

# Local Production and Developing Core Regions: Ceramic Characterization in the Lake Pátzcuaro Basin, Western Mexico

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*A core region is the first place for expected shifts in archaeological materials before, during, and after political changes like state emergence and imperial consolidation. Yet, studies of ceramic production have shown that there are sometimes limited or more subtle changes in the ceramic economy throughout such political fluctuations. This article synthesizes recent efforts to address political economic changes via geochemical characterization (neutron activation analysis; NAA) in the Lake Pátzcuaro Basin in western Mexico. This region was home to the Purépecha state and then empire (Tarascan; ca. AD 1350–1530), one of the most powerful kingdoms in the Americas before European arrival. The combined ceramic dataset from four sites in the region result in eight geochemical groups. Our analysis indicates that the region experienced long-term and relatively stable ceramic production that was not substantially altered by the emergence of the state and empire. In addition, we find evidence for (1) dispersed, localized production; (2) long-lived compositional ceramic recipes; and (3) a complex ceramic economy with differential community participation. We discuss why documenting local ceramic production and craft production more generally is important for the study of past political economies.*

**Keywords:** ceramics, geochemistry, political economy, imperial core, Purépecha (Tarascan)

*En una región geográficamente céntrica cabe esperar cambios en los materiales arqueológicos antes, durante y después de cambios políticos como el surgimiento de un estado central y la consolidación imperial. Sin embargo, estudios sobre la producción de cerámica han demostrado que con frecuencia los cambios en la economía de la cerámica a lo largo de tales fluctuaciones políticas son más limitados o más sutiles. Este artículo sintetiza los esfuerzos recientes por abordar tales cambios políticos y económicos en la cuenca del lago de Pátzcuaro, en el oeste de México, a través de la caracterización geoquímica (Análisis de activación de neutrones, o NAA). Esta región fue la sede del estado y eventualmente imperio Purépecha (tarasco; ca. 1350-1530 aC), uno de las mayores potencias de América antes de la llegada de los europeos. El conjunto de datos que proporcionan los restos cerámicos de cuatro yacimientos en la región da como resultado ocho grupos geoquímicos. Nuestro análisis indica que la región experimentó una producción cerámica a largo plazo y relativamente estable que no fue alterada sustancialmente por el surgimiento del estado y el imperio. Además, encontramos evidencia de: (1) producción dispersa y localizada; (2) recetas cerámicas compositivas de larga duración; y (3) una economía cerámica compleja con participación comunitaria diferencial. Discutimos por qué documentar la producción local de cerámica y la producción artesanal en general es importante para el estudio de las economías políticas del pasado.*

**Palabras clave:** cerámicas, geoquímica, economía política, un núcleo imperial, Purépecha (Tarasco)

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A core region is often the first place where there are visible shifts in archaeological materials before, during, and after significant changes in political complexity. Broadly

construed, the core is where states and empires take shape, and it can include cities, monumental architecture, and other edifices that serve to assert the authority of political regimes (Covey 2015;

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Sinopoli and Morrison 1995). Other characteristics of a core can include centralized and specialized production of both elite and quotidian goods and shifts in the production processes of these items as political control changes. In regions where states and empires developed, previous work has documented pre-/post-changes in raw material procurement (Darras 2008; Hayashida 1999; Rebnegger 2010), the standardization of production (Blackman et al. 1993; Costin and Hagstrum 1995; Fragnoli and Frangipane 2022; Roux 2003), and the organization of labor forces for agricultural and other extractive activities (Rosenzweig and Marston 2018; Sinopoli 2003).

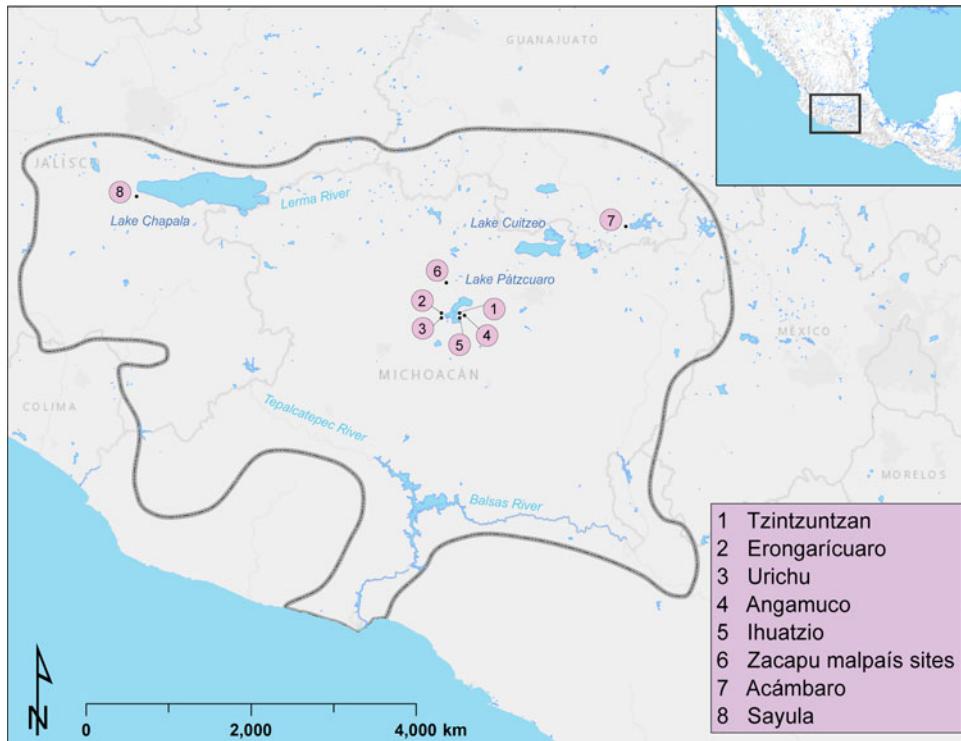
Although scholars expect to see changes in the periods before and after political consolidation occurs, there are also core regions in which there are limited or more subtle changes in certain aspects of the economy. For example, numerous studies have documented that even when new state and imperial styles were introduced via pottery, existing methods of pottery production often remained unchanged—not only in the political core region but also throughout expanding imperial territories (Barber and Pierce 2019; Bonomo 2018; Bray and Minc 2020; Carrano et al. 2009; Cohen 2016; Druc et al. 2020; Overholtzer et al. 2020; Williams et al. 2016). There are practical explanations for continued local pottery production despite political perturbations, including technological constraints and local knowledge; however, additional work is necessary to evaluate what long-term localized production means for core subjects and how or whether states and empires co-opted local production.

Here, we synthesize our recent efforts to address political-economic changes in core regions via geochemical characterization using neutron activation analysis (NAA) in western Mexico (Cohen et al. 2018, 2019; Hirshman and Ferguson 2012). The Purépecha (alternatively P'urhépecha; also called Tarascan in the literature when referring to the political entity) state and then empire (ca. AD 1350–1530) was one of the most powerful kingdoms in the Americas before European arrival, and yet very little is known about communities before and after the sociopolitical developments leading to the empire compared to their peers in

central and southern Mexico. Previous studies (Cohen et al. 2018, 2019; Hirshman and Ferguson 2012) focused on different sites in the Lake Pátzcuaro Basin region, all of which were occupied before, during, and after Purépecha state and empire formation in the Postclassic period (ca. AD 900–1530). In this article, we combine our data to examine changes in ceramic production, including raw material sources and paste recipes used to create vessels and other objects. Our analysis indicates that the region experienced long-term and relatively stable ceramic production that was not substantially altered by the emergence of the state and empire. In addition, we find evidence for (1) dispersed, localized production; (2) long-lived compositional ceramic recipes; and (3) a complex ceramic economy with differential community participation. These findings support our previous work in several ways, and here we discuss why documenting local ceramic production and craft production more generally is important for the study of past political economies.

### The Lake Pátzcuaro Basin and Political Change

The ceramics from this study come from archaeological investigations at four sites in the Lake Pátzcuaro Basin, located in Michoacán, Mexico (Figure 1). The Lake Pátzcuaro Basin is an intra-drainage, spring-fed freshwater lake situated in the late Quaternary Michoacán-Guanajuato Volcanic Field (Hasenaka and Carmichael 1987). The basin itself is 929 km<sup>2</sup> (92,890 ha<sup>2</sup>), with water encompassing approximately 14.6% of the basin surface (13,600 ha<sup>2</sup>) when the lake was at 2,050 m asl in the early sixteenth century (Pollard 1993:63, 66); at that time, it was considerably larger than its current size (Haskell and Stawski 2017). Typical stratigraphy of the region includes eroded andesitic-volcanic and basaltic-andesitic edifices, followed by volcanic materials like ash, sand, gravels, blocks, and lavas, and then various lacustrine deposits (Israde-Alcántara et al. 2005). Recent overviews of the lake basin environmental history, geology, and clay resources are available elsewhere (Cohen et al. 2018, 2019; Haskell and Stawski 2017; Hirshman and Ferguson 2012).



**Figure 1.** Map showing the extent of the Purépecha Empire during the latter part of the Late Postclassic period and the Lake Pátzcuaro Basin imperial core region discussed in this study (redrawn from Cohen 2021:Figure 1).

Habitation within the lake basin before European contact spans at least the Late Preclassic (50 BC) to the Late Postclassic (AD 1530) periods, with the Purépecha state probably emerging in the latter part of the Middle Postclassic (ca. AD 1100–1350) and the empire forming in the Late Postclassic (ca. AD 1350–1530; Table 1). As discussed later, there are distinctive changes in archaeological materials and population growth in the latter two periods, but there is no clear consensus on when the state and empire coalesced or whether this was a stepwise process. Thus, in this study, we combine the Middle to Late Postclassic cultural periods as a broader unit for understanding sociopolitical developments leading up to and including the Purépecha Empire. This is in contrast with the earlier periods—the Preclassic through Early Postclassic—when Purépecha sociopolitical developments are not as apparent in the archaeological materials or settlement patterns.

In general, occupation in the region can be defined at first by small polities exhibiting

Table 1. Chronology for the Lake Pátzcuaro Region.

Period	Local Phase	Dates (AD)
Colonial	N/A	After 1521
Late Postclassic	Tariácuri	1350–1525/1530
Middle Postclassic	Late Urichu	1000/1100–1350
Early Postclassic	Early Urichu	900–1000/1100
Epiclassic	Lupe–La Joya	600/700–900
Middle Classic	Jarácuaro	550–600/700
Early Classic	Loma Alta 3	350–550
Late/Terminal	Loma Alta 1 and 2	150 BC–AD 350
Preclassic		
Middle Preclassic	Chupícuaro	> 500–150 BC

*Note:* Based on Pollard (2008).

internal social inequality via exotic burial goods and long-distance trade, followed by increasing inequality via the consumption of nonlocal elite goods during the Late Classic and Epiclassic periods (Pollard 2008). During the Early to Middle Postclassic periods (AD 900–1350), populations in the region increased, and settlements were established on newly exposed islands and fertile lacustrine soil that

were exposed by lake regression. Pollard (2008) has argued that these settlements were expanded onto islands and defensible upland zones such as lava flows because of population pressure and resource competition. This is similar to the interpretations for contemporaneous archaeological occupations in the nearby Zacapu Basin (Michelet 2008).

At some time during the fourteenth century, the lake basin served as the political, economic, and ideological core for the development and consolidation of the Purépecha state and then empire. Evidence for state formation includes a growing number of nucleated sites on upland landforms and increasing populations overall, the import and export of goods and services through regional markets and state institutions, and material culture like polychrome ceramic vessels and metal bells, tweezers, and rattles (Hosler and Macfarlane 1996; Michelet 2008; Pollard 1993, 2008, 2017; Pulido Méndez 2006). The transition from state to empire is currently unclear and may have occurred quickly, but interpretations of the archaeological and ethnohistoric data point to two distinct phases of political changes. First, a kin group that migrated from the nearby Zacapu Basin, called the Uacúsecha, formed a powerful settlement in the eastern portion of the lake basin. Later, a second lineage emerged around the capital city of Tzintzuntzan and consolidated power throughout the lake basin and eventually beyond the imperial core region (Cohen 2021; Haskell, 2018, 2008). As contemporaries of the Aztec Triple Alliance, the Purépecha controlled a territory comprising much of the modern state of Michoacán, as well as parts of Guerrero, Jalisco, Colima, and Guanajuato. At its apogee, Purépecha state and imperial material culture involved distinctive keyhole-shaped pyramids called *yácatas* and associated monumental architecture like plazas and large buildings, fine polychrome spouted vessels, tripod bowls with globular supports, miniature vessels, and intricately carved ceramic pipes (Pulido Méndez 2006; Figure 2). Pollard (2008) has argued that local elites shifted from consuming exotic goods to locally produced items, a strategic move that established the region as the political-economic core of the eventual empire. Throughout imperial territories,

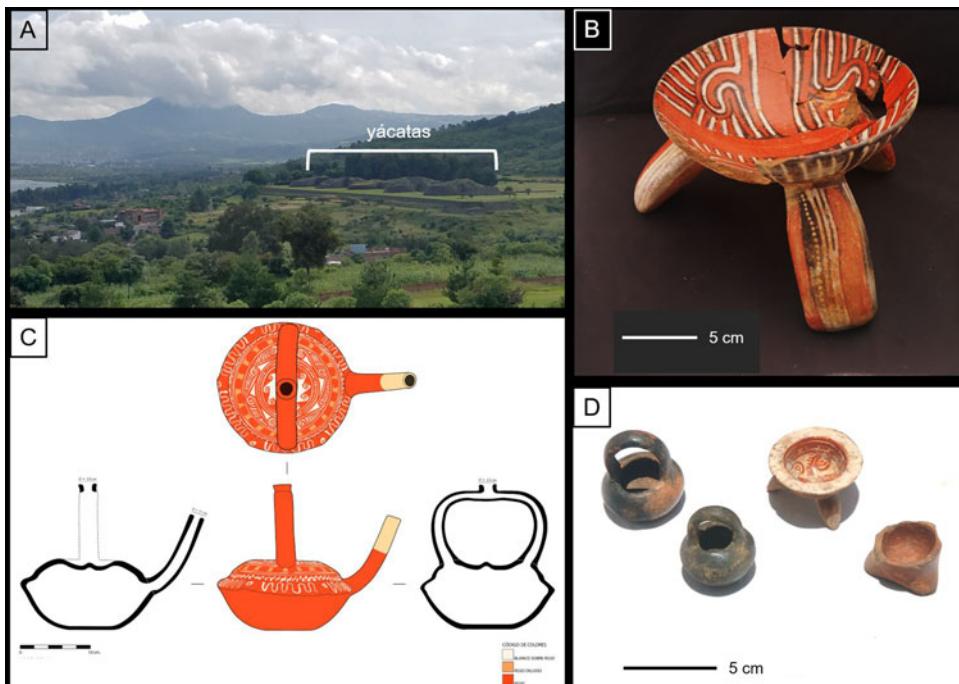
in excavated ceremonial contexts like *yácatas* and plazas, imperial-style artifacts such as spouted vessels have been recovered with elite burials, suggesting that regional imperial elites consumed items identical to those from the capital (Lefebvre 2011; Macías Goytia 1986, 2005; Ramírez Urrea and Cárdenas 2006).

An important component of archaeological work into pre-Purépecha and state/imperial period sites is the interpretation of ethnohistoric texts, particularly the *Relación de Michoacán* (Alcalá 2000). This text, which was written down between AD 1539 and 1541 from an official oral history of the origins of the Purépecha Empire, is often referenced in archaeological studies of the region. It relays the account of the Uacúsecha migrants and further suggests that these new elites co-opted existing social structures and created centralized, top-down production and tribute systems (Afanador-Pujol 2015; Beltrán 1982; Haskell 2018; Stone 2004). Although state control of resources may have occurred in terms of metallurgy, obsidian, and material markers of the empire like polychrome spouted vessels and *yácatas* pyramids (Hirshman 2008; Maldonado 2008, 2009; Pollard 2016; Rebnegger 2010), reorganization of ceramic production in the lake basin is less clear. Previous work has not found a substantial reorganization of raw material procurement and paste recipes at several sites (Cohen 2016; Cohen et al. 2018, 2019; Hirshman 2003, 2008; Hirshman and Ferguson 2012; Hirshman and Haskell 2016), yet certain distinctive styles and symbols clearly appear in association with consolidated political elite control (Cohen 2021; Pollard 2016). This article uses ceramic materials from sites that were occupied before and during political consolidation to examine production activities vis-à-vis geochemical characterization on a regional scale.

## Sample Locations and Methods

### Sample Overview and Locations

The ceramic characterization samples come from four sites in the lake basin, located on the southwestern and eastern sides of the lake (Figure 3). The samples consist of fragmented sherds; any information about forms and styles is briefly



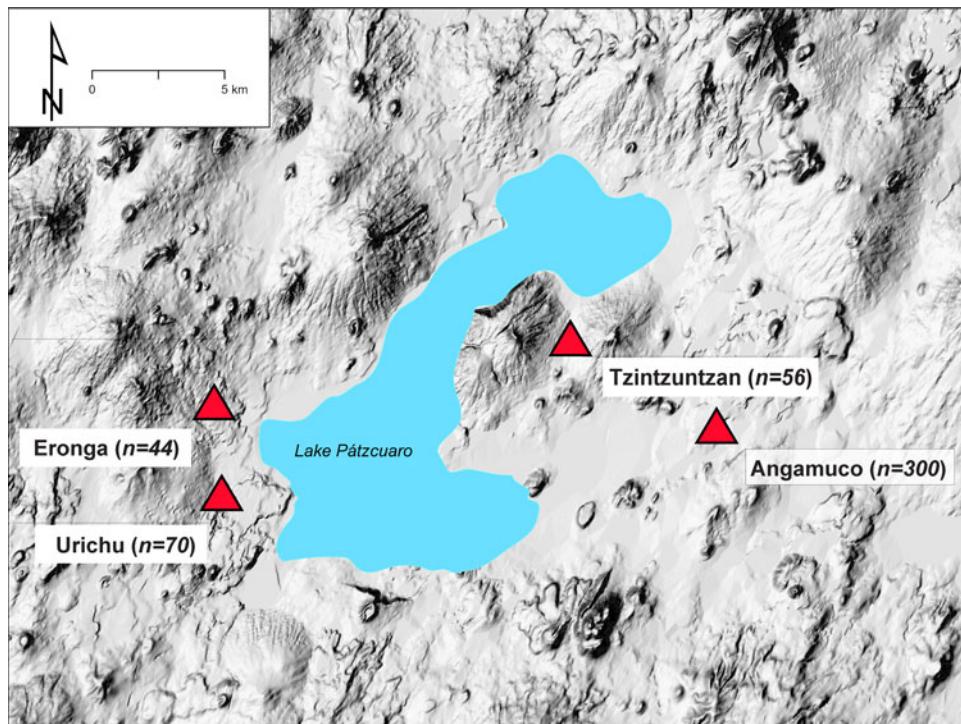
**Figure 2.** Material characteristics of the Purépecha Empire. (A) Remains of the five *yácatas* pyramids at Tzintzuntzan; (B) ceramic polychrome vessel with globular supports from Angamuco; (C) ceramic polychrome spouted vessel from Angamuco (drawing by D. Salazar Lama); (D) miniature ceramics vessels from Angamuco (all photos by Anna Cohen). (Color online)

noted by site later. The majority of ceramics recovered in the basin are sherds; in fact, whole vessels from excavation are quite rare. As a result, in this broader regional discussion, we provide basic information on sherd surface treatment, but we cannot elaborate on forms over time. Because all sites were occupied before and during the emergence of significant social complexity within the basin, we divided the ceramic samples into pre-state (Early Classic through Early Postclassic, ca. AD 250–1100) and state/early imperial to imperial periods (Middle to Late Postclassic, ca. AD 1100–1530; see Table 3). This ensures that our study examples reflect pre-Purépecha and Purépecha occupations in the lake basin region.

*Tzintzuntzan* ( $n = 56$ ). Tzintzuntzan was the imperial capital, though the site was not particularly important prior to emergence of the state, and only a small habitation locale has been noted to the north of the modern community along the lakeshore (Pollard 1993). The sherd samples were recovered in a surface survey of the

Purépecha capital in the 1970s, and all likely date to the Late Postclassic period. The samples are all fine wares, representing predominantly elite residential contexts and ritual residential activities (Hirshman and Ferguson 2012; Pollard 1993). The forms include Purépecha bowls, tripod bowls, and jars; the surface treatment commonly includes slipping with cream or red, as well as red or white paint or both. Ethnohistoric documents indicate that a regular market occurred at the site during the state period (Pollard 1972, 1993).

*Erongarícuaro* ( $n = 44$ ). These sherd samples derive from stratigraphic excavations and represent both a Preclassic/Classic period residential context and a Late Postclassic Purépecha elite residential zone associated with a public building (Haskell 2008, 2018). The samples are all fine wares and include both bowls and jars, most of which are slipped; if they are painted, red dominates throughout the time periods, and some Purépecha-period vessels are painted with red, white, or both. The site was a Late



**Figure 3.** Map of the Lake Pátzcuaro Basin showing the sample locations used in this study (map data from the USGS, NASA, and ESRI Living Atlas).

Postclassic secondary Purépecha administrative center (Hirshman and Ferguson 2012; Pollard 2005a, 2005b; Pollard and Haskell 2006).

*Urichu* ( $n = 70$ ). These sherd samples were also drawn from stratigraphic excavations and represent residential contexts during all time periods at the site from the Preclassic to Late Postclassic, when Urichu was a Purépecha tertiary administrative center (Hirshman and Ferguson 2012; Pollard et al. 2001, 2005). Again, fine wares were sampled, including bowls and jars, with cream or red slip; red paint is common throughout all time periods, and red or white or both colors are also common during the Late Postclassic Purépecha period (a description of the overall Urichu assemblage and the range of variation can be found in Hirshman et al. 2010). The site was also a canoe-landing location in the protohistoric period (Gorenstein and Pollard 1983; Pollard 1993).

*Angamuco* ( $n = 300$ ). Located approximately 9 km southeast of the imperial capital of Tzintzuntzan, the urban landscape of Angamuco is

primarily situated on 26 km<sup>2</sup> of lava flows. This site was occupied from at least the Classic through the Late Postclassic periods (ca. AD 250–1530; Cohen 2021). It is presumed to have already been a large civic center before imperial development and may have played a role in regional development and interaction. Sherd samples are from stratified excavations in six areas of Angamuco, including Late Postclassic ceremonial (*yácatas*) pyramid areas and Classic and Early Postclassic ritual and domestic contexts. When identifiable, pre-Purépecha sherds may include fragments of bowls with or without grinding bottoms (*molcajetes*) and jars; these sherds often have a reddish or cream-colored slip and occasional decoration with red paint. Purépecha state- and empire-period ceramics in this sample consist of forms like bowls, tripod bowls with globular supports, jars, and spouted vessels; decoration includes reddish or cream-colored slip, sometimes with red, black, and white paint and negative resist firing (for further information, see Cohen 2016:165–174). In

addition to the 300 archaeological specimens subjected to geochemical analysis, 30 raw clay deposits were sampled from the immediate vicinity to evaluate localized raw material procurement (as reported in Cohen et al. 2019).

### Methods

The samples from Erongarícuaro, Urichu, and Angamuco were analyzed at the University of Missouri Research Reactor (MURR) following established protocols (Glascoc 1992; Glascoc and Neff 2003; Neff 1992, 2000). The Tzintzuntzan samples were analyzed at the University of Michigan's Ford Nuclear Reactor and Phoenix Memorial Lab. Details of these analyses are available elsewhere (Cohen 2016; Cohen et al. 2018; Hirshman 2003; Hirshman and Ferguson 2012). The materials analyzed at Michigan were previously calibrated with the MURR analysis of the Erongarícuaro and Urichu materials (Hirshman and Ferguson 2012), so we are confident that these datasets are comparable. In earlier publications, the Angamuco samples were analyzed separately from the Tzintzuntzan/Erongarícuaro/Urichu (TEU) samples. Using MURR Statistical Routines for GAUSS software implementing principal component, cluster, and discriminant analyses; visual inspection of bivariate plots; and Mahalanobis distance measurements, we compared the Angamuco samples to the existing MURR ceramic dataset and to previous groups identified in the TEU analysis. In contrast to earlier publications that only compare results of individual site-specific studies, our current study reanalyzes these data as a single dataset and is the first to assess ceramic production at a regional level.

The first step in our regional analysis was to recalculate the range of variation for shared compositional groups between past studies. To promote clarity and to facilitate a more cohesive regional perspective, we present the different and overlapping NAA groups identified in more localized studies as a combined dataset and subsequently rename the previously published groups (Table 2). Initially, the TEU samples were classified into groups that were identified as Main Pottery Group and Pottery Groups 1, 2, 3, 4, and 5 (Hirshman and Ferguson 2012). The Angamuco samples, in contrast, were

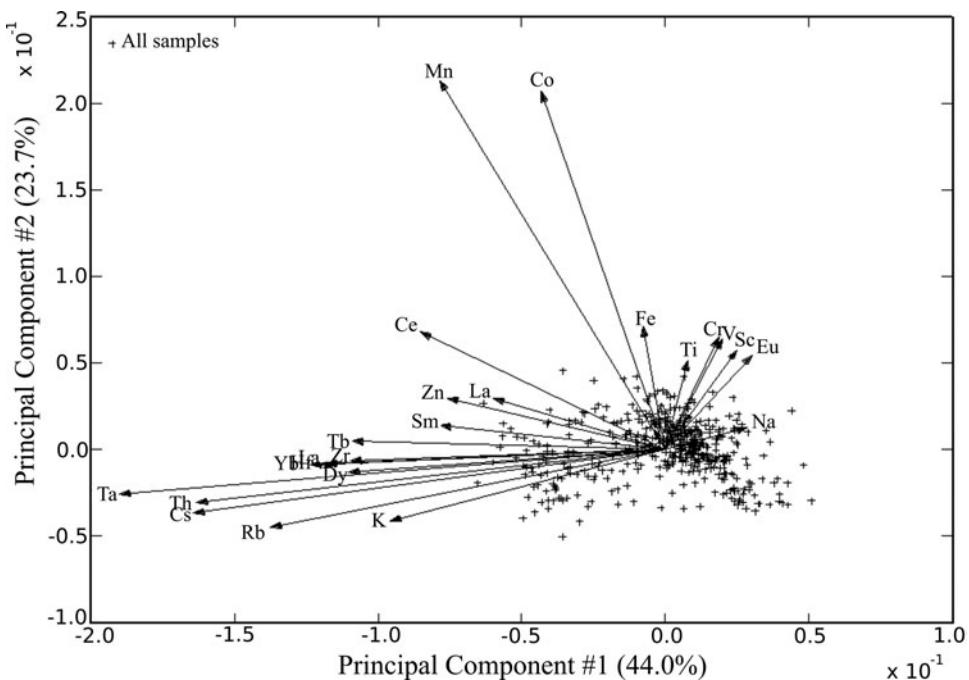
Table 2. Updated and Corresponding Previous Names of Lake Pátzcuaro Basin NAA Groups.

Updated Name	Previous Name(s)
Pottery Group A (PGA)	TEU Main Pottery Group; Angamuco Group A
Pottery Group 1 (PG1)	TEU Group 1; Angamuco Group C
Pottery Group 2 (PG2)	TEU Group 2
Pottery Group 3 (PG3)	TEU Group 3
Pottery Group 4 (PG4)	TEU Group 4
Pottery Group 5 (PG5)	TEU Group 5
Pottery Group 6 (PG6)	Angamuco Group B
Pottery Group 7 (PG7)	Angamuco Group D

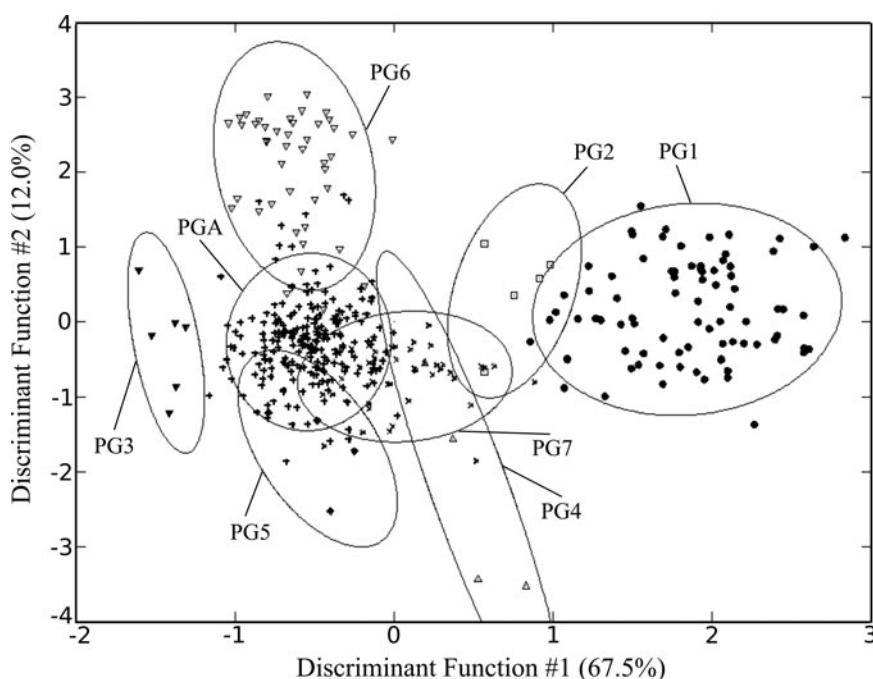
classified as Groups A, B, C, and D (Cohen et al. 2019). To limit confusion going forward, and because there is overlap between two of the Angamuco groups and the initial dataset, here we present the Lake Pátzcuaro Basin NAA groups as Pottery Group A and Pottery Groups 1–7.

To assess the validity of previous group identifications and redefine the compositional range of variation to consider a more robust sample at a regional perspective, we started with Pottery Group A (PGA) and Pottery Group 1 (PG1) as identified by Hirshman and Ferguson (2012). Because of their clear similarities, we combined these two groups with two others from Cohen and colleagues (2019; i.e., Angamuco Group A and C, respectively). Group separation relies on PCA transformation, which was performed using a variance-covariance matrix of the logged data (see Figure 4 and Supplemental Table 1 for the values of the first seven principal components). As discussed later, all other previously identified groups remained distinct: for example, PG1 is generally high in Ta, Th, Hf, Yb, Lu, Rb, Zr, Dy, and Cs, and low in Sc; PG2 is generally high in Cs and low in Cr and Sc; PG3 is low in Hf, Cs, Th, and Ta; PG4 is generally high in Cr and Sc; PG5 is low in Sm and Lu; and PG6 is low in Fe. There is, however, some compositional overlap with certain elements or principal components, such as between PGA, PG4, PG6, and PG7. Yet, despite the overlapping ellipses, the differentiation between the groups is clear (Figure 5).

To explore the overlapping compositional groups and to determine their conclusive



**Figure 4.** Bivariate R-Q plot showing the first two principal components demonstrating the significance of each element for those two components.

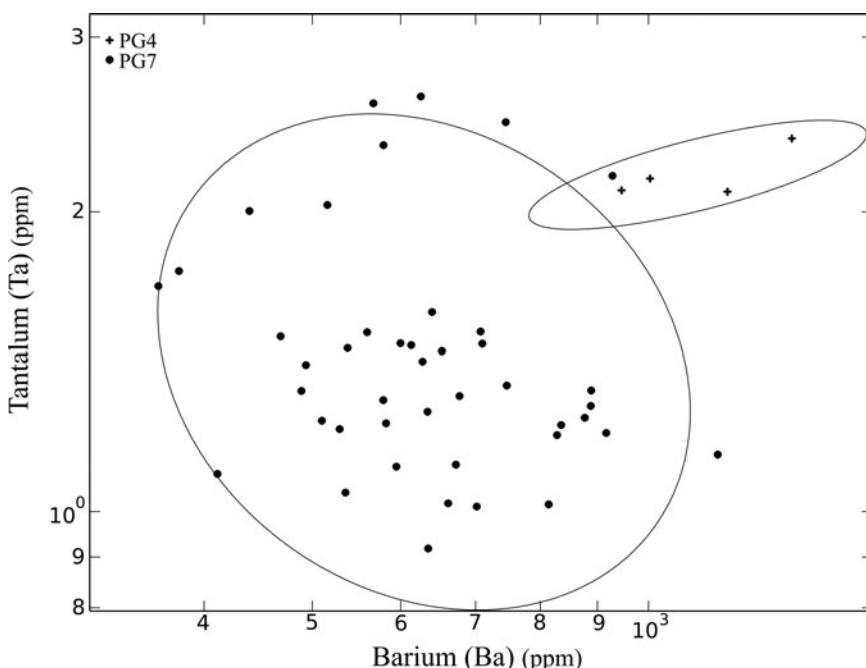


**Figure 5.** Bivariate plot illustrating eight distinct geochemical groups from the Lake Pátzcuaro Basin, based on the first two discriminant functions (explaining 76.1% of the discrimination).

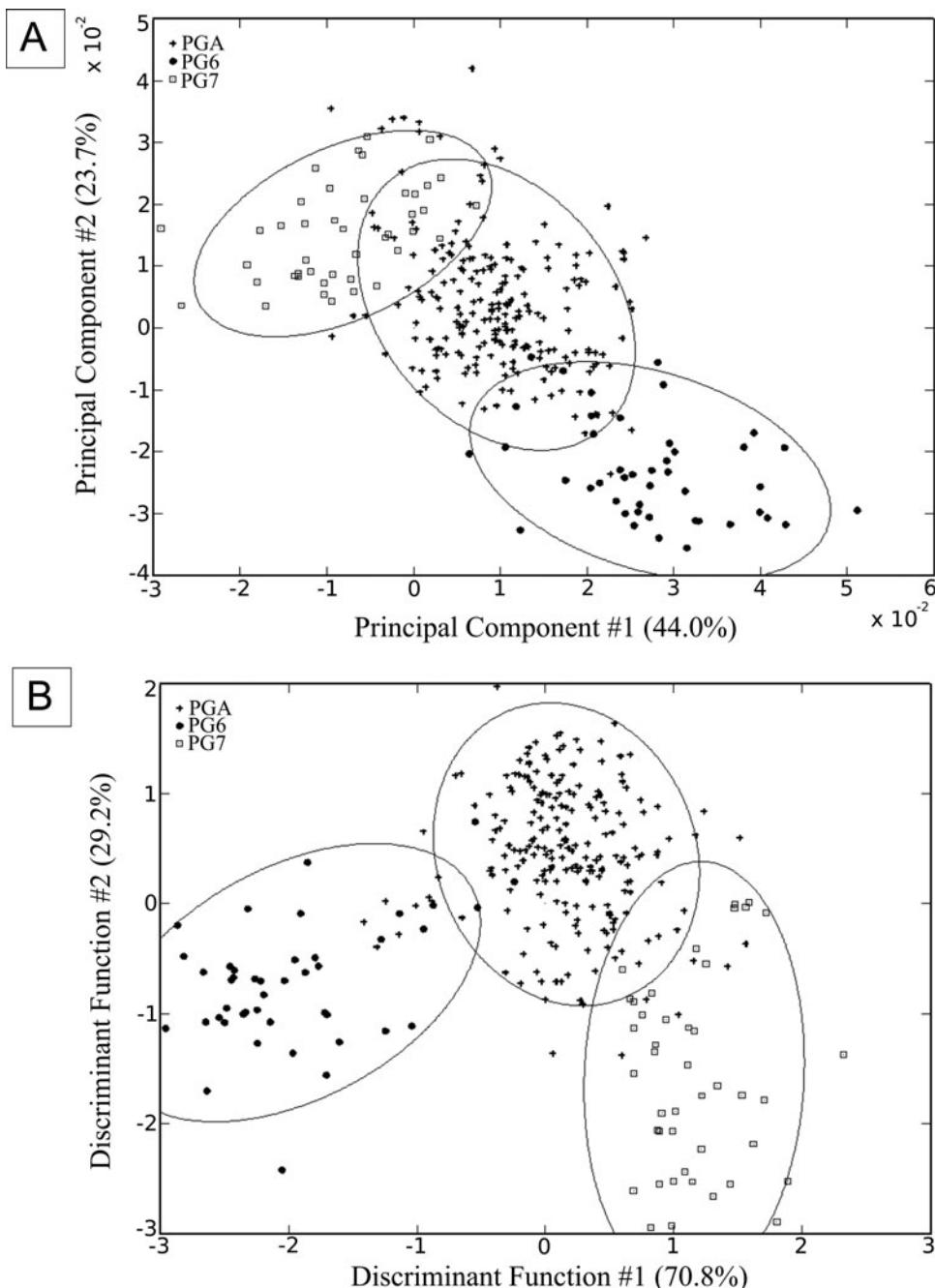
differences, we turned to bivariate plots. Specifically, we considered the overlapping groups individually to parse out any distinctions, element by element. This was done by first removing all groups that have already been established as unquestionably distinct based on previous studies (i.e., Cohen et al. 2019; Hirshman and Ferguson 2012) and confirmed by PCA transformation (see Figure 5). Among the remaining groups that featured some compositional overlap, we next focused on more clearly discriminating between PG7 and PG4. Direct comparisons demonstrate, however, that although they are similar in various ways, these two groups consistently differ in a number of elements while also showing individual homogeneity (Figure 6). For example, elements such as Ti, V, K, Ba, Ta, Tb, Th, Sb, Sc, Fe, Hf, Ce, Co, and Cr are consistently lower in PG7 than in PG4, whereas elements such as La, Lu, Nd, Sm, Yb, Eu, Fe, Hf, Sc, Tb, Zn, Al, Dy, Ti, and V are homogeneous with a coefficient of variation (CV) below 0.2 (see also Supplemental Table 1). These observations fulfill the two most critical aspects of the provenance postulate (Weigand et al. 1977) suggesting true distinction in paste recipes. Given the similarity between

them, however, their distinction may be based on certain aspects of production, rather than on raw materials alone. For example, similar raw materials may have been used but in different proportions (i.e., tempering agents and aplastic inclusions may have varied, resulting in slightly different paste recipes, as discussed for Angamuco by Cohen et al. [2018]). However, these two groups do appear to be distinct recipes and likely reflect differential production to some degree.

Analyzing the overlap between PGA, PG6, and PG7 (in Figure 5), we found that PG6 and PG7 are distinct from each other. However, each independently exhibits small amounts of overlap with PGA. Considering their individual elements, which do overlap to a degree, PG6 and PG7 are consistently clustered (i.e., cohesive homogeneous clusters) yet typically diverge from each other and from PGA (Figure 7A). To confirm the differentiation, we calculated discriminant functions based only on PGA, PG6, and PG7 (Figure 7B). By determining the discriminant functions of these three groups in isolation, we were able to remove the influence of all other groups on the single function(s) that differentiate the dataset as a whole.



**Figure 6.** Bivariate plot demonstrating differentiation of Groups PG4 and PG7 based on Ba and Ta.



**Figure 7.** Bivariate plot demonstrating differentiation of Groups PGA, PG6, and PG7 based on (A) principal components 1 and 2, and (B) discriminant functions 1 and 2 following reapplication of discriminant analysis.

Finally, the discrimination of groups was further supported through hierarchical cluster analyses including only these three groups. In the produced dendrogram using unweighted elemental concentrations, these three groups do

largely cluster independently of each other; Mahalanobis and Euclidean distance calculations also support this interpretation. Not only do these three compositional groups remain distinct when taking a regional perspective but also

this analysis brings us to eight distinct groups for the region in total.

## Results

Overall, our combined NAA study of the pottery indicates that there are eight compositional groups among the 470 basin samples (Table 3). In this regional assessment, group membership as had been presented by individual site-specific studies in the past changed little. However, very rarely, samples from PGA and PG6 were conservatively switched to the “unassigned” category, because they now fell within the outer margins of compositional hyperspace for more than one group when viewed in a regional perspective. Nonetheless, no samples were switched from one group to another in their identification: the groups remained intact and distinct, confirming not only the adequacy of previous analyses (as

evidenced by their replicability in multiscale approaches) but also the robusticity of the regional approach. At TEU, Pottery Group (PG) A and PGs 1–5 (PG1, PG2, PG3, PG4, PG5) were identified. At Angamuco, in contrast, we identified PGA, PG1, and groups PG6 and PG7, both of which are unique to this site.

The PGA group ( $n = 210$ , 45% of the total sample) and PG1 ( $n = 79$ , 17% of the total sample) are the two largest compositional groups and are found at all sites in every sampled time period, from the Classic through the Late Postclassic (Cohen 2016; Cohen et al. 2019). The PGA group is distinguished from PG1 mainly by the enrichment of transition metals and lower concentrations of Rb, K, Th, Cs, U, and Ta. PGA shows some similarities to small groups PG3 and PG5, whereas PG1 shows similarities to PG2 and PG4. Nevertheless, our analysis of the entire Lake Pátzcuaro dataset demonstrates that

Table 3. Samples by Compositional Group, Time Period, and Site.

Compositional Group	Tzintzuntzan	Erongarícuaro	Urichu	Angamuco	Total
Pottery Group A ( $n = 210$ )					
<i>Middle–Late Postclassic</i>	23	10	14	112	159
<i>Early Classic–Early Postclassic</i>	0	27	14	10	51
Pottery Group 1 ( $n = 79$ )					
<i>Middle–Late Postclassic</i>	20	1	4	24	49
<i>Early Classic–Early Postclassic</i>	0	0	13	17	30
Pottery Group 2 ( $n = 5$ )					
<i>Middle–Late Postclassic</i>	0	0	5	0	5
<i>Early Classic–Early Postclassic</i>	0	0	0	0	0
Pottery Group 3 ( $n = 6$ )					
<i>Middle–Late Postclassic</i>	0	1	2	0	3
<i>Early Classic–Early Postclassic</i>	0	1	2	0	3
Pottery Group 4 ( $n = 4$ )					
<i>Middle–Late Postclassic</i>	0	0	4	0	4
<i>Early Classic–Early Postclassic</i>	0	0	0	0	0
Pottery Group 5 ( $n = 4$ )					
<i>Middle–Late Postclassic</i>	0	0	4	0	4
<i>Early Classic–Early Postclassic</i>	0	0	0	0	0
Pottery Group 6 ( $n = 52$ )					
<i>Middle–Late Postclassic</i>	0	0	0	47	47
<i>Early Classic–Early Postclassic</i>	0	0	0	5	5
Pottery Group 7 ( $n = 43$ )					
<i>Middle–Late Postclassic</i>	0	0	0	41	41
<i>Early Classic–Early Postclassic</i>	0	0	0	2	2
Unassigned ( $n = 67$ )					
<i>Middle–Late Postclassic</i>	13	3	6	40	62
<i>Early Classic–Early Postclassic</i>	0	1	2	2	5
TOTAL	56	44	70	300	470

Note: The Middle–Late Postclassic periods correspond to the state/early imperial to imperial phases of political development.

all groups continue to be stable and that the additional samples from Angamuco do not fall into these four groups.

At Angamuco, PG6 ( $n = 52$ ) was clearly distinguished from other paste recipes in the PC plot: it was comparatively low in elements such as Sm, Hf, Ce, and Mn and comparatively high in Ca and Sr. This group does not match raw clay samples collected anywhere in the region. The fact that this group is dissimilar to all other samples in the MURR NAA database, including those collected far beyond the lake basin, suggests that it likely represents local materials and production (Cohen et al. 2019).

The other unique Angamuco group, PG7 ( $n = 43$ ), is the most heterogeneous of the Angamuco groups in terms of individual elements but is more cohesive in multivariate analysis, such as through a principal components analysis. In general, it is higher in Co, C, and Fe than most of the assemblage. It is also the only Angamuco group that overlaps compositionally with any locally collected clay samples ( $n = 10$ ; see Cohen et al., 2019). However, some other clays are more like some of the TEU groups, namely PG3 and PG5, and we anticipate investigating this similarity further as we integrate the results of petrographic analysis from the region (e.g., Cohen et al. 2018; Hirshman 2009, 2017a, 2018a). The similarity with local clays and the dissimilarity with nonlocal ceramics in the MURR database thus support the conclusion of local production for all regional groups.

## Discussion

### *Intra-Basin Pottery Production in the Purépecha Core*

Our intraregional assessment of the lake basin ceramic NAA data yields several key findings. First, this combined dataset reinforces the stability of the NAA groups within the basin over time (Hirshman and Ferguson 2012). Clearly the addition of the Middle–Late Postclassic Angamuco samples highlight the long-term stability of the PGA and PG1. These two groups are well represented at each site and through time (Table 3). Moreover, Erongarícuaro and Urichu continue to exhibit an increase in the number of NAA

groups in the Middle to Late Postclassic—an increase from two and three groups, respectively, to three and six groups—which is concurrent with the onset of increased political complexity in the basin. All four NAA groups identified in the Angamuco samples—including the two groups unique to Angamuco, PG6 and PG7—were also present in both pre-state and state/empire occupations (see Cohen et al. 2019). The number of groups both over time and at the four lake basin sites supports an interpretation of long-lived compositional recipes, with the addition of new recipes over time (Hirshman and Ferguson 2012).

Second, the Lake Pátzcuaro Basin NAA data affirms the previously published model of stable, long-term ceramic production, with localized and dispersed community potting traditions within the lake basin (Hirshman 2018b; Hirshman and Ferguson 2012; Hirshman et al. 2010). Although this dataset includes only a small number of pre-state and empire samples for Angamuco, we suggest that PG6 (five samples) and PG7 (two samples) demonstrate a long-term production tradition at this site, which supports previous observations about Angamuco ceramics (Cohen et al. 2018, 2019). The addition of PG6 and PG7 at Angamuco, and only at Angamuco in this dataset, and the match between PG7 and local Angamuco clays strongly suggest thriving ceramic production at the site in addition to other locales in the basin. PGA and PG3 occur at Erongarícuaro and Urichu in both time periods, demonstrating long-lived potting traditions beyond Angamuco. Moreover, the increased number of small NAA groups at both western basin sites marks an increase in the number of NAA groups within the lake basin as greater sociopolitical complexity emerges in the Middle to Late Postclassic. The increase in compositional groups indicates that more recipes are in use, which is likely due to more potters, potting locales, or both participating in ceramic production within the basin concurrent with larger political changes, rather than any attempt to control or consolidate production by the political elites.

Third, our combined dataset does not support a significant reorganization of the ceramic economy with the emergence of the Purépecha state and empire. As noted, the two largest NAA

groups, PGA and PG1, are important through time and at each site. Their inclusion in Angamuco's ceramic assemblage is especially noteworthy because it demonstrates this site's ceramic—and economic—connection with the larger basin both before and after the Middle Postclassic. In the Late Postclassic period, these groups are associated with undecorated vessels, as well as decorated (i.e., slipped or painted with one color; incised drawings) and polychromes at all the sites, including imperial styles at Angamuco (Cohen 2016:248–254; Hirshman and Haskell 2016; Hirshman et al. 2010). The adoption of new styles within existing production contexts explains a stylistic, but not technological, shift in the assemblage (Hirshman 2018b).

Previous research by Pollard (2016, 2017) indicates that only very restricted classes of ceramics (e.g., spouted vessels, a highly decorated vessel form with paint and negative thin strap handles; vertical tubes; and zoomorphic forms; see also Hirshman and Haskell [2016:211]) moved via elite networks during the imperial period. Other bichrome, polychrome, and utilitarian vessels seemed to move more freely throughout the basin before and after the state and empire emerged (Hirshman 2017b; Hirshman and Haskell 2016). This free movement is also apparent at Angamuco: the relative abundance and generally wide distribution of PG7, associated with polychromes within Middle to Late Postclassic contexts, suggest widespread access rather than the exclusivity sometimes associated with access to elite or exotic goods.

Although this evidence affirms the general model of stable and dispersed ceramic production, this research has also complicated our understanding of the larger ceramic and political economy of the lake basin, especially as political complexity increased over time. This is most clearly seen through the inclusion of the Angamuco ceramic assemblage, at least as represented by these NAA samples, which does not seem to be engaged in the same ceramic economy as the more centrally located sites. For example, the lack of representation of the Angamuco-related PG6 and PG7 elsewhere in the lake basin indicates that these ceramics were not being brought into the center of the basin. This may be due to

the distance of the site from basin markets; Hirshman and Stawski (2013:Figure 6) mention that Angamuco is one of the communities that is more distant from a known basin market, and thus Angamuco potters may not have carried their wares into the center (see also Pollard 1993:89, Figure 3.5). Also of interest is the lack of the smaller pottery groups at Angamuco (PG2, PG3, PG4, and PG5) that were identified at the western basin sites of Erongarícuaro and Urihu. This means that Angamuco was selectively receiving ceramics from the lake basin. The local Angamuco potting tradition likely met most of the needs of the community, at least in the Late Postclassic imperial period. Again, the PGA and PG1 are bichromes and polychromes at the western basin sites, and perhaps they were special-purpose ceramics not mimicked by the Angamuco potters. This distinction also implies that vessels made with PGA and PG1 paste recipes were somehow distinguishable, either by decoration (which seems unlikely at this point), by aspects of the ceramic distribution system, or by another mechanism we cannot currently hypothesize. The relative lack of compositional diversity in the Tzintzuntzan ceramics may be another dimension of this question.

All these results highlight an intricate ceramic political economy with differential participation on the part of potters and communities within the lake basin and perhaps with communities outside the basin as well. The PG6, restricted to Angamuco, may represent connections with communities to the east, because the site sat at a key pass out of the lake basin. The region to the east has not been studied archaeologically, and no comparative archaeological or NAA data currently exist.

#### *Long-Term Potting Traditions*

What does long-term localized production mean for political core subjects and how states and empires co-opted local production activities? The Lake Pátzcuaro Basin ceramic dataset provides an opportunity to explore the impacts (or lack thereof) of political changes on pottery production and consumption in what became an imperial core region. As discussed earlier, we found that over a thousand-year period, pottery

production in the region was relatively stable, localized, and diverse. Other scholars have pointed out that raw materials and pottery production techniques impose technological constraints and can therefore be stable over time (e.g., Sinopoli 1991; Womack et al. 2019). The continuation of paste recipes from the periods before and after the political consolidation of the Purépecha state and empire indicates that, despite shifts in the ceramic forms and decorative styles being produced, the same resources and technologies were being used. Moreover, based on information from Purépecha potting ethnographies, Hirshman (2018b) found that local potters were at least mimicking Purépecha decorations on their vessels. All this suggests not only that producers were successful in using these techniques and materials but also that social shifts motivating forms and styles were not so extensive that they changed the raw materials selected or the techniques used to prepare clay.

Similar stability has been documented in other state and imperial regions (Davenport 2020; Nichols et al. 2002; Overholtzer et al. 2020; Williams et al. 2016), and greater nuance in understanding ancient political economies and market structures has come to the fore (Berdan 1989; Hirth 2013; Huster 2018; Smith and Berdan 2003). This research has implications for how states and empires formed and affected the daily lives of new subjects. Within the Purépecha case specifically, we have growing evidence for a complex economic system. Some dimensions of the economy—notably obsidian importation and distribution (Rebnegger 2010) and aspects of metallurgical processing and distribution (Maldonado 2009, 2008)—came under firm political control. Using ethnohistoric records, Aguilar González (2012:Footnote 1) highlights the political control exerted through the tax system but finds that taxes were focused on five main resources: corn, beans, chili, cotton, and firewood (see also Beltrán 1982). However, although agricultural production intensified with increased elite activity and growing populations within the basin (Fisher et al. 1999), documentary sources suggest that agricultural products from the basin and beyond moved through both market

and tribute mechanisms (e.g., Gorenstein and Pollard 1983). As demonstrated here, most ceramics seem to be locally produced with long-term and stable recipes. Even when imperial-style ceramic forms, like spouted ceramic vessels and bowls with globular supports, appear, producers used similar paste recipes as in the past. It is still possible that the production of specialized imperial forms, just as their distribution, was under elite control. If so, the political elite actively distinguished among resources and goods that they chose to directly control.

The emerging archaeological data imply pre-state and imperial contexts in which existing settlements were integrated into the emerging regime through various negotiations and potentially bottom-up processes (Cohen 2016; Haskell and Stawski 2017; Hirshman 2008; Rebnegger 2013). As such, we can modify our understanding of the complexities of Purépecha development and consolidation. The *Relación de Michoacán* highlights the tribute that was extracted from lake basin settlements and throughout the territories to Tzintzuntzan, as well as the control over craft production (e.g., Aguilar González 2012), but these political-economic strategies are not immediately apparent within the Lake Pátzcuaro Basin. The Aztec imperial economy might be useful as a point of comparison, because the adjacent contemporary empire used a variety of strategies to ensure that tribute demands could be met by various subjugated populations and that the needs of their population within their political core could also be satisfied (Berdan et al. 1996; Nichols et al. 2002). In the Basin of Mexico and in other territories, an existing market system was coopted by imperial elites, and goods continued to flow through this system during imperial control (Garraty and Stark 2002; Huster 2018; Minc 2009; Skoglund et al. 2006; Stoner et al. 2014). However, goods also moved by nonmarket processes, including via tribute payments, large-scale elite gifting, and extended family ties (Fargher et al. 2010; Huster 2018). Our case study in the Lake Pátzcuaro Basin suggests that similarly diverse processes likely structured imperial core region ceramic economies.

## Conclusion

The study of ancient pottery production is useful for understanding political-economic changes in regions where communities, cities, and states were formulated and reconfigured over time (Bishop 2014; Nichols et al. 2002; Rice 2009; Sinopoli 1988). Geochemical characterization of pottery can help document specific social changes or continuity in the locations of raw material procurement, vessel preparation, and trade and exchange (Hayashida 1999). Identifying whether there is continuity or change in these practices enriches our understanding of how political regimes came to power and the extent to which these regimes infiltrated daily life vis-à-vis practices like clay collection, mixing, and subsequent vessel production activities. Regional ceramic characterization studies highlight broader trends in ceramic production and consumption activities (Nichols et al. 2002; Schachner et al. 2011; Stark et al. 2007), which are especially important in core regions where the impacts of state and empire formation are poorly understood.

The compositional diversity within the Lake Pátzcuaro Basin indicates a geochemical and productive complexity approaching that of the Valley of Mexico (e.g., Crider 2013; Nichols et al. 2002), a much larger region and one whose underlying geochemistry and structure of ceramic production are better known. This study shows that the lake basin experienced long-term and relatively stable ceramic production before and during Purépecha state and imperial developments. Future work should better integrate local clay samples into the analysis and broadly discuss the role of this data in the Purépecha political economy.

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**Data Availability Statement.** All data are publicly available at the University of Missouri Research Reactor and with the authors.

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Supplemental Table 1. PCA Values of the First Seven Principal Components.

**Competing Interests.** The authors declare none.

## References Cited

- Afanador-Pujol, Angélica Jimena  
 2015 *The Relación de Michoacán (1539–1541) and the Politics of Representation in Colonial Mexico*. University of Texas Press, Austin.
- Aguilar González, J. Ricardo  
 2012 Los [uh]cambecha y el Sistema tributario en el Estado Tarasco: Tradiciones interpretativas sobre la Relación de Michoacán. In *Abriendo caminos: Ellegado de Joseph Benedict Warren a la historia y a la lengua de Michoacán*, edited by Luise M. Enkerlin Pauwells, pp. 241–274. Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán, Mexico.
- Alcalá, Jerónimo de  
 2000 *Relación de las ceremonias y ritos y población y gobernanza de los indios de la provincia de Michoacán*. Edited by Moisés Franco Mendoza. Colegio de Michoacán, Morelia, Mexico.
- Barber, Sarah B., and Daniel E. Pierce  
 2019 Ceramic Production and Consumption in an In-Between Place: Instrumental Neutron Activation Analysis of Ceramics from the Manialtepec Basin of Oaxaca, Mexico. *Journal of Archaeological Science: Reports* 23:868–880. DOI: [10.1016/j.jasrep.2018.11.036](https://doi.org/10.1016/j.jasrep.2018.11.036).
- Beltrán, Ulises  
 1982 Tarascan State and Society in Prehispanic Times: An Ethnohistorical Inquiry. PhD dissertation, Department of History, University of Chicago, Chicago.
- Berdan, Frances F.  
 1989 Trade and Markets in Precapitalist States. In *Economic Anthropology*, edited by Stuart M. Plattner, pp. 78–107. Stanford University Press, Palo Alto, California.
- Berdan, Frances F., Richard E. Blanton, Elizabeth H. Boone, Mary Hodge, Michael E. Smith, and Emily Umberger (editors)  
 1996 *Aztec Imperial Strategies*. Dumbarton Oaks, Washington, DC.

- Bishop, Ronald L.  
2014 Instrumental Approaches to Understanding Meso-American Economy: Elusive Promises. *Ancient Mesoamerica* 25:251–269.
- Blackman, M. James, Gil J. Stein, and Pamela B. Vandiver  
1993 The Standardization Hypothesis and Ceramic Mass Production: Technological, Compositional, and Metric Indexes of Craft Specialization at Tell Leilan, Syria. *American Antiquity* 58:60–80. DOI:[10.2307/281454](https://doi.org/10.2307/281454).
- Bonomo, Michael F.  
2018 Ceramic Production and Provenance in the Yilou Basin (Henan, China): Geoarchaeological Interpretations of Utilitarian Craft Production in the Erlitou State. *Archaeological Research in Asia* 14:80–96. DOI:[10.1016/jара.2017.02.005](https://doi.org/10.1016/jара.2017.02.005).
- Bray, Tamara L., and Leah Minc  
2020 Imperial Inca-Style Pottery from Ecuador: Insights into Provenance and Production Using INAA and Ceramic Petrography. *Journal of Archaeological Science: Reports* 34:102628. DOI:[10.1016/j.jasrep.2020.102628](https://doi.org/10.1016/j.jasrep.2020.102628).
- Carrano, Julia L., Gary H. Girty, and Carl J. Carrano  
2009 Re-Examining the Egyptian Colonial Encounter in Nubia through a Compositional, Mineralogical, and Textural Comparison of Ceramics. *Journal of Archaeological Science* 36:785–797. DOI:[10.1016/j.jas.2008.11.002](https://doi.org/10.1016/j.jas.2008.11.002).
- Cohen, Anna S.  
2016 Creating an Empire: Local Political Change at Angamuco, Michoacán, Mexico. PhD dissertation, Department of Anthropology, University of Washington, Seattle.  
2021 Urbanization and Imperial Integration at Angamuco, Michoacán, Mexico. *Journal of Field Archaeology* 46:333–348. DOI:[10.1080/00934690.2021.1893424](https://doi.org/10.1080/00934690.2021.1893424).
- Cohen, Anna S., Michael L. Galaty, and Christopher T. Fisher  
2018 Petrographic Analysis of Ceramics and Clay from Angamuco, Michoacán. *Journal of Archaeological Science: Reports* 19:155–165. DOI:[10.1016/j.jasrep.2018.02.035](https://doi.org/10.1016/j.jasrep.2018.02.035).
- Cohen, Anna S., Daniel E. Pierce, and Christopher T. Fisher  
2019 Geochemical Analysis and Spatial Trends of Ceramics and Clay from Angamuco, Michoacan. *Journal of Archaeological Science: Reports* 23:216–230.
- Costin, Cathy L., and Melissa B. Hagstrum  
1995 Standardization, Labor Investment, Skill, and the Organization of Ceramic Production in Late Prehispanic Highland Peru. *American Antiquity* 60:619–639.
- Covey, R. Alan  
2015 Kinship and the Inca Imperial Core: Multiscale Archaeological Patterns in the Sacred Valley (Cuzco, Peru). *Journal of Anthropological Archaeology* 40:183–195. DOI:[10.1016/j.jaa.2015.08.004](https://doi.org/10.1016/j.jaa.2015.08.004).
- Crider, Destiny L.  
2013 Shifting Alliances: Epiclassic and Early Postclassic Interactions at Cerro Portezuelo. *Ancient Mesoamerica* 24:107–130. DOI:[10.1017/S0956536113000047](https://doi.org/10.1017/S0956536113000047).
- Darras, Véronique  
2008 Estrategias para la producción de navajas de obsidiana en la región de Zacapu y la vertiente del Lerma (Michoacán, México) entre el Epiclásico y el Posclásico tardío. *Ancient Mesoamerica* 19:243–264. DOI:[10.1017/S0956536108000370](https://doi.org/10.1017/S0956536108000370).
- Davenport, James A.  
2020 The Organization of Production for Inka Polychrome Pottery from Pachacamac, Peru. *Journal of Anthropological Archaeology* 60:101235. DOI:[10.1016/j.jaa.2020.101235](https://doi.org/10.1016/j.jaa.2020.101235).
- Druc, Isabelle, Mirosz Giersz, Maciej Kałaska, Rafal Siuda, Marcin Syczewski, Roberto Pimentel Nita, Julia M. Chyla, and Krzysztof Makowski  
2020 Offerings for Wari Ancestors: Strategies of Ceramic Production and Distribution at Castillo de Huarmey, Peru. *Journal of Archaeological Science: Reports* 30:102229. DOI:[10.1016/j.jasrep.2020.102229](https://doi.org/10.1016/j.jasrep.2020.102229).
- Fargher, Lane, Richard E. Blanton, and Verenice Y. Heredia Espinoza  
2010 Egalitarian Ideology and Political Power in Prehispanic Central Mexico: The Case of Tlaxcallan. *Latin American Antiquity* 21:227–251.
- Fisher, Christopher T., Helen P. Pollard, and Charles Frederick  
1999 Intensive Agriculture and Socio-Political Development in the Lake Pátzcuaro Basin, Michoacán, Mexico. *Antiquity* 73:642–649. DOI:[10.1017/S0003598X00065248](https://doi.org/10.1017/S0003598X00065248).
- Fragnoli, Pamela, and Marcella Frangipane  
2022 Centralisation and Decentralisation Processes and Pottery Production at Arslantepe (SE Anatolia) during the 4th and Early 3rd Millennium BCE. *World Archaeology* 53:834–861. DOI:[10.1080/00438243.2021.2015623](https://doi.org/10.1080/00438243.2021.2015623).
- Garraty, Christopher P., and Barbara L. Stark  
2002 Imperial and Social Relations in Postclassic South-Central Veracruz, Mexico. *Latin American Antiquity* 13:3–33. DOI:[10.2307/971739](https://doi.org/10.2307/971739).
- Glascocock, Michael D.  
1992 Characterization of Archaeological Ceramics at MURR by Neutron Activation Analysis and Multivariate Statistics. In *Chemical Characterization of Ceramic Pastes in Archaeology*, edited by Hector Neff, pp. 11–25. Prehistory Press, Madison, Wisconsin.
- Glascocock, Michael D., and Hector Neff  
2003 Neutron Activation Analysis and Provenance Research in Archaeology. *Measurement Science and Technology* 14:1516–1526.
- Gorenstein, Shirley, and Helen Perlstein Pollard  
1983 *The Tarascan Civilization: A Late Prehispanic Cultural System*. Vanderbilt University, Nashville, Tennessee.
- Hasenaka, Toshiaki, and Ian S. E. Carmichael  
1987 The Cinder Cones of Michoacán-Guanajuato, Central Mexico: Petrology and Chemistry. *Journal of Petrology* 28:241–269. DOI:[10.1093/petrology/28.2.241](https://doi.org/10.1093/petrology/28.2.241).
- Haskell, David L.  
2008 Tarascan Kingship: The Production of Hierarchy in the Prehispanic Pátzcuaro Basin, Mexico. PhD dissertation, Department of Anthropology, University of Florida, Gainesville.  
2018 *The Two Tarácuris and the Early Colonial and Prehispanic Past of Michoacán*. University Press of Colorado, Boulder.
- Haskell, David L., and Christopher J. Stawski  
2017 Re-Envisioning Tarascan Temporalities and Landscapes: Historical Being, Archaeological Representation, and Futurity in Past Social Processes. *Journal of Archaeological Method and Theory* 24:611–639. DOI:[10.1007/s10816-016-9279-x](https://doi.org/10.1007/s10816-016-9279-x).
- Hayashida, Frances M.  
1999 Style, Technology, and State Production: Inka Pottery Production in the Leche Valley, Peru. *Latin American Antiquity* 10:337–352.
- Hirshman, Amy J.  
2003 A Case Study in the Relationship between Social Complexity and the Organization of Production from

- the Lake Pátzcuaro Basin, Michoacán, Mexico. PhD dissertation, Department of Anthropology, Michigan State University, East Lansing.
- 2008 Tarascan Ceramic Production and Implications for Ceramic Distribution. *Ancient Mesoamerica* 19:299–310. DOI:10.1017/S0956536108000424.
- 2009 Petrographic Analysis of Paste Variability in Tarascan Fine Ware Ceramics: A Preliminary Assessment. Paper presented at the 108th Annual Meeting of the American Anthropological Association, Philadelphia.
- 2017a Ollas, pastas y producción: Complejidad cerámica tarasca. Paper presented at El 2 Coloquio de la Arqueología en Michoacán, Morelia, Mexico.
- 2017b Documenting Accommodation and Change in the Tarascan Ceramic Economy. In *Innovative Approaches and Exploration in Ceramic Case Studies*, edited by Sandra L. Lopez Varela, pp. 41–52. Archaeopress, Oxford.
- 2018a Petrographic Perspectives on the Ceramic Complexity in the Lake Pátzcuaro Basin. Paper presented at the 83rd Annual Meeting of the Society for American Archaeology, Washington, DC.
- 2018b Product Continuity and Change in Persistent Household Ceramic Production: The Tarascan Case. In *Ceramics of Ancient America: Multidisciplinary Approaches*, edited by Yumi Park Huntington, Dean E. Arnold, and Johanna Minich, pp. 335–354. University Press of Florida, Gainesville.
- Hirshman, Amy J., and Jeffrey R. Ferguson
- 2012 Temper Mixture Models and Assessing Ceramic Complexity in the Emerging Tarascan State. *Journal of Archaeological Science* 39:3195–3207. DOI:10.1016/j.jas.2012.05.003.
- Hirshman, Amy J., and David L. Haskell
- 2016 Evaluating Contrasting Models of Ceramic Production in the Tarascan State: Negotiations in Clay. In *Cultural Dynamics and Production Activities in Ancient Western Mexico: Papers from a Symposium Held in the Center for Archaeological Research, El Colegio de Michoacán 18–19 September 2014*, edited by Eduardo Williams and Blanca Maldonado, pp. 201–214. Archaeopress, Oxford.
- Hirshman, Amy J., William A. Lovis, and Helen P. Pollard
- 2010 Specialization of Ceramic Production: A Sherd Assemblage Based Analytic Perspective. *Journal of Anthropological Archaeology* 29:265–277. DOI:10.1016/j.jaa.2010.03.003.
- Hirshman, Amy J., and Christopher J. Stawski
- 2013 Distribution, Transportation, and the Persistence of Household Ceramic Production in the Tarascan State. *Ethnoarchaeology* 5:1–23. DOI:10.1179/1944289013Z.0000000002.
- Hirth, Kenneth G.
- 2013 The Merchant's World: Commercial Diversity and the Economics of Interregional Exchange in Highland Mesoamerica. In *Merchants, Markets, and Exchange in the Pre-Columbian World*, edited by Kenneth G. Hirth and Joanne Pillsbury, pp. 5–112. Dumbarton Oaks, Washington, DC.
- Hosler, Dorothy, and Andrew Macfarlane
- 1996 Copper Sources, Metal Production, and Metals Trade in Late Postclassic Mesoamerica. *Science* 273:1819–1824.
- Huster, Angela C.
- 2018 Regional-Level Exchange in Postclassic Central Mexico. *Journal of Anthropological Archaeology* 50:40–53. DOI:10.1016/j.jaa.2018.02.003.
- Israde-Alcántara, I., Victor Hugo Garduño-Monroy, Christopher T. Fisher, Helen P. Pollard, and Miguel A. Rodríguez-Pascua
- 2005 Lake Level Change, Climate, and the Impact of Natural Events: The Role of Seismic and Volcanic Events in the Formation of the Lake Patzcuaro Basin, Michoacan, Mexico. *Quaternary International* 135:35–46. DOI:10.1016/j.quaint.2004.10.022.
- Lefebvre, Karine
- 2011 Acámbaro, en los confines del reino tarasco: Una aculturación discreta (1440–1521 d. C.). *Trace: Travaux et recherches dans les Amériques du Centre* 59:74–89.
- Macías Goytia, Angelina
- 1986 Los entierros de un centro ceremonial tarasco. In *Estudios de antropología biológica: IV Coloquio de Antropología Física Juan Comas*, 1986, edited by Carlos Serrano and María Elena Salas, pp. 531–559. Universidad Nacional Autónoma de México, Instituto Nacional de Antropología e Historia, Mexico City.
- 2005 La cerámica tarasca antes de la conquista. In *La producción alfarera en el México antiguo*, edited by Beatriz Leonor Merino Carrión and Angel García Cook, pp. 321–341. Instituto Nacional de Antropología e Historia, Mexico City.
- Maldonado, Blanca E.
- 2008 A Tentative Model of the Organization of Copper Production in the Tarascan State. *Ancient Mesoamerica* 19:283–297. DOI:10.1017/S0956536108000400.
- 2009 Metal for the Commoners: Tarascan Metallurgical Production in Domestic Contexts. *Archeological Papers of the American Anthropological Association* 19:225–238.
- Michelet, Dominique
- 2008 Vivir diferentemente: Los sitios de la fase Milpillas (1250–1450 d.C.) en el Malpaís de Zacapu (Michoacán). In *El urbanismo en Mesoamérica: Urbanism in Mesoamerica*, edited by William T. Sanders, Alba Guadalupe Mastache de Escobar, and Robert H. Cobean, pp. 593–620. Instituto Nacional de Antropología e Historia, Mexico City.
- Minc, Leah
- 2009 Style and Subsistence: Evidence for Regionalism within the Aztec Market System. *Latin American Antiquity* 20:343–379.
- Neff, Hector
- 1992 Introduction. In *Chemical Characterization of Ceramic Pastes in Archaeology*, edited by Hector Neff, pp. 1–10. Prehistory Press, Madison, Wisconsin.
- 2000 Neutron Activation Analysis for Provenance Determination in Archaeology. In *Modern Analytical Methods in Art and Archaeology*, edited by Enrico Ciliberto and Giuseppe Spoto, pp. 81–134. Wiley and Sons, New York.
- Nichols, Deborah L., Elizabeth M. Brumfiel, Hector Neff, Mary Hodge, Thomas H. Charlton, and Michael D. Glascock
- 2002 Neutrons, Markets, Cities, and Empires: A 1000-Year Perspective on Ceramic Production and Distribution in the Postclassic Basin of Mexico. *Journal of Anthropological Archaeology* 21:25–82. DOI:10.1006/jaar.2001.0389.
- Overholtzer, Lisa, Daniel E. Pierce, and Michael D. Glascock
- 2020 Aztec Black-on-Orange and Redware Pottery Production from the Middle Postclassic to Early Colonial Period: Insight from Instrumental Neutron Activation Analysis (INAA) at Xaltocan, Mexico. *Journal of*

- Archaeological Science: Reports* 34:102642. DOI:[10.1016/j.jasrep.2020.102642](https://doi.org/10.1016/j.jasrep.2020.102642).
- Pollard, Helen P.
- 1972 Prehispanic Urbanism at Tzintzuntzan, Mexico. PhD dissertation, Department of Anthropology, Columbia University, New York.
  - 1993 *Tarfácuri's Legacy: The Prehispanic Tarascan State*. University of Oklahoma Press, Norman.
  - 2005a Michoacán en el mundo mesoamericano prehistórico: Erongarícuaro y los estados Teotihuacano y Tarasco. In *El Antiguo occidente de México: Nuevas perspectivas sobre el pasado prehispánico*, edited by Eduardo Williams, Phil Weigand, Lorenza López Mestas, and David C. Grove, pp. 283–303. El Colegio de Michoacán A.C., Zamora, Mexico.
  - 2005b *Proyecto Erongarícuaro: Informe técnico parcial, temporada 1 (campo) 2001, temporada 2 (laboratorio) 2002e2004*. Consejo de Arqueología, Instituto Nacional de Antropología e Historia, Mexico City.
  - 2008 A Model of Emergence of the Tarascan State. *Ancient Mesoamerica* 19:217–230. DOI:[10.1017/S0956536108000369](https://doi.org/10.1017/S0956536108000369).
  - 2016 Ceramics, Social Status, and the Tarascan State Economy. In *Cultural Dynamics and Production Activities in Ancient Western Mexico*, edited by Eduardo Williams and Blanca Maldonado, pp. 163–178. Archaeopress, Oxford.
  - 2017 Markets, Tribute, and Class in Tarascan Commodity Consumption: The Lake Patzcuaro Basin. *Americae* 2:7–27.
- Pollard, Helen P., and David Haskell
- 2006 *Proyecto Erongarícuaro: Informe técnico parcial al Consejo de Arqueología, INAH. Temporada II*. Consejo de Arqueología, Instituto Nacional de Antropología e Historia, Mexico City.
- Pollard, Helen Perlstein, Amy J. Hirshman, Hector Neff, and Michael D. Glascock
- 2001 Las élites, el intercambio de bienes y el surgimiento del área nuclear Tarasca: Análisis de la cerámica de cuenca de Patzcuaro. In *Estudios cerámicos en el occidente y norte de México*, edited by Eduardo Williams and Phil Weigand, pp. 289–309. El Colegio de Michoacán, Zamora, Michoacán, Mexico.
  - 2005 Exchange, Elites, and the Emergence of the Tarascan Core. In *Archaeology without Limits: Papers in Honor of Clement W. Meighan*, edited by Brian B. Dillon and Matthew A. Boxt, pp. 295–307. Labyrinthos, Lancaster, California
- Pulido Méndez, Salvador
- 2006 *Los tarascos y los tarascos-uacísecha: Diferencias sociales y arqueológicas en un grupo*. Instituto Nacional de Antropología e Historia, Mexico City.
- Ramírez Urrea, Susana, and Cinthya Cárdenas
- 2006 Análisis de la cerámica del postclásico. In *Transformaciones socioculturales y tecnológicas en el sitio de La Peña, Cuenca de Sayula, Jalisco*, edited by Catherine Liot, Susana Ramírez Urrea, Javier Reveles, and Otto Schöndube, pp. 307–372. Universidad de Guadalajara, INAH, Guadalajara, Mexico.
- Rebnegger, Karin J.
- 2010 Obsidian Production and Changing Consumption in the Lake Patzcuaro Basin, Michoacan, Mexico. *Ancient Mesoamerica* 21:79–89. DOI:[10.1017/S0956536110000167](https://doi.org/10.1017/S0956536110000167).
- 2013 Obsidian Production and Consumption in the Tarascan State. PhD Dissertation, Department of Anthropology, Michigan State University, East Lansing.
- Rice, Prudence M.
- 2009 Late Classic Maya Pottery Production: Review and Synthesis. *Journal of Archaeological Method and Theory* 16:117–156. DOI:[10.1007/s10816-009-9063-2](https://doi.org/10.1007/s10816-009-9063-2).
- Rosenzweig, Melissa S., and John M. Marston
- 2018 Archaeologies of Empire and Environment. *Journal of Anthropological Archaeology* 52:87–102. DOI:[10.1016/j.jaa.2018.08.004](https://doi.org/10.1016/j.jaa.2018.08.004).
- Roux, Valentine
- 2003 Ceramic Standardization and Intensity of Production: Quantifying Degrees of Specialization. *American Antiquity* 68:768–782. DOI:[10.2307/3557072](https://doi.org/10.2307/3557072).
- Schachner, Gregson, Deborah L. Huntley, and Andrew Duff
- 2011 Changes in Regional Organization and Mobility in the Zuni Region of the American Southwest during the Pueblo III and IV Periods: Insights from INAA Studies. *Journal of Archaeological Science* 38:2261–2273. DOI:[10.1016/j.jas.2011.03.029](https://doi.org/10.1016/j.jas.2011.03.029).
- Sinopoli, Carla M.
- 1988 The Organization of Craft Production at Vijayanagara, South India. *American Anthropologist* 90:580–597. DOI:[10.1525/aa.1988.90.3.02a00040](https://doi.org/10.1525/aa.1988.90.3.02a00040).
  - 1991 *Approaches to Archaeological Ceramics*. Plenum Press, New York.
  - 2003 *The Political Economy of Craft Production: Crafting Empire in South India, c.1350–1650*. Cambridge University Press, Cambridge.
- Sinopoli, Carla M., and Kathleen D. Morrison
- 1995 Dimensions of Imperial Control: The Vijayanagara Capital. *American Anthropologist* 97:83–96. DOI:[10.1525/aa.1995.97.1.02a00110](https://doi.org/10.1525/aa.1995.97.1.02a00110).
- Skoglund, Thanet, Barbara L. Stark, Hector Neff, and Michael D. Glascock
- 2006 Compositional and Stylistic Analysis of Aztec-Era Ceramics: Provincial Strategies at the Edge of Empire, South-Central Veracruz, Mexico. *Latin American Antiquity* 17:541–559. DOI:[10.2307/25063071](https://doi.org/10.2307/25063071).
- Smith, Michael E., and Frances Berdan (editors)
- 2003 *The Postclassic Mesoamerican World*. University of Utah Press, Salt Lake City.
- Stark, Barbara L., Robert J. Speakman, and Michael D. Glascock
- 2007 Inter-Regional and Intra-Regional Scale Compositional Variability in Pottery from South-Central Veracruz, Mexico. *Latin American Antiquity* 18:59–84. DOI:[10.2307/25063086](https://doi.org/10.2307/25063086).
- Stone, Cynthia L.
- 2004 *In Place of Gods and Kings: Authorship and Identity in the Relación de Michoacán*. University of Oklahoma Press, Norman.
- Stoner, Wesley D., John K. Millhauser, Enrique Rodríguez-Alegria, Lisa Overholzer, and Michael D. Glascock
- 2014 Taken with a Grain of Salt: Experimentation and the Chemistry of Archaeological Ceramics from Xaltocan, Mexico. *Journal of Archaeological Method and Theory* 21:862–898. DOI:[10.1007/s10816-013-9179-2](https://doi.org/10.1007/s10816-013-9179-2).
- Weigand, Phil C., Garman Harbottle, and Edward V. Sayre
- 1977 Turquoise Sources and Source Analysis: Mesoamerica and the Southwestern U.S.A. In *Exchange Systems in Prehistory*, edited by Timothy K. Earle and Jonathon E. Ericson, pp. 15–34. Academic Press, New York.

- Williams, Verónica I., Calogero M. Santoro, Robert J. Speakman, Michael D. Glascock, Álvaro Luis Romero Guevara, Daniela Valenzuela, Vivien G. Standen, and Terence N. D'Altroy  
2016 Instrumental Neutron Activation Analysis of Inka and Local Pottery from Northern Chile's Atacama Desert. *Journal of Archaeological Science: Reports* 9:481–492. DOI:[10.1016/j.jasrep.2016.08.028](https://doi.org/10.1016/j.jasrep.2016.08.028).
- Womack, Andrew, Hui Wang, Jing Zhou, and Rowan Flad  
2019 Continuity and Change: A Petrographic Analysis of Clay Recipes in Late Neolithic Northwestern China. *Antiquity* 93:1161–1177.

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