and II Black-on-Orange pottery, Phase 2 was associated with Chalco Polychrome and small amounts of redwares, particularly Black on Red, and with Brown Incised ware. Two ^{14}C dates with medians of cal AD 1235 and 1300 indicated that Phase 2 represents the height of Xaltocan's power during the Early–Middle Postclassic.

Phase 3 was associated with pure deposits of Aztec II Black-on-Orange pottery, large quantities of redwares, especially Black and White on Red, and some Chalco Polychrome. It had two ^{14}C dates with medians of cal AD 1395 and 1425, representing occupation during Xaltocan's subordination to Cuauhtitlan and Azcapotzalco during the Middle Postclassic.

Phase 4 was associated with Aztec III and IV Black-on-Orange pottery and redwares, especially Black-on-Red. It had one ^{14}C date with a median of cal AD 1421, but the midden that produced that sample also yielded a colonial-style figurine, suggesting that this phase represents occupation during the Late Postclassic and colonial period. Phases 3 and 4 remained poorly understood, since Phase 3 was represented by only two dates and Phase 4 by a single date, and there was no chronological separation between the ^{14}C dates for Phases 3 and 4.

METHODS

Samples and Sample Context

Recent extensive excavations of domestic structures clarify the site's occupational history and provide the opportunity to revisit Brumfiel's chronology. Excavations carried out by Brumfiel and Kristin De Lucia (Brumfiel 2005a, 2009; De Lucia 2011, 2013) between 1997 and 2008 focused on occupation during Brumfiel's Phases 1 and 2, while those by the author (Overholtzer 2012, 2013)

centered on Phases 3 and 4. These stratified domestic contexts produced new stratigraphic information on the ordering of deposits containing the diagnostic Aztec I–IV ceramics used to construct Xaltocan's chronology. The excavations also produced 50 samples of charcoal and bone that were sent for radiometric analysis and which were available for Bayesian modeling. For this article, ^{14}C determinations were available from nearly all the excavations carried out at the site to date, and these determinations are broadly distributed spatially (Figure 3), as well as stratigraphically, spanning the island's occupation from its founding through the early colonial period.

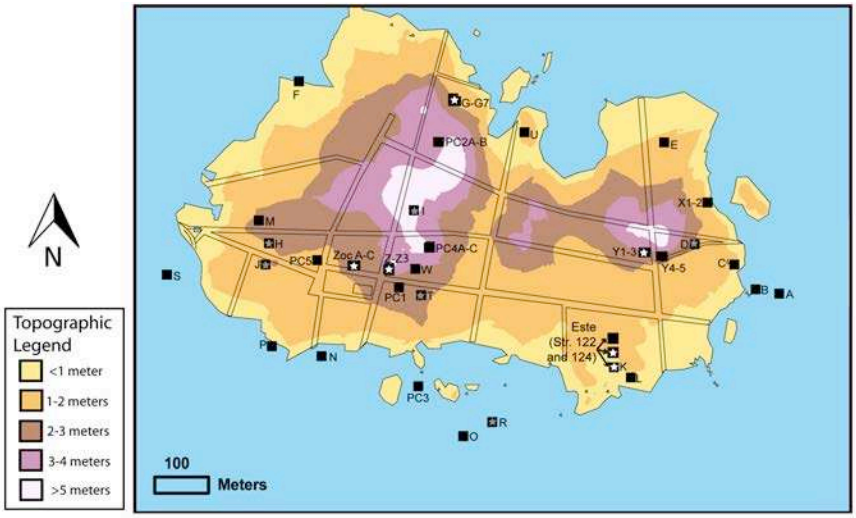

Figure 3 Reconstructed island of Xaltocan, showing excavation units as black squares and radiometric sampling as stars within the squares. Radiometric samples from recent extensive excavations of domestic contexts are denoted by white stars, while those from test pit excavations are shown in gray.

Brumfiel submitted 27 carbon samples for ^{14}C dating (21 AMS and 6 standard radiometric dates) at Beta Analytic, Inc. From Overholtzer's excavations, 23 bone and charcoal samples were submitted for dating by accelerator mass spectrometry (AMS) at the University of Arizona. Bone samples were processed utilizing the modified Longin method (Brown et al. 1988). All bone samples yielded sufficient collagen and all charcoal samples sufficient carbon for dating. Two dates from the mixed Aztec II–III construction fill were excluded from Bayesian modeling, because while they could offer insight into the timing of that particular construction, they could not be associated with a single phase. The remaining dates were combined with the 10 ^{14}C dates from Brumfiel's original test pit excavations to form the basis for the chronology built using Bayesian statistical modeling (Appendix Table S1, available as an online Supplemental file with this article).

All dates were calibrated using OxCal (v 4.2; Bronk Ramsey 2009a,b) and the IntCal09 calibration curve (Reimer et al. 2009). Because of a strong "wiggle" in the calibration curve, the colonial period dates demonstrate bimodal distributions and have two likely date ranges—one in the 16th and one in the 17th centuries. Unfortunately, the material culture present in the middens does not allow us to exclude either date range.

The first attempt at Bayesian modeling of Xaltocan's occupational history, conducted for the author's dissertation (Overholtzer 2012), tested Brumfiel's four-phase chronological framework using the newly available ^{14}C determinations. This initial attempt indicated that a substantial revision of the site chronology was necessary. First, Phase 4 could and should be divided into pre-Hispanic

and colonial contexts. Unfortunately, excavations have uncovered only two colonial-period houses that directly overlie Aztec III occupation, and in those instances, the ground surface was the same. However, using ^{14}C dating and the presence of Europe faunal remains and European style motifs on ceramics and figurines, it was determined that colonial period deposits from the 16th and 17th centuries at Xaltocan can be distinguished by the presence of large quantities of Aztec IV pottery. This is consistent with Charlton's (1968, 1972) findings for Otumba.

Second, no statistically viable model in which Phases 2 and 3 were abutting and not completely overlapping could be created, leading Overholtzer to conclude that Brumfiel's Phase 2 did not exist, and that such deposits likely represented mixed contexts (Overholtzer 2012:106). However, this explanation was unsatisfactory, since it did not account for other evidence for the phase: specifically the association of mixed Aztec I and II and pure Aztec II deposits with distinct redwares and other decorated ceramics as revealed by Brumfiel's multidimensional scaling.

Subsequent comparison of the data of Brumfiel, De Lucia, and the author for an article on changes in household practices over time (Overholtzer and De Lucia, forthcoming) revealed domestic contexts pertaining to Brumfiel's Phases 2 and 3—middens with Aztec I and II pottery and middens with purely Aztec II pottery, respectively—with the same associated redwares and other decorated ceramics. Moreover, these contexts produced ^{14}C determinations that overlapped entirely. Further examination of the data revealed that Phase 2 contexts always represented continuous occupation from Phase 1 (reflected in middens with Aztec I and II pottery that stratigraphically overlie Aztec I domestic contexts), while Phase 3 contexts were associated with newly created land around the former lakeshore (and were seen in the first deposits that overlie the mixed fill placed to create habitable land). The data also indicated the existence of significant differences in the practices of "Phase 2" and "Phase 3" occupants, including radically distinct burial customs and spatial patterning of household life. The authors argued that during the Middle Postclassic, Aztec II-consuming migrants—who, based on burial practices and ceramic consumption patterns, may have come from elsewhere in northern central Mexico and may have been Nahuatl speakers—settled around Xaltocan's lakeshore. These settlers joined the original inhabitants, who adopted some Aztec II pottery while still using the Aztec I ware they had consumed for centuries. Thus, it was clear that Brumfiel's Phase 2 was "real" in the sense that it represented an assemblage of materials used by a set of people at Xaltocan during a particular point in time; this period simply overlapped chronologically (but not spatially) with Phase 3.

Several questions remain regarding this transition, however. Some contexts from Brumfiel's excavations showed Aztec II deposits overlying deposits containing mixed Aztec I and II. This suggests that some residents may have stopped using Aztec I pottery before the arrival of Aztec III wares. Further research, including additional extensive excavations of domestic contexts, is necessary to determine the likely variable timing of this shift. For now, this study acknowledges and models the basic chronology of a phase associated with the arrival of Aztec II pottery, and comments on the timing of the use of Aztec I and II wares in the two households for which we currently have data.

Stratigraphic information on the ordering of Aztec I–IV deposits from these recent excavations at Xaltocan validates the new four-phase chronology proposed here. In all excavations at the site, a similar stratigraphic sequence was evident: deposits containing Aztec III ceramics overlie contexts containing Aztec II ceramics (either alone or alongside Aztec I ceramics), which in turn overlie pure Aztec I deposits (Figures 4 and 5; Table 1). While in the limited excavations carried out to date, colonial period occupation took place on the same stratigraphic interface as the Late Postclassic (see Figure 5), colonial contexts can be differentiated on the basis of significant quantities of Aztec IV

pottery; in these, Aztec III and IV ceramics are similarly ubiquitous. The new model proposed here combines dates from deposits that would have been called Phases 2 and 3 in Brumfiel's chronology, and separates her Phase 4 into two distinct phases. ^{14}C dates from deposits associated with these four phases—determined by the presence of Aztec I, Aztec I and II or pure Aztec II, Aztec III, or Aztec III and IV ceramics—and prior knowledge of archaeological context were used to make Bayesian statistical models.

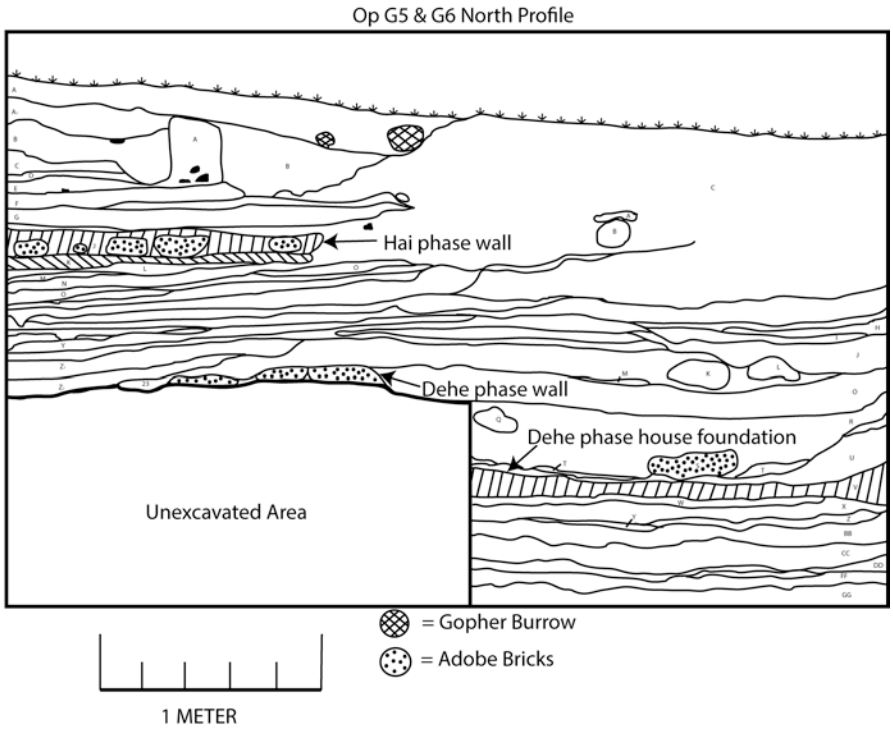

Figure 4 North profile of Op G5/G6, showing Hai phase domestic architecture superimposed on Dehe phase domestic architecture encountered in the Op G-G7 excavation units. Three ^{14}C dates from this occupational sequence are included in the Bayesian statistical model: Hai phase sample Beta-110217 and Dehe phase samples Beta-41911 and Beta-110219.

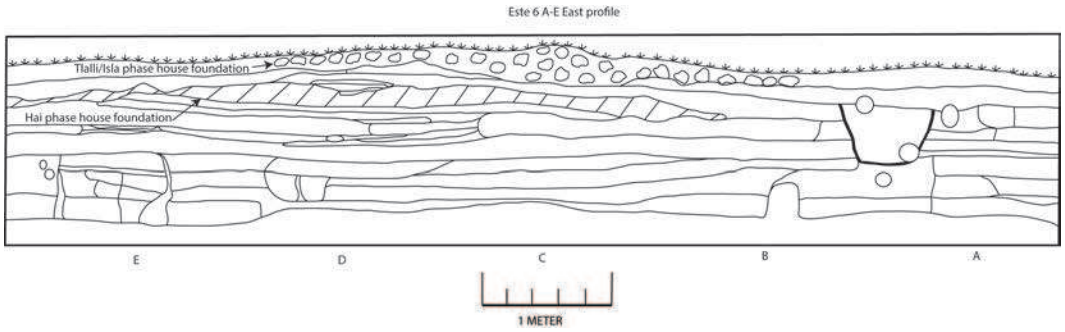

Figure 5 East profile of Este 6, showing Tlalli and Isla phase domestic architecture superimposed on Hai phase domestic architecture encountered on Structure 122. Fifteen ^{14}C dates from this occupational sequence are included in the Bayesian statistical model: Tlalli phase samples AA91379, AA91385, AA91366, AA91369, AA91371, AA91372, AA91373, AA91374, and AA91376; and Hai phase samples AA91377, AA91378, AA91383, AA91367, AA91368, and AA91370.

Table 1 Rim sherd counts from middens and fill deposits associated with the Dehe, Hai, Tlalli, and Isla phase domestic architecture seen in Figures 4 and 5.

	Aztec I	Aztec II	Aztec III	Aztec IV	Plain red	Black-on-red	Black-and-white on red	Yellow-on-red	Red-on-buff	Poly-chrome	Brown incised	Total
G2-G7 Dehe phase deposits	181	3	0	0	12	2	1	0	9	46	5	259
G2-G7 Hai phase deposits	19	56	2	2	44	7	19	0	1	15	4	169
G2-G7 Hai phase midden	18	17	1	0	42	5	27	0	2	10	0	122
Structure 122 Hai phase middens	4	162	0	0	143	11	65	0	0	4	3	392
Structure 122 Tlalli phase fill deposits	2	58	116	25	145	28	99	17	0	8	0	498
Structure 122 Tlalli phase middens	0	13	28	0	19	6	6	0	0	1	0	73
Structure 122 Isla phase midden	1	17	39	30	53	25	22	26	0	4	0	217

THE PROPOSED BAYESIAN MODEL

The chronological model proposed in this article is qualitatively, quantitatively, and methodologically different from its precursor. Qualitative sample context merits some attention, as the chronological model proposed for the later phases is based predominantly on samples from vertical and horizontal household excavations from two areas of the site. The model it is designed to replace was based entirely on samples from test pit excavations. Test pit samples, by virtue of being distributed widely across the site, result in chronologies that are more likely to be representative of population-wide trends. By contrast, single households might not have been occupied for the full range of a given ceramic phase, or their occupants could have adopted the use of a diagnostic ceramic type earlier or later than most residents. Thus, the use of ^{14}C samples from fewer locations across the site may lead to sampling bias. In the case of the samples used for this article, the concordance between individual dates from Aztec II contexts in two distinct parts of the site—centrally located Op Zoc, and Op Este, on the southeastern edge of the island (see Figure 3)—suggests that sampling bias is not an issue. Unfortunately, no other Aztec III or colonial period household contexts have been excavated at Xaltocan, but the dates we do have correspond with published chronologies for other sites. This concordance suggests that no severe sampling bias exists. Sampling bias issues notwithstanding, samples from extensive household excavations facilitate a better understanding of stratigraphy and sample context, and this understanding of context leads to more accurate and more precise chronologies. The author suggests that this factor is responsible for the significant change in chronology proposed in this article.

Quantitatively speaking, continued research at the site has increased the available number of ^{14}C determinations from the 10 used in Brumfiel's chronology to a sample size of 61, 59 of which were included in the model. The significantly larger number of determinations facilitates the construction of a much tighter chronology and allows us to identify outlier samples more easily. Of the 59 original dates, five were excluded as outliers, resulting in a final model sample size of 54 ^{14}C dates.

Methodologically, most previous chronological studies in central Mexico, including that of Brumfiel, have focused on ceramic seriation. In order to achieve finer temporal resolution in Morelos and the Toluca Valley, Michael Smith (Smith 1987; Smith and Doershuk 1991; Hare and Smith 1996; Smith et al. 2013) applied multiple techniques, including the calculation of Euclidian distances and nonmetric multidimensional scaling. In addition, Smith and colleagues seriated whole excavated contexts, rather than relying on the presence of diagnostic ceramic types such as Aztec Black-on-Orange. Contexts were then grouped into phases using discriminant analysis. While such analysis has enabled the construction of finer chronologies, the application of new Bayesian statistical methods to ^{14}C dates has also shown significant promise for the creation of more precise phase-based chronologies.

The Bayesian approach to ^{14}C dating (Buck et al. 1996) is a way to combine archaeological knowledge on the nature of the sample, archaeological context, and stratigraphy, called "prior information" in Bayesian terminology, with explicit, probabilistic modeling of date estimates. The use of *a priori* knowledge in the interpretation of data is the fundamental difference between Bayesian and classical approaches to statistical inference (Buck et al. 1996:17). For example, archaeologists can use the information that a set of samples comes from a stratigraphic sequence—sample A is older than sample B, which is older than sample C—to create a more precise probabilistic range for each date. Because prior information can greatly influence the resulting chronology, scholars must be careful when translating their archaeological knowledge into statistical inputs (Buck et al. 1996:26). Archaeologists should create multiple models, evaluate their robusticity, and propose the preferred model. This combination of archaeological knowledge and probabilistic modeling results in better estimates for dates and finer chronologies, sometimes on the scale of a single human generation.

Archaeologists have applied Bayesian theories to the interpretation of ^{14}C dates of single monuments, such as the stone circles at Stonehenge (Bayliss et al. 1997), single events, such as the date of the eruption of Santorini (Friedrich et al. 2006), and cultural series and sequences in China and the Aegean Bronze Age (Lu et al. 2001; Manning et al. 2006). Within central Mexico, Bayesian statistical modeling has been applied to traditional phase designations at the capital of Teotihuacan, resulting in calibrated intervals up to 70% shorter (Beramendi-Orosco et al. 2009).

RESULTS

Bayesian statistical modeling was performed using BCal and OxCal v 4.2, both online Bayesian ^{14}C calibration tools. BCal (http://bcal.sheffield.ac.uk) is hosted by the Department of Probability and Statistics at the University of Sheffield (Buck et al. 1999), while OxCal is hosted by the Radiocarbon Accelerator Unit at Oxford University (Bronk Ramsey 2009a). Nearly identical results were obtained (cf. Overholtzer 2012:120–2), with OxCal producing posterior calendar year probability distributions that were slightly more conservative. In some cases, the distributions were the same; in others, the date ranges were 10 yr longer. In all cases, the ranges produced with the two models overlapped completely, and the medians for the beginnings and ends of phases were identical. This article reports the more conservative OxCal estimates and notes that the comparable results indicate that the proposed model is robust. In accordance with stratigraphic evidence, all phases in the model are abutting, that is, there are neither chronological gaps nor overlapping periods. In addition, 1521 was set as the absolute calendar date separating the Aztec III and Aztec III/IV phases. In this article, calibrated and modeled dates are rounded to the nearest 10 yr. Both 1σ and 2σ ranges are included for calibrated dates, and the 2σ range and intercept are reported for modeled dates.

The first run of the model identified six possible outlier dates (see Appendix Table S1). Outliers were identified using the agreement index calculated by OxCal; when the value for a sample fell

below 60%, rejection was considered (Bronk Ramsey 2009b). In five of the six cases, the dates were excluded. In the sixth, sample Beta-243617 had a borderline agreement index of 51%. This sample represents the first appearance of Aztec II pottery alongside Aztec I in one household. While it is possible that the sample represents a case of old wood, it is also possible that this household may have been one of the earliest adopters of Aztec II pottery and may have done so before the arrival of Aztec II-using migrants. Thus, the sample was not excluded, but its low agreement was noted. After excluding the five outliers, the model was rerun and the overall agreement index was calculated to be 80%, indicating that the model is acceptable.

The resulting model (Appendix Table S2; Figures 6–10) produced individual posterior calendar year probability distributions with more precise date ranges than those of the previously accepted chronology. At 2σ, the average range of error for all calibrated dates was reduced by a modest 33%. More importantly, the model also created posterior calendar year probability distributions for phase boundaries. The mean values were used to provide estimates of the beginning and end dates of the four ceramic phases, although the 2σ posterior calendar year probability distributions for phase boundaries are reported in Table S2 of the Appendix (online Supplemental file). The site-wide chronology proposed here is as follows (Table 2; Figure 11): Aztec I occupation, called the *Dehe* ('water' in Otomí) phase, dates to AD 920 to 1240; occupation after the adoption of Aztec II ceramics, called the *Hai* ("land" in Otomí) phase, dates to AD 1240–1350; occupation after the arrival of Aztec III ceramics, called the *Tlalli* ("land" in Nahuatl) phase, dates to AD 1350–1521; and colonial occupation, called the *Isla* ("island" in Spanish) phase, dates to AD 1521–1680.

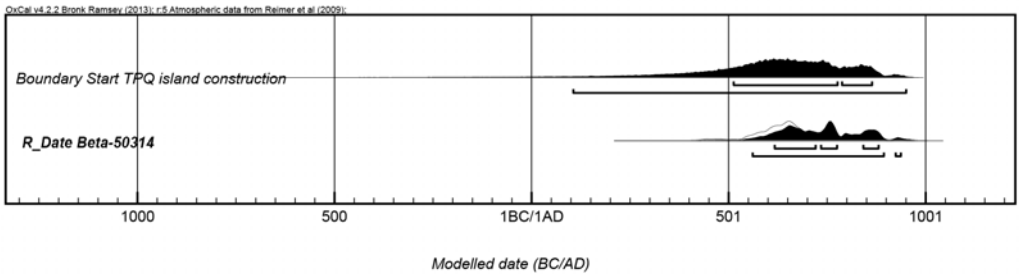

Figure 6 Probability distribution for boundary transition. Samples calibrated individually are shown in gray lines and with Bayesian model as black areas.

Table 2 Comparison of Brumfiel and revised chronologies.

Brumfiel (2005b) model				Revised model				
Phase	Ceramics	*n*	Range of medians (cal AD)	Phase	Ceramics	*n*	Range of medians (cal AD)	Phase range (cal AD)
1	Aztec I	4	880–990	Dehe	Aztec I	24	960–1210	920–1240
2	Aztec I & II	2	1240–1300	Hai	Aztec I & II or Aztec II	16	1250–1330	1240–1350
3	Aztec II	2	1400–1430					
4	Aztec III & IV	1	1420	Tlalli	Aztec III	11	1380–1480	1350–1521
				Isla	Aztec III & IV	2	1560–1650	1521–1680

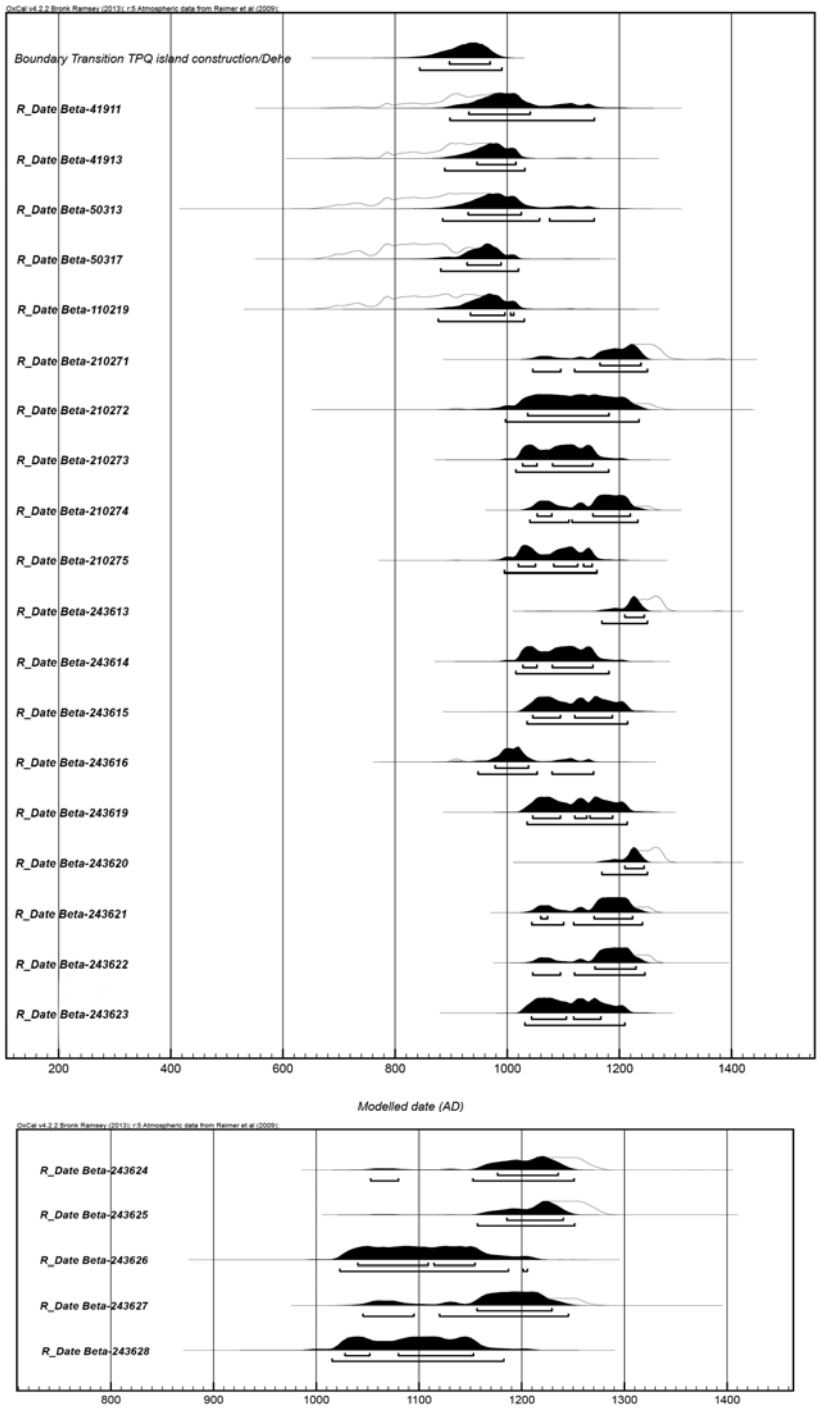

Figure 7 Probability distribution for Dehe phase determinations. Samples calibrated individually are shown in gray lines and with Bayesian model as black areas.

The phases were given names rather than numbers to avoid confusion with Brumfiel's Phase 1–4 designations. Otomí words were chosen for the periods when Xaltocan is thought to have been an

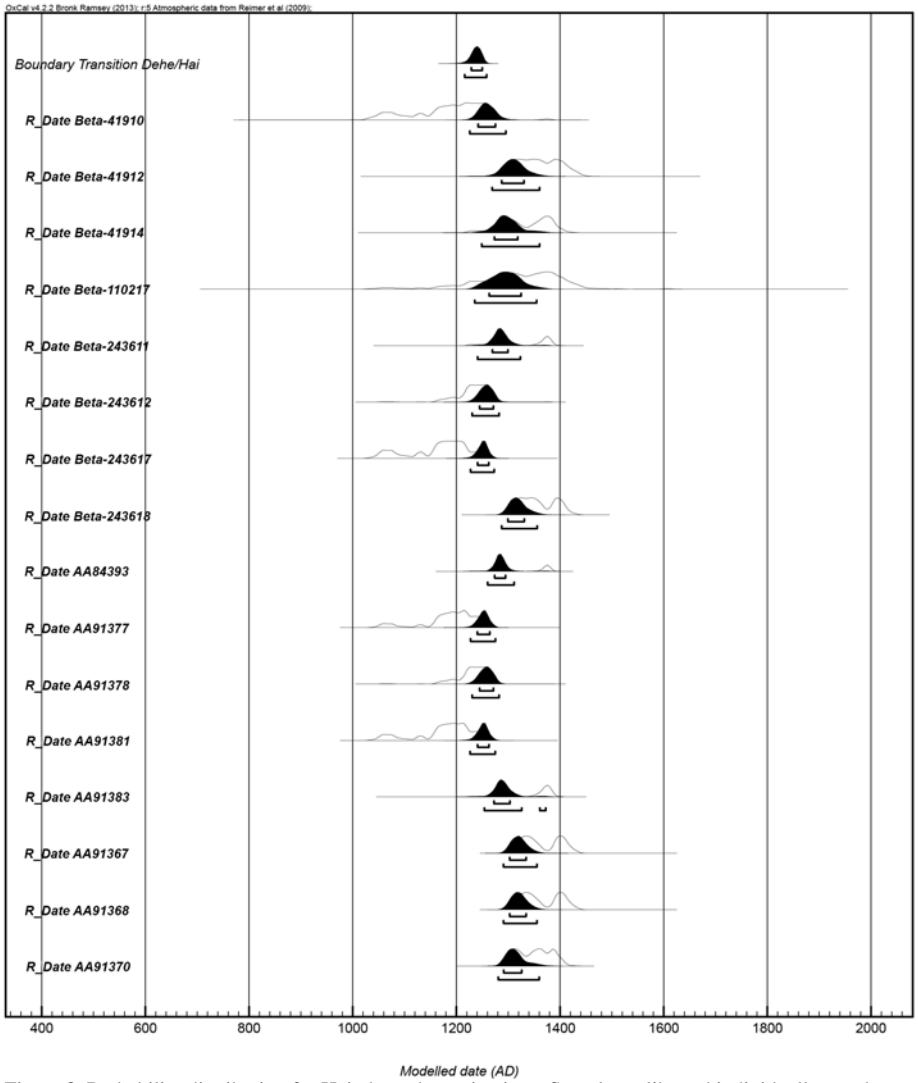

Figure 8 Probability distribution for Hai phase determinations. Samples calibrated individually are shown in gray lines and with Bayesian model as black areas.

Otomí polity, a Nahuatl word for the period during which we see a distancing from Otomí ethnicity and during which Xaltocan was subsequently incorporated into the Aztec Empire, and a Spanish word for the colonial phase. All words chosen relate to the fact that Xaltocan was located on an island.

The resulting new date ranges for all ceramic phases are significantly different than the phases implied by Brumfiel's (2005a) interpretation of median ^{14}C dates. In addition to the new distinction between pre-Hispanic Aztec III and early colonial Aztec III and IV, the Aztec II and III date ranges resulting from analysis of new samples from secure household contexts are significantly earlier. The large number of determinations used in the proposed Bayesian model and the excellent understanding of the stratigraphic context of the samples lends credence to these revisions.

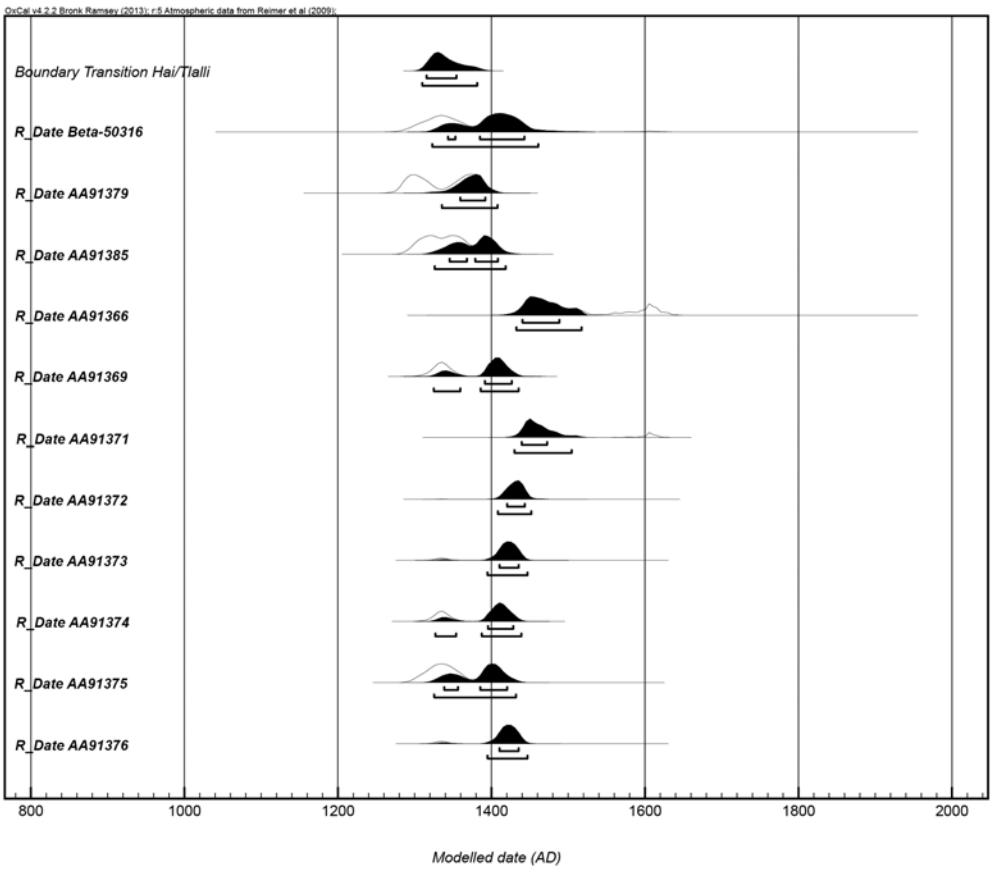

Figure 9 Probability distribution for Tlalli phase determinations. Samples calibrated individually are shown in gray lines and with Bayesian model as black areas.

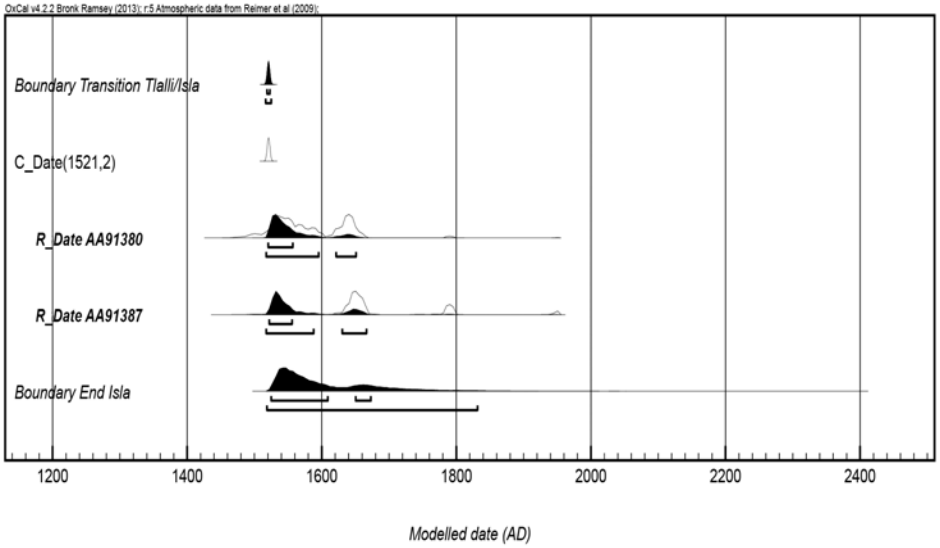

Figure 10 Probability distribution for Isla phase determinations. Samples calibrated individually are shown in gray lines and with Bayesian model as black areas.

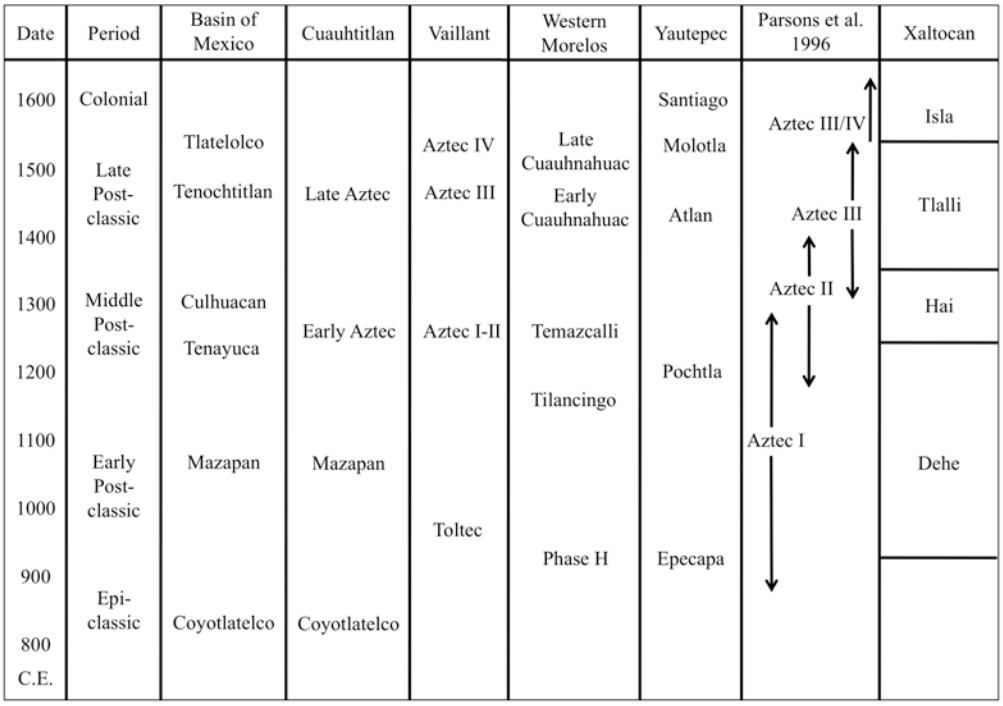

Figure 11 Comparison of cultural sequences in central Mexico, including new proposed chronology for Xaltocan

In addition, the resulting posterior calendar year probability distributions for several ^{14}C dates presents preliminary evidence for the timing of the contemporaneous consumption of Aztec I and II wares by some residents while others used Aztec II pottery. This sample, while admittedly small, provides the first such data set for central Mexico. Excavations from two houses on the eastern edge of the island indicated that the island had been expanded and people using Aztec II pottery had settled on the new lakeshore by AD 1240. Three ^{14}C dates (AA91377, AA91378, and AA91381) from the earliest pure Aztec II middens were all estimated in the Bayesian model to cal AD 1230–1280. Also by 1240, households located in the center of Xaltocan had adopted Aztec II alongside Aztec I pottery. For the Op Z household excavated by De Lucia and Brumfiel, De Lucia (2013) reports that ^{14}C dates place Aztec I occupation of the house in the mid-11th through mid-13th centuries. The consumption of Aztec II pottery alongside Aztec I in this household is represented by a single sample (AA84393) from a stratigraphically later midden; this date was estimated at cal AD 1260–1310 (De Lucia 2011, 2013; see also Overholtzer and De Lucia, forthcoming). In the Op Zoc household excavated by Brumfiel, several pure Aztec I deposits yielded samples estimated at 95% probability to as late as cal AD 1160–1250 or 1170–1250. The earliest adoption of Aztec II wares alongside Aztec I in this household is represented by stratigraphically later sample Beta-243617 from an informal hearth associated with a sealed midden containing Aztec I and II rims. This determination was calibrated to have a 78% likelihood of dating to cal AD 1120–1260, though unfortunately, this date has poor agreement in the model, as mentioned previously. The declining use of Aztec I in this household is represented by sample Beta-243611 from a stratigraphically later midden containing Aztec I and II pottery; this sample was estimated at 95% probability to cal AD 1240–1320. Thus, Aztec I and II household use at Xaltocan certainly begins by the mid-13th century, though when it ends remains unclear. More dates from additional household contexts are needed to assess the potentially variable chronology of this consumption.

CONCLUSION

Precise understandings of past chronologies have always been a central concern of archaeologists. New tools such as Bayesian statistical modeling of ^{14}C dates permit the construction of chronologies with more precise phases and individual ^{14}C dates. In this article, Bayesian statistical modeling was applied to a suite of 54 ^{14}C dates ranging from cal AD 920–1680 from household excavations at Xaltocan. This modeling was compared to earlier chronologies at the site, and a new chronology was proposed. The conclusions reached here are of broad relevance to central Mexican archaeology because this article provides an extensive radiometric data set from sealed, stratified domestic contexts spanning the Early Postclassic to Early Colonial periods, the first data set of its kind in the Basin of Mexico.

The new chronology—composed of the *Dehe*, *Hai*, *Tlalli*, and *Isla* phases—clarifies the temporal distribution of all four Postclassic and colonial indigenous Black-on-Orange ceramic types at Xaltocan: Aztec I–IV. Aztec I pottery was used for over 300 yr after the site's founding in the 10th century. Aztec II pottery was adopted in households in the mid-13th century, alongside Aztec I ceramics in descendants of the original inhabitants, and exclusively by settlers from a place without a tradition of using Aztec I ceramics. Aztec III pottery was consumed by AD 1350, some 45 yr before the site's conquest and 80 yr prior to incorporation into the Aztec Empire. The Tlalli phase, therefore, does not correspond only to the period of Aztec rule at Xaltocan, but rather also includes several decades of pre-conquest life. Distinguishing between pre- and post-conquest practices at Xaltocan must rely on other methods, such as Bayesian statistical modeling of specific stratigraphic sequences, as was done for particular household contexts (Overholtzer 2012), or perhaps seriation of whole contexts using multiple statistical techniques, as Smith has done for sites outside the Basin of Mexico (Smith 1987; Smith and Doershuk 1991; Hare and Smith 1996; Smith et al. 2013). Unfortunately, existing data are insufficient to characterize fully the chronology of Aztec IV use at Xaltocan, but preliminary evidence suggests that Aztec IV pottery was consumed in low frequencies during the pre-Hispanic period, and early colonial residents used mainly Aztec III and IV pottery until nearly the end of the 17th century, if not later. While this research makes progress in clarifying dates for the arrival of Aztec I–IV pottery at Xaltocan, and suggests that adoption of these wares may have varied by household or neighborhood, additional excavations of household contexts across the site are needed to define the nature of that variation, e.g. how long different households continued to use Aztec I pottery alongside the newly adopted Aztec II ware.

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