Obsidian sourcing and dynamic trade patterns at Izapa, Chiapas, Mexico: 100 BCE–400 CE

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ABSTRACT

Recent research on Mesoamerican economies has demonstrated that Prehispanic trade networks were not static, but constantly evolving. Relationships between peoples in different settlements and regions shift as social, political, and economic circumstances change. One question that results from these findings is how significant events such as sociopolitical decline or abandonment affect exchange networks. This study investigates changes in obsidian procurement during a period of widespread upheaval across southern Mesoamerica, ca. 100–250 CE, from the perspective of a surviving capital on the Pacific coast of Chiapas, Mexico. X-Ray Fluorescence (XRF) analysis using a Bruker Tracer III-V was conducted for obsidian collected from Terminal Formative (100 BCE–250 CE) and Initial Early Classic (250–400 CE) domestic contexts to evaluate how obsidian procurement patterns at the ancient city of Izapa were affected by events in neighboring regions. Obsidian results are compared to known shifts in sociopolitical relationships as observed through ceramics, burials, and art styles. Data indicate that residents of Izapa shifted trade from east to west over the Terminal Formative to Early Classic period transition. Patterns correspond with sociopolitical turmoil at the Guatemalan highland capital of Kaminaljuyú and the rise of the central Mexican city of Teotihuacan. Results also indicate, however, that economic relationships may continue even in places where political affiliations have been severed. Results suggest that datasets for different artifact classes, when viewed independently, introduce additional nuance into the questions of collapse and resilience of ancient societies.

1. Introduction

Recent advancement in archaeological techniques has allowed researchers to reevaluate the organization of ancient economies. Whereas pre-modern economic activity was once relegated to a few economic types, such as reciprocity and redistribution (Polanyi, 1957) and the ritual-regal model for urban economies (Fox, 1977; Sanders and Webster, 1988), archaeologists have now documented a greater range of ancient economic systems. Dynamic cycles of economic growth and decline have been recognized, as well as waves of globalization and regionalization, where economic shifts occur simultaneously across great regions (Frank, 1993; Hodos, 2017; Jennings, 2011; Ur, 2010). The introduction of sourcing techniques such as X-Ray fluorescence (XRF) and neutron activation analysis (NAA) have become essential tools for tracking interregional and intraregional exchange, data which have been used to demonstrate a complex array of past economic activities (Aoyama, 2001; Braswell and Glascock, 2002; Moholy-Nagy et al., 2013; Neff et al., 1989, 1994; Nichols et al., 2002).

Recent research on Mesoamerican economies has demonstrated that Prehispanic trade networks were not static, but constantly evolved in response to new technologies and changing social, political, and economic circumstances (Braswell and Glascock, 2002; Golitko and Feinman, 2015; Nichols et al., 2002; Stark et al., 2016). Much of the work devoted to Mesoamerican economies has emphasized trade during horizon periods, or eras of widespread interaction, associated with prominent cultural groups, such as the Olmec, Teotihuacanos, Late Classic Maya, and Aztecs (e.g. Blanton et al., 1978; Blomster et al., 2005; Braswell, 2003a; Smith and Berdan, 2003; Stoltman et al., 2005). Fewer scholars have directly addressed how the collapse of ancient cities affected ancient trade networks (but see Masson et al., 2010; Pool and Loughlin, 2015; Reese-Taylor and Walker, 2002).

The following study investigates obsidian trade during an early period of widespread disruption, between 100 CE and 250 CE, when many of southern Mesoamerica's first cities declined. Changing patterns of obsidian importation are evaluated for the Pacific coastal capital of Izapa, Chiapas, Mexico using X-Ray fluorescence (XRF) sourcing of obsidian recovered from domestic contexts. Documentation of domestic obsidian for a capital city that survived the Formative period “collapse”
helps to define how the 100–250 CE decline of prominent southern Mesoamerican cities impacted interregional exchange systems.

In addition to tracking regional economic shifts, this study explores whether effects of collapse can be better understood by separating datasets associated with different materials. Do obsidian procurement patterns support the ceramic, monument, and burial data that suggest an abrupt decline in Izapeños' (residents of Izapa) external relationships following the 100–250 CE events?

Obsidian sourcing results generally corroborate previously observed shifts in ties between Izapeños and peoples of neighboring regions. Changing rates of imported blades of El Chayal source obsidian support data that relationships between Izapeños and peoples at capitals within the “Mirafloros sphere” of highland Guatemala and western El Salvador (Demarest and Sharer, 1986) surged during the Terminal Formative period (100 BCE–250 CE) but were severed by the onset of the Early Classic period (250–400 CE). Obsidian blades recovered from the Sierra de Pachuca source (hereafter, Pachuca) in Jaritas phase (250–400 CE) contexts now represent the earliest known appearance of this central Mexican obsidian at Izapa and suggest that new relationships were established to the west by this time. The initiation of these western ties could have been prompted either by the collapse of Izapeños' eastern trade partners, including the highland Guatemalan capital of Kaminaljuyú, or the rise of the central Mexican city of Teotihuacan. More likely, Izapeños shifted their import patterns in response to multiple such events.

The continued appearance of some El Chayal obsidian at Izapa after 250 CE, however, suggests that, while political relationships may have ceased with Miraflores capitals such as Kaminaljuyú, economic activity may have continued between these two zones. Results suggest that social, political, and economic datasets, when viewed independently, introduce additional nuance into questions of the collapse and regeneration of ancient societies.

2. Formative period collapse in southern Mesoamerica

In Mesoamerica, the transition between the Formative and Classic periods, between 100 BCE and 400 CE, was a time of great social change, including the apogee and subsequent decline of several powerful Formative period cities. During the first half of this period, from 100 BCE to 100 CE, archaeologists and art historians have documented the spread of low relief sculptural traditions with writing and the depictions of rulers, the establishment of kingy burial practices, and the development of a widespread network for the procurement of foreign goods and materials (Freidel and Schele, 1988; Guernsey, 2006; Inomata and Henderson, 2016; Reese-Taylor and Walker, 2002). Many of the earliest Mesoamerican cities, such as El Mirador, Kaminaljuyú, and Takalik Abaj were at their height of artistic production and monumental construction. Levels of interregional interaction also appear to have been high, with mounting evidence for a widespread ceramic horizon and exchange network (Inomata et al., 2014; Mendelsohn, 2018a; Mendelsohn, 2018b; Reese-Taylor and Walker, 2002).

By the close of the Formative period, many prominent cities were abandoned, while others experienced significant disruptions. For the period between 100 and 250 CE, archaeologists have documented population declines, cessations in construction activities and monument production, signs of warfare, environmental stress, and abrupt changes in artifact assemblages, all pointing to collapse or turmoil at many southern Mesoamerican cities at this time (Doyle, 2017: 112–129; Estrada-Belli, 2011; Grube, 1995; Love, 2012; Popenoe De Hatch, 1998; Reese-Taylor and Walker, 2002). As more datasets for the Formative to Classic period transition are becoming available, it is increasingly clear that disruption at the close of the Formative period was variable.

Among the regions affected was the Pacific coast. Archaeologists have documented an apparent depopulation of coastal settlements at the close of the Formative period. Surveys of coastal Guatemala have revealed limited Early Classic activity in this zone (Coe and Flannery, 1967: 6; Shook, 1965: 185–186). Michael Love’s research at the Guatemalan coastal site of El Ujuxte suggests that this capital collapsed shortly after 100 CE (Love, 2002, 2007, 2018). Unlike the Guatemalan Pacific coast, however, data from the Izapa polity suggest continuity (Lowe et al., 1982: 145; Rosenswig and Mendelsohn, 2016). Izapa
appears to have followed a different trajectory than neighboring cities. Instead, signs of turmoil appear to occur 200 years earlier, between 100 BCE and 100 CE (Lowe et al., 1982: 139, 194).

2.1. Izapeños and their neighbors during the Formative to Classic period transition

The archaeological site of Izapa is located in the Soconusco region of Chiapas, Mexico (Fig. 1). It lies within a Pacific coastal region of Mesoamerica that is defined for its high level of rainfall and known for important Mesoamerican products, such as cotton, rubber, bird feathers, and cacao (Gasco and Voorhies, 1989). Cacao was a particularly important export for this region and is represented in art of the Late Formative period (Guernsey et al., 2018).

Early excavations at Izapa focused on culture historical questions, including documentation of the famous “Izapan” style low relief monuments (Drucker, 1948; Guernsey, 2006; Norman, 1976; Parsons, 1986; Smith, 1984) and developing a chronology for the site (Drucker, 1948; Lowe et al., 1982). The largest-scale excavations to date were undertaken by the New World Archaeological Foundation in the 1960s (Lowe et al., 1982). Subsequent excavations in the Formative period core have been directed by Hernando Gómez Rueda (1995) and Robert Rosenswig (Rosenswig et al., 2018). Rosenswig’s regional settlement survey and recent LiDAR (light detection and ranging) mapping of the site have helped to put events at Izapa in broader spatial and temporal context (Rosenswig and Mendelsohn, 2016; Rosenswig et al., 2013).

Following their 1960s excavations, Lowe et al. (1982) developed the first preliminary culture-historical view of Izapa. Construction of the city’s primary ceremonial center began with the creation of the principal mound (Mound 30a) in the Duende phase, between 850 and 750 BCE. Growth at Izapa continued throughout the Formative period, with the greatest era of monumental construction and stone sculpture erection proposed for the Guillen phase (300–100 BCE) of the Late Formative period (Lowe et al., 1982: 23, 133).

With the onset of the Terminal Formative period, radical changes occurred at Izapa. During the Hato phase (100 BCE–100 CE), reports suggest the cessation of large-scale construction activities and stone monument production, the introduction of new burial practices, and the initiation of a second ceremonial center to the north (Lieske, 2013; Lowe, 1993; Lowe et al., 1982: 194, 315). This era of apparent disruption was followed by an age of stability (Lowe et al., 1982: 141). Construction activities resumed at the site during the Istapa phase (100–250 CE), and, while the city did not maintain its former grandeur in scale and monument carving, Izapa would continue to be occupied for another 1000 years (Lowe et al., 1982; Rosenswig and Mendelsohn, 2016).

Lowe used ceramic styles to document shifts in Izapeños’ trade and foreign relationships over the history of the city. Results suggest that from 750 to 500 BCE, during the latter part of the Middle Formative period, Izapan potters participated in the widespread “Modified Olmec” horizon, where “splotchy” orange ceramics were encountered from central Mexico to El Salvador (Clark and Cheetham, 2005; Lowe, 1977). By the Late Formative period, he observed a regionalization in ceramic styles. Ties between Izapa and the Gulf Coast region diminished (Pool et al., 2018), though the presence of a continuous orange-slipped ceramic tradition along the Pacific coast suggests strong social ties were sustained within this zone (Mendelsohn, 2018a). The onset of the Terminal Formative period marked an era of re-integration. The introduction of modal changes on Hato phase (100 BCE–100 CE) ceramics, such as Usulutan-style resist decoration and the introduction of tripod nubbin supports (Clark and Cheetham, 2005), suggests a close relationship with peoples of the Miraflores ceramic sphere in highland Guatemala and El Salvador (Demarest and Sharer, 1986; Lowe et al., 1982: 139).

But by the onset of the Early Classic period, links to sites associated with the Miraflores sphere to the southeast were virtually nonexistent. In fact, limited Jaritas phase (250–400 CE) ceramic ties are observed with any neighboring area, indicating a period of relative regionalization (Lowe et al., 1982: 145). Similarities in ceramic styles that do exist appear to be restricted to the western Soconusco, suggesting a westward shift in social relationships (Mendelsohn, 2017: 264–268; Pfeiffer, 1983: Vol. II, 224–246). This shift was likely associated with “collapse” or disruption at early capitals in the Miraflores zone and elsewhere in the Maya lowlands. While these data are a useful baseline for interpreting foreign relationships, using ceramic styles to predict economic relationships can be misleading, as style is influenced by a complex set of factors, including ethnicity, religious affiliation, political alliances, and economic connections (Bowser, 2000; David et al., 1988; Hegmon and Kulow, 2005; Plog, 1983).

3. Obsidian and the Soconusco economy

Obsidian is a volcanic glass that was commonly used as a cutting material in Mesoamerica. Because it is only available in select volcanic deposits, obsidian was not locally available in most regions of Mesoamerica and had to be imported through long-distance exchange. As a result, obsidian is often considered a good indicator of economic activity (Aoyama, 1996; Braswell, 2003b; Stark et al., 2016). Obsidian provenance studies indicating the volcano from which an individual piece was obtained are helpful for determining distribution networks of this important material (e.g. Asaro, 1978; Cobean et al., 1971; Sidrys et al., 1976).

Early obsidian studies in Mesoamerica emphasized the political and religious aspects of trade in this resource (Clark, 1987; Sidrys, 1976). Clark (1987), for example, saw early blade-making (that is, trade in blade cores accompanied by the local production of prismatic blades) as a political rather than economic act. The adoption of blade technology in the Early Formative period, he argues, was used by “paramount chiefs” to strengthen their political position; obsidian blades were used as political currency (Clark, 1987: 278). Sidrys (1976) also conceptualized obsidian as a status good for the Late Formative and Early Classic periods, suggesting it reflected political and religious ties. During the subsequent Classic period, however, obsidian blades became more widely available and more began to serve as utilitarian goods (Sidrys, 1976).

The recent increase in obsidian studies from non-elite domestic contexts (e.g. DeLeón et al., 2009; Hirth, 1998; Stark et al., 2016), have allowed archaeologists to evaluate the role of obsidian as an economic resource, rather than as ritual or political currency. In his distributional model, Hirth (1998) outlines how the composition of household assemblages will differ depending on whether obsidian is being distributed by elites or is obtained through marketplace exchange. Data from DeLeón et al. (2009) challenge the established model that obsidian industries evolved from trade in finished blades in the Formative period to widespread trade in cores in the Classic period. Identifying correlates for whole-blade trade, processed-blade trade, and local-blade production, they found that there was considerable regional variability in the manner in which the obsidian blade trade evolved from the Middle to Late Formative periods (400 BCE–100 CE). Stark et al. (2016) observe that, in the coastal lowlands zone, additional cutting materials such as chert are not available. Obsidian flakes and blades in this region, they argue, would have been utilitarian, rather than luxury goods.

Here, obsidian results are compared with the social and political data inferred from ceramic styles and elite burial goods to determine whether different datasets illustrate the same shifts in Izapeños’ inter-regional relationships over the Formative to Classic period transition. Investigation into obsidian consumption at Izapa, a center that survived the Terminal Formative collapse, allows us to determine how trade networks may have been impacted by the decline of important southern Mesoamerican cities between 100–250 CE.
The obsidian sources closest to Izapa are located in Guatemala (Fig. 1). The nearest source, Tajumulco, is located just across the modern-day border to Guatemala and represents a prominent point on the horizon at the site. Despite being the closest source to Izapa, Tajumulco obsidian (technically, ignimbrite) has a more granular texture and coarse matrix and is generally considered unsuitable for the production of pressure blades (Clark et al., 1989). The closest obsidian sources to Izapa with material of sufficient quality for blade-making come from other Guatemalan volcanoes, including San Martin Jilotepeque, El Chayal, and Ixtepeque. Additional sources of Mesoamerican obsidian have been identified in central Mexico, including the Sierra de Pachuca source, famous for its distinctive green color and its association with the central Mexican city of Teotihuacan (Spence, 1996).

Because obsidian is not found locally at Izapa, changes in consumption patterns of this material can track shifting economic interactions through time. Temporal trends of obsidian consumption patterns of the Soconusco region were previously compiled by Clark et al. (1989) using visual sourcing. Pooling materials from several sites in the region, including Izapa (Table 1), they suggest temporal trends in obsidian exchange for the full range of occupation in the area, for the Archaic to Colonial periods (Clark et al., 1989).

Golitko and Feinman (2015) have since investigated dynamic changes in obsidian consumption patterns at a pan-regional scale. Previous results from Izapa, derived from the Clark et al. (1989) study, are placed into a broader regional context using Social Network Analysis. Golitko and Feinman compare networks for eight distinct time periods. They find that, during the Late and Terminal Formative periods (250 BCE–250 CE), sites in the Soconusco region “are relatively peripheral to the overall network structure,” primarily linking sites in the Guatemalan highlands with the Maya lowlands (Golitko and Feinman, 2015: 221). However, they observe that Late and Terminal Formative cities in the Soconusco region play an important role in bridging eastern and western spheres of obsidian procurement, overtaking a role previously served by centers in the Gulf Coast. The bridging role of Soconusco centers in Golitko and Feinman’s network models is maintained during the Early and Middle Classic periods (300–600 CE), particularly through the western Soconusco city of Los Horcones (García-Des Lauriers, 2007).

While both studies are helpful as preliminary impressions of obsidian consumption and trade at Izapa, several problems are present with the data that was available for these studies. First, because screening was not undertaken during 1960s New World Archaeological Foundation excavations (Lowe et al., 1982: 84), quantitative results of the Clark et al. (1989) study are not reliable. Without a consistent recovery methodology, equal rates of obsidian collection across archaeological contexts cannot be assumed. Second, samples are from excavations in the two Izapa ceremonial centers. Recovery from such specialized contexts may be more indicative of religious obsidian use or elite consumption patterns, rather than a representation of the domestic obsidian economy at Izapa. Third, small sample sizes were available for the Terminal Formative and Early Classic periods. Results, therefore, may not be an accurate reflection of the Izapa economy for these periods. In the Golitko and Feinman (2015) study, Terminal Formative period results were excluded from the social network analysis precisely for this reason. However, the lack of data from a regional capital such as Izapa for their Terminal Formative period network, may lead to an underrepresentation of the role of Soconusco-region peoples in greater Mesoamerican economies during this time. Indeed, results from a recent compilation of obsidian quantification data by Stark et al. (2016), suggest that, because of their position at a regional capital, Izapeños may have had preferred access to obsidian, particularly during the Early Classic period.

4. The Izapa Household Archaeology Project (IHAP)

The obsidian data presented here from the Izapa Household Archaeology Project (IHAP) expand on previous results from the Izapa ceremonial core with data recovered from the southern periphery of the site. The IHAP results represent the first systematically collected obsidian data from Izapa, recovered through screened excavations in domestic contexts. Increased sample sizes resulting from the excavation of new Terminal Formative and initial Early Classic contexts at this capital city are valuable as a reference point for understanding how the Terminal Formative collapse affected Mesoamerican exchange spheres.

The IHAP sought to document domestic activity at Izapa. The project consisted of 25 excavation units at seven mounds in the southern periphery of the site (Fig. 2). Significant contexts included Terminal Formative construction and occupation at Mound 255 and Early Classic domestic debris at Mound 260 (Mendelsohn, 2017: 117–164). Together, these contexts represent a combination of construction fill, primary occupation, and midden deposits associated with the Hato (100 BCE–100 CE), Ixtapa (100–250 CE), and Jaritas (250–400 CE) phases, which span the Formative period to Classic period transition at the site. Obsidian recovered from the IHAP was collected through consistent screening. Fill from all excavated lots was dry-screened for artifact recovery using ¼ inch mesh screens. The volume of the soil removed from each lot was also recorded, so that artifact densities could be calculated in proportion to the volume of material excavated.

Subsequent provenance analyses of the obsidian were undertaken to investigate several questions. From which sources did Izapeños obtain their obsidian? How do the results from southern Izapa compare to previous results from the ceremonial centers? Do patterns of obsidian procurement shift over the Terminal Formative to Early Classic period transition, in association with the 100–250 CE collapse? Are patterns of obsidian importation correlated with ceramic ties? Sourcing using XRF was employed to address these questions.

Hypotheses were derived from previous interpretations of ceramic ties. If economic relationships were to correspond with social and political ties, as determined by ceramic data and art styles, then the following patterns might be expected. For the Terminal Formative period (100 BCE–250 CE), when ceramic styles at Izapa share close ties with sites in the Miraflores sphere of highland Guatemala and western El Salvador (Demarest and Sharer, 1986; Lowe et al., 1982: 139), increased rates of El Chayal and Ixtepeque obsidian are projected. Higher rates of El Chayal obsidian would indicate an increased relationship with the Guatemalan highland capital of Kaminaljuyú, where blade production workshops of this material have been identified and, some have even argued, maintained control of this source (Hay, 1978; Kaplan, 2002, 2011; Love, 2007: 297–298). Importation of obsidian from the Ixtepeque source would indicate strengthening ties with El Salvador, as this was the predominant source of obsidian for settlements in that region (Braswell et al., 1994; Neivens and Demarest, 2002).
Patterns of obsidian procurement were expected to shift with the onset of the Early Classic period (250–400 CE), as trade networks would be affected by the collapse of prominent cities between 100–250 CE. Based on the break in ceramic ties between Izapa and the Miraflores region (Lowe et al., 1982: 145), and subsequent increase in stylistic similarities with the western Soconusco (Mendelsohn, 2018a; 1983: Vol. II, 224–246), a decline in obsidian from Guatemalan sources and an increase in the appearance of sources from Mexico was projected.

The archaeological contexts selected to address these questions consisted of obsidian recovered from two mounds at the southern periphery of the site, Mounds 255 and 260 (Fig. 2). Results from Mound 255 and its associated off-mound excavation unit represent the Terminal Formative period (100 BCE–250 CE), while obsidian from Mound 260 represent the onset of the Early Classic period Jaritas phase (250–400 CE).

Results from Mound 255 included obsidian recovered from three 1x3m vertical excavation units, Suboperations 104a, 104b, and 104d, as well as Suboperation 104c, the shallow 2x3m horizontal extension west of Suboperation 104a. Mound 255 was constructed during the Hato phase (100 BCE–100 CE) of the Terminal Formative period, with both carbon and offerings dating to this era (Mendelsohn, 2017: 118–135, Mendelsohn, 2018b). Materials from as early as the Cuadros phase (1350–1200 BCE) of the Early Formative period, however, were also recovered in construction fill. Known technological changes and the metric measurements of blades from Mound 255 help to narrow
down the temporal range of some of this material to the Terminal Formative period (see below). Nevertheless, results from Mound 255 are the most tentative presented and should be re-evaluated as additional Terminal Formative data become available from Izapa.

The second context where Terminal Formative materials were recovered was Suboperation 104e, a 1 × 2 m vertical off-mound excavation unit immediately south of Mound 255 (Fig. 3). This unit revealed signs of construction activity as well as a layer of domestic debris. Suboperation 104e contained Terminal Formative ceramics associated with the Hato and Itstapa phases, with a layer (Levels 8–10) of Itstapa phase (ca. 100–250 CE) occupation discovered atop a possible floor (Mendelsohn, 2017: 139–145; Mendelsohn, 2018b). Because the occupation at Suboperation 104e is believed to be slightly later and is more securely associated with the Terminal Formative period, it was considered separately.

Mound 260 (Fig. 4) was a small, one-meter-high structure occupied exclusively during the Jaritas phase (250–400 CE). Excavated deposits were domestic in nature, including a trash pit and fired clay feature (Mendelsohn, 2017: 147–164; Mendelsohn, 2018b). Obsidian from Mound 260 was recovered from the three vertical excavations units atop this mound: Suboperation 105a (1 × 3 m), 105b (1 × 3 m), and 105d (1 × 2 m). Obsidian was also recovered from Suboperation 105c, a small extension (40 × 65 cm) excavated to recover material from the trash deposit discovered at the corner of Suboperation 105a. Because Jaritas phase results derive from this one mound, it is possible that they are not representative of all Jaritas phase obsidian consumption at the site. As with the Terminal Formative period contexts, results should be updated as additional data becomes available. Nevertheless, with their systematic collection and increased sample sizes, the results from Mound 260 currently represent the best Early Classic economic data available at Izapa. Because Mound 260 obsidian derives from a non-elite domestic trash pit, it is assumed that materials from Mound 260 represent functional utilitarian goods rather than ritual activity.

5. XRF analysis

While visual sourcing is often reliable for this region for those with a trained eye (such as John Clark, who conducted the prior visual analyses of the Izapa obsidian), previous studies of the efficacy of visual sourcing have revealed that Iztepeque and “black” obsidians derived from central Mexican sources may be under-identified through visual sourcing alone (Braswell et al., 2000). Because the identification of
obsidian from Ixtepeque and Mexican sources was an important objective for answering the research questions, I elected to conduct XRF analysis of the IHAP obsidian. To test the above hypotheses, all obsidian blades from Terminal Formative and Early Classic contexts (n = 121) and select deposits of non-blade obsidian dating to these periods (n = 442) underwent compositional analysis (Supplemental Tables 1 and 2).

Provenance data for blades were obtained through XRF analysis at the New York State Museum, where a Bruker Tracer III-V model was used. The machine was set to heavy metals mode, using a filter containing 6 μm of Copper, 1 μm of Titanium, and 12 μm of Aluminum. Samples were run using the S1PXRF program at 40 kV and 22 microamps, matching the settings used for the obsidian calibration previously analyzed on the instrument. Following the methodology developed by Moholy-Nagy et al. (2013), samples were run for 90 s each and control samples were run at the beginning and end of each day, so that any changes in the readout of the machine could be observed (see Mendelsohn, 2017: 292–295 for additional methodological details). Each blade was visually sourced prior to XRF analysis to test the rate of efficacy for my visual identifications.

Parts per million (ppm) concentrations were generated for Mn, Fe, Zn, Ga, Th, Rb, Sr, Y, Zr, and Nb (Supplemental Table 1) using the obsidian calibration provided for the machine (GL1.cfz). These values were then run through a hierarchical cluster analysis. Control samples from each day of analysis were included to assure accurate clustering and aid in the identification of the source materials for the statistical groups. Multiple iterations of the hierarchical cluster analysis were completed using different subsets of elements. The test which best separated the control samples into the correct groupings included four elements: Rubidium (Rb), Strontium (Sr), Yttrium (Y), and Zirconium (Zr). Group membership probabilities were also calculated using Mahalanobis distance for Rb and Sr to confirm that the group assignments produced by the cluster analysis were accurate. Results were the same for both tests.

The statistical analyses resulted in five main groups (Figs. 5, 6). The chemical composition of Group 1 was the most distinct and denoted the Sierra de Pachuca source of green obsidian in the state of Hidalgo in central Mexico. Group 2 consisted solely of control samples of the Ixtepeque source. Obsidian in Group 3 came from the nearby Tajumulco source. Group 4 represented obsidian from El Chayal. Group 5 included obsidian from the San Martin Jilotepeque source.

To make the data more comparable with previous Izapa sourcing...
results, sourcing of a sub-sample of the non-blade obsidian recovered from the IHAP excavations was also undertaken (Supplemental Table 2). Because of the limited time available with the machine, contexts that were of the greatest temporal security for the Terminal Formative and Early Classic periods were targeted for analysis. For the Terminal Formative period, this included obsidian from Suboperation 104e, the off-Mound unit south of Mound 255, with Terminal Formative ceramics and a layer of Itstapa phase occupation. For the Early Classic period contexts, obsidian from Suboperation 105a and the associated Suboperation 105c extension, which contained the best domestic deposits recovered during the project, were targeted for analysis.

The sourcing methodology for the non-blade obsidian sourcing was different than that of the blades. Because visual sourcing for the blades had produced a 90.4% success rate (Mendelsohn, 2017: 301), non-blade obsidian pieces were visually sorted into groups by source. These groups were then tested with shorter (30 s.) runs on the XRF. Pieces with the least secure visual identifications were targeted for testing. Correct or incorrect associations were determined by the form of the spectra produced by the machine, rather than by elemental concentrations. Multiple pieces were tested until confidence was reached that all fragments were accurately assigned. Counts and weights of each group were then modified, as needed.

5.1. Terminal Formative period (100 BCE–250 CE) results

Results for the Terminal Formative period (Table 2) were derived from the excavations at Mound 255 and the associated off-mound unit Suboperation 104e (Fig. 3). Blades recovered from on-mound excavations (Suboperations 104a, 104b, 104c, 104d) derived from Hato phase (100 BCE–100 CE), or early Terminal Formative period, construction fill. The non-blade obsidian at Mound 255 could date to any period between 1350 BCE and 100 CE and was, therefore, not targeted for analysis. Prismatic blade technology, however, is not present in the Soconusco region until after 900 BCE (Clark, 1987; Jackson and Love, 1991), so it can be safely assumed that the 74 blades recovered from Mound 255 represent obsidian from the Middle Formative period through the Terminal Formative Hato phase, or 900 BCE–100 CE. Results for the blades from Mound 255 indicate that 45 (60.8%) came from the San Martin Jilotepeque source, 25 (33.8%) came from El Chayal, and 4 more (5.4%) were associated with Tajumulco. No blades of Ixtepeque or Pachuca obsidian were recovered from Mound 255.

While the blades from construction fill on Mound 255 could represent any period from 900 BCE–100 CE, their width distributions may offer additional insight into the temporal association of these pieces (Fig. 7). The size of the larger blades of El Chayal source obsidian is comparable to Terminal Formative examples found in neighboring regions. Clark and Lee Jr. (2007: 117) suggest that wide (up to 31 mm) Terminal Formative blades of El Chayal obsidian from the inland Chiapas site of El Cerrito date to this period and were likely imported as completed products. Given their comparable widths and evidence that Mound 255 was constructed during the Hato phase, it is likely that the large El Chayal blades recovered from fills in Mound 255 are associated with Hato phase (100 BCE–100 CE) occupation and economic activity in this zone.

Obsidian blades obtained from the Suboperation 104e unit are more securely dated to the Terminal Formative period. Of the eight blades recovered from Suboperation 104e (Table 2), four of them were from the El Chayal source (50%), three came from San Martin Jilotepeque (37.5%), and one derived from Tajumulco (12.5%). The two blades recovered from the Itstapa phase occupation layer in Levels 8–10 were both from the El Chayal source. As with the Mound 255 results, no Ixtepeque or Pachuca blades were recovered from Suboperation 104e. The absence of Ixtepeque obsidian in Terminal Formative contexts came as a surprise, given the heightened connections between Izapa and El Salvador observed through ceramic burial goods dating to the Terminal Formative period (Love, 1993).

For the non-blade results from Suboperation 104e, Tajumulco obsidian chunks dominated the assemblage, at 81.0%. San Martin Jilotepeque (7.6%) and El Chayal (10.5%) obsidian was present in roughly equal proportions. One piece (1.0%) could not be assigned with confidence. For the Itstapa phase debris in Levels 8–10, however, only two non-blade pieces of San Martin Jilotepeque obsidian was recorded from the total of 34 non-blade pieces and three blades recovered. Instead, El Chayal blades and Tajumulco chunks were most prevalent in 1 The appearance of Tajumulco blades was surprising given previous reports that this material could not be used for blade production (Clark et al., 1989). Upon renewed inspection, it became clear that I had been more liberal in the pieces I assigned as blades at the beginning of the analysis (i.e. for the Suboperations at Mound 255 and Mound 260) than I was as the analysis progressed. The pieces assigned as Tajumulco blades all had triangular or trapezoidal cross sections and parallel sides but were not third series pressure blades (Clark and Bryant, 1997). This identification contributed to the appearance of Tajumulco "blades" in the Terminal Formative and Early Classic assemblages.
Levels 8–10.

The Mound 255 and Suboperation 104e results suggest that a small spike in El Chayal obsidian may have occurred with the onset of the Terminal Formative period at Izapa. Of the blades recovered from Mound 255, 33.8% of them were sourced to El Chayal. This rate is significantly higher than previous results reported for both the Middle to Late Formative periods (1.7%) or the Terminal Formative period (4%) at Izapa (Clark and Lee Jr., 2013: 10; Clark et al., 1989).

For IHAP contexts associated with both the Terminal Formative and initial Early Classic periods, El Chayal obsidian was recovered almost exclusively as wide blade fragments. For the non-blade obsidian analyzed, only 11 pieces (10.6%) of El Chayal obsidian were recovered exclusively as wide blade fragments. For the non-blade obsidian from Early Classic contexts, I elected to analyze the Suboperation 105a unit, which contained the best single-piece, San Martin Jilotepeque, is assumed to be the correct designation. Likewise, the Terminal Formative evidence from Izapa, with the presence of wide blade fragments of El Chayal obsidian and overall lack of production debris from the same source, suggests that completed El Chayal blades were being imported by Izapa residents during the Terminal Formative period.

5.2. Initial Early Classic period (250–400 CE) results

Obsidian recovered from domestic occupation at Mound 260 represented the beginning of the Early Classic period. This was the era immediately following the decline of many southern Mesoamerican capitals, when a regionalization of ceramic styles is documented. The Jaritas phase (250–400 CE) obsidian from Mound 260 included 39 blades (Table 2). Of these, 20 (51.3%) were derived from the San Martin Jilotepeque source, seven (17.9%) came from the El Chayal source, five (12.8%) were obtained from the Pachuca source in central Mexico, and six (15.4%) came from the Tajumulco source. One final blade (X12) was unassigned due to an erroneous result associated with the intense curvature of the piece. The visual source assigned to this piece, San Martin Jilotepeque, is assumed to be the correct designation.

For the non-blade obsidian from Early Classic contexts, I elected to analyze the Suboperation 105a unit, which contained the best single-occupation domestic deposits recovered during the project. Obsidian from the Suboperation 105c extension, excavated to recover vessels associated with the Jaritas phase trash pit found in the southeastern...
corner of Suboperation 105a, was also analyzed. The results of non-blade obsidian from Early Classic contexts in Suboperations 105a and 105c (Table 2) demonstrated a different profile than the Terminal Formative results. Rates of Tajumulco obsidian also dominated the assemblage, though at slightly lower rates than Terminal Formative contexts, with 67.1% percent in Suboperation 105a and 42.9% in the Suboperation 105c extension. The proportion of El Chayal obsidian, however, dropped significantly in Jaritas phase contexts. El Chayal obsidian represented only 1.9% of the non-blade material in Suboperation 105a (n = 338), down from 10.6% in Suboperation 104e (n = 104). The proportion of San Martin Jilotepeque obsidian increased substantially from 7.7% in the Terminal Formative period to 31% in the Suboperation 105a context. San Martin Jilotepeque obsidian also accounted for over half (57.1%) of the obsidian recovered from the Suboperation 105c trash pit.

These findings suggest that Izapeños in this section of the site either had reduced access to El Chayal obsidian by the Jaritas phase, or that their preferences for obsidian procurement had changed. The high percentage of San Martin Jilotepeque obsidian associated with the Jaritas phase trash pit, and the large flakes of this material, including some with traces of cortex, (Mendelsohn, 2017: Fig. 7.3), suggest that San Martin Jilotepeque obsidian was being imported to Izapa as cores and that the flaking of this material by Jaritas phase residents took place at Mound 260. The five blades of Pachuca obsidian recovered from Mound 260 currently represent the earliest known appearance of this central Mexican source at Izapa. Izapeños may have supplemented a decline in the availability of completed El Chayal blades with finished blades from this newly available source.

Yet, despite its reduced rates, the continued appearance of El Chayal obsidian at Mound 260 is significant. Seven blades (17.9%) and six pieces (1.8%) of non-blade obsidian from this source were recovered from Jaritas phase contexts. While these rates of El Chayal obsidian are lower than in the Terminal Formative contexts, their presence at Mound 260 suggests that distribution networks of El Chayal obsidian did not completely collapse with the 100–250 CE decline. This is a departure from the ceramic data, which suggest regionalization during the Jaritas phase and a notable decline in stylistic ties with peoples of the Miraflores ceramic sphere. The implications of this discrepancy are discussed further below.

6. Discussion

Though preliminary, the Terminal Formative and Early Classic period obsidian provenance data from the IHAP offer important clues about trade at Izapa before and after the widespread decline of southern Mesoamerican cities between 100 and 250 CE. Changing proportions of El Chayal obsidian are observed over the Formative to Classic period transition, mirroring the increase and subsequent decrease in ceramic ties between Izapa and the Miraflores ceramic sphere of highland Guatemala and western El Salvador. By the Jaritas phase (250–400 CE), San Martin Jilotepeque becomes the predominant source of Guatemalan obsidian used in southern Izapa. Completed blades of Sierra de Pachuca obsidian are also introduced to the assemblage. Despite these changes, the continued availability of El Chayal obsidian at Izapa during the Jaritas phase suggests that obsidian distribution networks may have operated independently of political ties, at least after the decline of prominent Terminal Formative kingdoms.

The IHAP results suggest that the availability of El Chayal blades to consumers at Izapa increased during the Terminal Formative period. Three different possibilities, or a combination thereof, might reasonably explain this result. First, residents of Izapa may have shifted their reliance from a highland trade network to a coastal trade network. Second, changes in the obsidian industry at the San Martin Jilotepeque source may have meant that Izapeños' preferred (or at least, traditional) obsidian source became more difficult to obtain. Finally, the increasing importation of ready-made blades from the El Chayal source may have been associated with a burgeoning export industry of El Chayal blades at Kaminaljuyú.

The first possibility is a shift in the reliance of different distribution networks from highland to coastal during the Terminal Formative period. Clark proposes different highland and coastal procurement networks for San Martin Jilotepeque and El Chayal obsidian, respectively, dating to the Early Formative period (Clark and Lee Jr., 2007; Clark and Salcedo Romero, 1989). By the Late Formative period, Love (2011) posits three exchange spheres, highland distribution of San Martin Jilotepeque, coastal circulation of El Chayal, and an eastern dispersal of Ixtepeque obsidian.

In this scenario, the Terminal Formative increase in the importation of El Chayal obsidian at Izapa would indicate increasing use of the coastal trade network during that period, while the Early Classic use of San Martin Jilotepeque obsidian could indicate a return to obsidian procurement through highland networks. While it is possible that Izapeños shifted their reliance to a coastal network for obsidian procurement during the Terminal Formative period, it seems unlikely that Izapeños suddenly gave up their established system for procuring San Martin Jilotepeque obsidian from highland networks unless other political and economic factors were at play.

One such factor may have been the decreasing availability of obsidian from the San Martin Jilotepeque source. Braswell (2002) has suggested, based on his survey results in the San Martin Jilotepeque zone, that the region surrounding this source was largely abandoned during the Late and Terminal Formative periods, from 300 BCE to 250 CE. The area was later heavily reoccupied during the Early Classic period, from 250–600 CE (Braswell, 2002).

The settlement patterns of San Martin Jilotepeque presented by Braswell correspond remarkably well to the obsidian data from Izapa. During the Middle to Late Formative (Clark et al., 1989) and Early Classic periods, obsidian from the San Martin Jilotepeque source at Izapa appears to be at its highest levels. Clark and colleagues suggest that macro-cores of San Martin Jilotepeque obsidian were distributed to regional capitals such as Izapa at this time (Clark and Lee Jr., 2007; Clark et al., 1989). During the Terminal Formative period, the rate of San Martin Jilotepeque obsidian dropped and the importation of El Chayal blades increased. At Izapa, as elsewhere in Mesoamerica, the decline in San Martin Jilotepeque obsidian during the Terminal Formative period may have been associated with a depopulation of the area surrounding this source.

The final possibility is that an incentive arose to import El Chayal obsidian. The availability of ready-made blades for export entering the market may have provided one such motivation. Increasing specialization in blade production, where specialists at Kaminaljuyú were producing blades for export, is recorded beginning in the Late Formative period (500–200 BCE), with output greatly increasing by the Early Classic period (200–400 CE) (Hay, 1978). While comparable data is not available for the Terminal Formative period (200 BCE–200 CE) in between, Hay estimates that during the intervening period, “production for export was differentiated from the remainder of Kaminaljuyú’s economy, and became centralized and more highly specialized” (Hay, 1978: 142). Clark and Lee Jr. (2007) have suggested that the wide Terminal Formative blade segments imported into inland Chiapas, recovered at sites such as El Cerrito, were likely imported from specialized workshops at Kaminaljuyú. Another possibility is importation from nearby coastal centers, such as El Ujuxte, where prismatic blade cores of El Chayal obsidian have been recovered (Michael Love, personal communication 2018), though evidence of sufficient production to support an export industry has not yet been documented for that site.

Given that the El Chayal blades recovered from IHAP contexts appear to have been imported as final products, and that the production of El Chayal blades for export has been documented at Kaminaljuyú (Hay, 1978), the Terminal Formative obsidian data at Izapa appear to support increased trade between consumers at Izapa and blade makers from Kaminaljuyú. An increased economic relationship between residents of
These results indicate that, even while social relationships with cities in Izapa and Kaminaljuyú during the Hato phase would support the ceramic and burial data at Izapa, which suggest an increase in ties between Izapeños and residents of the Miraflores ceramic sphere, including peoples of Kaminaljuyú, at this time (Lowe, 1993; Lowe et al., 1982: 139). Though the dating of Izapan style monuments is less certain, this art style could also have been introduced to Kaminaljuyú during the Terminal Formative period.

Given these close ceramic ties to the Miraflores sphere, the lack of Ixtepeque obsidian in Terminal Formative contexts was surprising. No Ixtepeque obsidian was recovered from Mound 255 or the adjacent off-mound unit, Suboperation 104E. At present, the only documented contexts of Ixtepeque obsidian at Izapa are from Terminal Classic (or “Early Postclassic”) deposits (Clark et al., 1989). This suggests that, while Hato phase ceramics from Izapa indicate participation in a horizon style reaching at least as far as Chalchuapa, and pots from El Salvador were recovered from offerings at Izapa, the obsidian source characteristic of western Salvadoran sites is not found in domestic contexts at Izapa during the Terminal Formative period. The presence of pots imported from El Salvador in elite burials at Izapa, but lack of Ixtepeque obsidian during this period, suggest that Izapeños’ relationships with the peoples of El Salvador was social and/or political, but not economic during the Terminal Formative period.

The Jaritas phase pattern of higher rates of obsidian from the San Martin Jilotepeque source more closely approximate the Middle to Late Formative results for Izapa observed by Clark et al. (1989). This pattern suggests one of three things about the Jaritas phase economy at Izapa. The first possibility is that, after a fleeting period during the Terminal Formative period when El Chayal obsidian was popular at Izapa, Izapeños returned to their previous procurement system of San Martin Jilotepeque obsidian, perhaps in association with a repopulation in the source zone (Braswell, 2002). The second possibility is that El Chayal blades were no longer available to the residents at Izapa or were accessible in diminishing quantities due to sociopolitical turmoil at the highland capital of Kaminaljuyú. The final possibility is that El Chayal obsidian was still popular at Izapa but may have become more restricted to the elite at the site, and, therefore, did not trickle down to commoners in peripheral zones, such as the residents of Mound 260.

Of these possibilities, the decline in the availability of ready-made El Chayal blades due to a break in political ties between Izapa and Kaminaljuyú, currently seems the most likely. Ceramic and burial data suggest a sharp break in political and social ties between Izapa and sites associated with the Miraflores ceramic sphere after the Terminal Formative period (Lowe et al., 1982: 145; Mendelsohn, 2018a). This may have been associated with turmoil at the highland Guatemalan capital of Kaminaljuyú, where evidence for desiccation of the Laguna Miraflores, monument destruction, ritual termination events, and even a possible population displacement have been presented for the period beginning around 150 CE (Arroyo, 2015; Popenoe De Hatch, 1998; Popenoe de Hatch et al., 2002). While specialized production of El Chayal blades at Kaminaljuyú appears to have increased during the Early Classic period (Hay, 1978), sociopolitical disruption documented at the Guatemalan highland capital may have impacted the distribution of these blades to the Pacific coast.

The presence of obsidian from both San Martin Jilotepeque and El Chayal at Mound 260, however, suggests that Jaritas-phase Izapeños were still obtaining obsidian from Guatemala through trade networks. While this statement may seem self-evident given the proximity of the obsidian sources in Guatemala, it is at odds with the ceramic data, which suggest a marked break in imported ceramics and shared ceramic styles with highland Guatemala by the onset of the Early Classic period. These results indicate that, even while social relationships with cities in the Miraflores ceramic sphere dissolved by this time and potters developed increasing regionalization in ceramic styles, mechanisms for the distribution of Guatemalan obsidian were still in operation. The Jaritas phase results from the IHAP suggest that the obsidian economy during the initial Early Classic period may have been conducted independently of social and political ties.

Another new finding from the IHAP obsidian analyses is that green obsidian from the Sierra de Pachua source in Hidalgo, Mexico, was reaching Izapa by the first half of the Early Classic period. The discovery of the green obsidian from a Jaritas phase (250–400 CE) domestic context currently represents the earliest recorded use of Pachua obsidian at the site. Initial results did not record Pachua obsidian until the Late Classic period (Clark et al., 1989), though findings of this green obsidian at Izapa in Loros phase (500–600 CE) contexts have since come to light (Clark and Lee Jr., 2018). Five blades of Pachua obsidian were recovered during the IHAP excavations at Mound 260. Given that Mound 260 was occupied exclusively within the Jaritas phase, all these pieces can be confidently dated to this era. The discovery of Pachua obsidian from a Jaritas phase domestic context at Izapa suggests that some level of exchange was occurring between Izapeños and Teotihuacanos before 400 CE.

The Mound 260 results provide support for Bove and Medrano Bustos’ (2003) proposal that Teotihuacanos contact may have been earlier on the Pacific coast than in the adjacent highlands, and that these early activities did not involve conquest or control by Teotihuacanos. As at the Guatemalan coastal site of Balberta (Bove, 1993), there is nothing in the Jaritas phase ceramic complex or burial data at Izapa to suggest particularly close ties – certainly not conquest – by Teotihuacanos at this time. While economic data from the Jaritas phase are still limited, the discovery of Pachua obsidian in non-elite domestic contexts at Mound 260 would appear to support Bove and Medrano Bustos’ (2003) projection of an initial relationship between Teotihuacanos and residents of the Pacific coast based on mutual exchange.

7. Conclusion

Obsidian provenance data from the IHAP suggest that, whereas many capital cities collapsed at the close of the Formative period (100–250 CE), disrupting trade networks, residents at Izapa responded by importing obsidian from other easily-obtainable sources. The shifting patterns of obsidian consumption over the Formative to Classic period transition suggest that Izapeños capitalized on multiple options for trade, accounting for waning exports of pre-made El Chayal blades to this region by increasing their reliance on other available options. The pattern apparent from the IHAP results is that when important cities and trade networks collapsed, Izapeños imported obsidian from other sources.

This flexibility was likely made possible by the interest of many Mesoamerican cultures, from the Olmec, to the Maya, to the Teotihuacanos, to the Aztecs, in products from the Pacific coast. Despite frequent depiction of this area as peripheral (e.g., Parsons, 1978), due to the Soconusco region’s role as a producer of valuable commodities such as cacao, the Pacific coast was never truly in danger of becoming marginal in the Mesoamerican world system. The very central role of the Pacific coast in Mesoamerican commerce allowed economic flexibility for Izapa residents.

Whereas many centers collapsed with the sociopolitical turmoil at the southern Terminal Formative capitals, Izapa residents appear to have responded by adjusting their trade ties from east to west. The increased presence of Pachua obsidian during the Early Classic Jaritas phase suggests that this transition may have had as much to do with the Izapeños’ desire to capitalize on the expanding economy at Teotihuacan, as it did with declining capitals to the southeast. The ability of Izapa residents to import goods from several distinct networks may have given the population a competitive advantage. In the case of the Formative to Classic period transition, shifts in obsidian importation allowed Izapeños to continue business as usual as they sustained occupation at the site for the next 1000 years.

Yet the continued appearance of Guatemalan obsidian at Izapa after 250 CE, suggests that economic relationships over the Formative to Classic period transition may have been conducted independently from...
social and political ties. The presence of El Chayal obsidian in initial Early Classic contexts, in particular, suggests that Izapa's economic relationships may have continued with peoples of the Miraflores city of Kaminaljuyú despite a decline in ceramic ties and evidence for political turmoil at the distant capital. Obsidian sourcing results from Izapa thus present a cautionary tale against assumptions that economic systems will collapse as sociopolitical systems falter. Archaeologists investigating the collapse and resilience of ancient societies will reveal a more complete picture of important cultural transitions if datasets from different artifact classes are evaluated independently.

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