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XRF OF OBSIDIAN: ANALYSIS OF THE VESTER COLLECTION

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XRF OF OBSIDIAN: ANALYSIS OF THE VESTER COLLECTION

A Thesis

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Applied Archaeology

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by

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ABSTRACT

The main goal of this study is to provide context and provenance to the Vester Collection of Mesoamerican artifacts by sourcing the obsidian objects in the collection through the use of an X-ray fluorescence device. The artifacts were looted by Mr. Gerhard Vester while he was in Mexico from 1946 – 1953 and are reported to be from Teotihuacán and the surrounding area. Despite the decontextualized nature of this collection, it can still provide valuable information. The obsidian artifacts, in particular, can be used to provide more information on the network of trade systems in Classic (300 – 950 CE) and Postclassic (950 – 1521 CE) Mesoamerica and on political relationships in the area. The results of this thesis demonstrate that working with an 'orphaned' collection can still provide both research and meaningful information. I analyzed the artifacts at California State University, San Bernardino using a Thermo Scientific Niton FXL Field X-ray Lab XRF and created a data table with 23 Mesoamerican obsidian sources. Thirteen of the artifacts were sourced to seven Mesoamerican obsidian sources.

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I would like to thank my advisor and Chair, Dr. Guy Hepp. He has been a great mentor, who has been incredibly helpful and patient with me. Even though this research has taken longer than it should, Dr. Hepp has been with me throughout the process.

Also, thank you to Dr. Matthew Des Lauriers. While I have not taken any classes with him, as the chair of the Applied Archaeology Program he has done very much in a short amount of time. He has helped me advance to candidacy and other paperwork at CSUSB.

I would like to thank Dr. Erik Melchiorre who helped me with the sourcing of the Vester obsidian. I used the Niton XRF in his lab and he calibrated and made sure the machine was running well and the results were accurate.

I would also like to thank my family and friends who have supported me throughout my time at CSUSB. My parents have sacrificed a lot to put me, and my brothers, through good schools and this thesis is the result of what they have done. My brothers have always been curious about what I studied and talking to them about my work reaffirmed my love for archaeology. Carly has been an inspiration during the last half of my research. She works incredibly hard and this has made me want to work harder on my thesis and other aspects of my life.

Lastly, I would like to thank punk, ska, reggae, oi, country, Ben Kissel, Marcus Parks, and Henry Zebrowski for help keeping me sane. Hail yourself.

DEDICATION

This thesis is dedicated to my family.

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CHAPTER ONE

INTRODUCTION

Obsidian is a volcanic glass found in many places in the world, primarily in areas that are or were volcanically active. Ancient cultures used obsidian to create a variety of tools and jewelry. In Mesoamerica, obsidian was a highly valued resource. The obsidian sources that were used in Mesoamerican trade systems had a broad reach. These trade networks spanned hundreds of kilometers and spread throughout Mesoamerica into what is now the United States and Guatemala (Hirth et al. 2013; Moholy-Nagy et al. 2013; Ponomarenko 2004).

Obsidian is useful in the study of trade systems and political relations because it can be geologically sourced to its original quarry (Hirth et al. 2013; Joyce et al. 1995; Stross et al. 1983). The reason for this is because each obsidian quarry has its own unique elemental composition. Past research has shown that each obsidian source has unique amounts of certain elements within them (such as rubidium, strontium, and zirconium) (Gordus et al. 1968b; Key 1969; Sheets et al. 1990). Obsidian sourcing has been done using a variety of methods, such as neutron activation analysis (NAA), electron probe analysis, and X-ray fluorescence (XRF) analysis. In this instance, an XRF analysis of the Vester obsidian is preferred because it is inexpensive, very little sample preparation is required, and it is a nondestructive form of sourcing, unlike NAA.

Recently, a portable version of the XRF device (which uses X-rays to excite electrons and measures the fluorescent radiation emitted from the atoms of the sample) has become available. This fluorescent radiation is used to determine the elemental composition of a sample (see discussion below). This method has been used by various archaeologists around the world to source obsidian artifacts and helps determine past trade routes and interaction systems (Forster and Grave 2012; Gay et al. 2017; Milić 2014; Phillips and Speakman 2009; Sheppard et al. 2011). There has been some debate about whether or not a portable XRF device is as accurate as a laboratory XRF (Nazaroff et al. 2010). Recent work has shown that the pXRF devices, when properly calibrated, can produce reliable and accurate results.

With this study, I seek to source the obsidian artifacts in the Vester Collection (see Appendix C for an artifact list) by using a portable XRF device. By sourcing and analyzing these artifacts, I seek to both add context to some of the artifacts in the Vester Collection and to demonstrate that it is possible and in fact necessary to study 'orphaned' collections. I undertook the sourcing of the Vester obsidian at California State University, San Bernardino. The obsidian artifacts were not sent out to be examined by another party. I examined published scholarly articles (Joyce et al. 1995; Lopez-García et al. 2019; Millhauser et al. 2011; Pierce 2015; Smith et al. 2007; Williams 2012) and I compiled a list of 616 obsidian artifacts with their elemental composition data. I used these data and compared them to the elemental data obtained from the Vester obsidian.

Performing this analysis on the Vester Collection poses some problems, as there is no clear provenience or date provided for many of the artifacts in the collection, including those of obsidian.

Despite the numerous challenges inherent in studying this collection, I believe that there is an important reason why it should be examined. This research adds more information and context to an ‘orphaned’ collection, which currently has so little. The context of this collection was destroyed when Gerhard Vester used bribery to excavate the artifacts without recording much information about their location and how they were obtained, leaving behind only a few notes that may have been translated into English (and have since been lost) (Grider 1962:2–3). Working with this collection raises certain ethical issues. These issues will be addressed as best as I possibly can in Chapter Three.

While it has been the tradition in archaeology that ‘orphaned’ collections are often overlooked, I believe that it is not only my responsibility, but it is the responsibility of archaeologists, in general, to bring as much context and information as possible to such collections. This collection deserves to have some dignity to be restored to it, and hopefully this research can be used an example for other ‘orphaned’ collections.

CHAPTER TWO

BACKGROUND INFORMATION

Obsidian Trade Routes and Systems in Mesoamerica

Research on obsidian trade routes and systems in Mesoamerica has spanned from the Formative period (2000 BCE – 250 CE) to the Postclassic (900 – 1521 CE). Early obsidian trade systems were quite complex and extensive. This can be seen in the trade system that was present in the Formative site of San Lorenzo, an early Olmec center. Through both NAA and XRF sourcing, it was found that obsidian from 11 different sources was being used by the people at San Lorenzo (Hirth et al. 2013). The obsidian trade at San Lorenzo appears to have helped the Olmec make the site a center of political power, as it appears to have been a part of at least two different trade networks. In the later phases of San Lorenzo, the site's occupants used obsidian from sources further away (300 – 600 km), which may be a sign that San Lorenzo may have been extending its influence as during the Chicharras Phase (1500 – 1400 BCE) further obsidian sources were used (Hirth et al. 2013:2796-2716).

Other examples of obsidian trade routes and systems during the Formative period are evident in Oaxaca, Central Mexico, the Gulf Coast, the Maya Lowlands, and Guerrero (Blomster and Glascock 2010; Ebert et al. 2015; Golitko and Feinman 2015; Hepp 2019; Joyce et al. 1995). One of these obsidian trade systems was along the Pacific Coast of Mesoamerica and the highland area. Obsidian from various sources was being transported to different sites such as La Zanja and Etlatongo during the Formative Period. These sites were a part of a trade route that connected Central Mexico, coastal Guerrero, the Oaxaca Valley, and the Pacific Coast (Ebert et al. 2015; Hepp 2019).

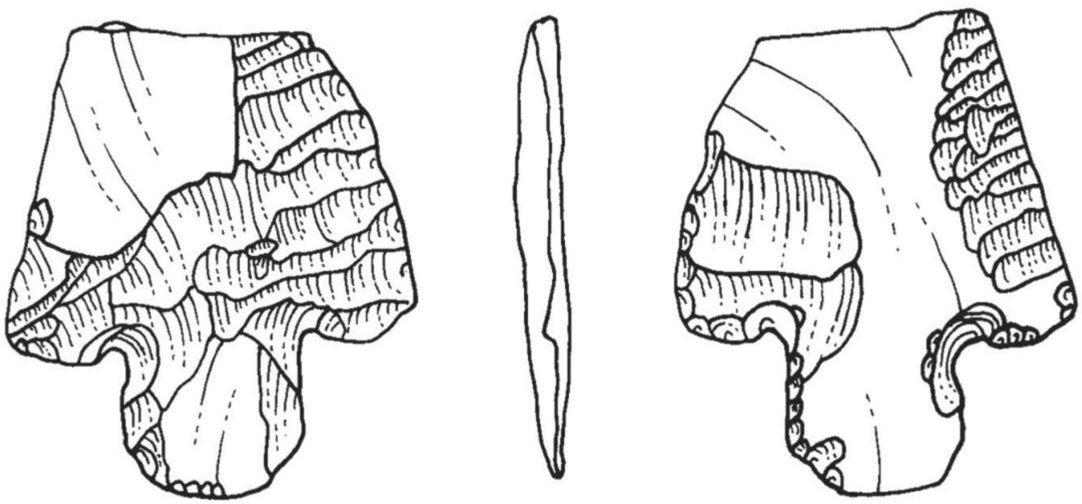


Figure 1. 1 Illustration of a stemmed dart point from Central Mexico. From Carballo et al. 2007:Figure 1. This image provides an example of the types of projectile points that could be found.

The State of Oaxaca and the Oaxaca Valley were involved in several different trade systems, as there are no obsidian sources in the area. For example, consider La Consentida, an Early Formative (2000 – 1000 BCE) village located on the western coast of Oaxaca, in the Lower Rio Verde Valley. Obsidian samples obtained from middens, hearths, burial contexts, and fill were sourced using an XRF device (Joyce et al. 1995, Hepp 2019). A total of 45 obsidian artifacts were sourced to obsidian sources located in Central Mexico and the Gulf

Coast (Guadalupe Victoria, Malpaís, Otumba, Paredón, Pico de Orizaba, Zaragoza) (Hepp 2019). Two of the obsidian artifacts recovered at La Consentida were collected from hearths that were dated, and they provide the earliest dates of obsidian interaction networks in the Lower Rio Verde Valley. The dates provided by the hearths, through AMS radiocarbon dating, are 1904 – 1692 cal BCE (LC09 A-F4) and 1746 – 1530 cal BCE (LC09 B-F15) (Hepp 2019:53). These dates demonstrate that obsidian interaction networks were established in the Early Formative period in Oaxaca.

In the Nochixtlán Valley, obsidian artifacts from three different Formative sites (Etlatongo, Yucuita, and Rancho Dolores Ortíz) were sourced through neutron activation analysis and it was found out that the main obsidian source used changed over time (Blomster and Glascock 2010). In the earlier Cruz A phase (1500 – 1200 BCE) villages, Yucuita and Rancho Dolores Ortíz, obsidian was coming from the Gulf Coast. For Yucuita, about 98% of the obsidian assemblage was sourced to the Guadalupe Victoria and Pico de Orizaba obsidian sources. One obsidian fragment from Yucuita comes from the Paredón source in Central Mexico (Blomster and Glascock 2010). In Rancho Dolores Ortíz, the pattern is very similar. The majority of the obsidian, 95%, was sourced to the Guadalupe Victoria source. The other obsidian fragment from this site was not from Central Mexico, as was the case with Yucuita. The fragment was sourced to the El Chayal source in Guatemala. It is believed that Rancho Dolores Ortíz may have played a significant role in the exchange of obsidian through the

Nochixtlán Valley during the Cruz A phase and this included exchange networks incorporating Guatemalan obsidian (Blomster and Glascock 2010). It is possible though, that this single obsidian artifact from Guatemala may not be evidence of an exchange network that included the El Chayal source. There could be a number of different ways that this artifact ended up in Rancho Dolores Ortíz.

In the later Cruz B phase (1200/1150 – 850 BCE) obsidian recovered from Etlatongo was mainly coming from sources in Central Mexico (Paredón, Otumba, and Tulancingo). Other obsidian sources from the Gulf Coast, Western Mexico, and Guatemala are present at Etlatongo as well, though in smaller numbers (Blomster and Glascock 2010). The change in the main obsidian sources utilized is believed to be evidence of increased interregional interaction in the area and occurred when tool uses were changing, and prismatic blades were introduced (Blomster and Glascock 2010:192). Additional evidence of this changing of obsidian sources from the Gulf Coast to Western Mexico over time is present in La Consentida as well. The primary sources represented in early La Consentida are Guadalupe Victoria and Pico de Orizaba, representing 18% and 58% of sourced samples, respectively (Hepp 2019:69). Paredón on the other hand makes up 3% of the obsidian artifacts (Hepp 2019:69). This follows the same pattern presented by Blomster and Glascock above, where in the earlier sites Gulf Coast obsidian is the primary source of obsidian (2010).

More evidence of changing obsidian sources and trade routes is provided by Joyce and colleagues (1995). These authors sourced four different sites in the valley that were dated to either the Formative or Classic period. The majority of the artifacts came from the Basin of Mexico and Michoacán. Initially, the most utilized source was Paredón, but during the Classic period the Pachuca source became the dominant source of obsidian for these sites (Joyce et al. 1995). In addition to this information, it was discovered through these data that interaction between the western and eastern portions of the Oaxacan coast was not significant. These authors also suggested that obsidian trade at the end of the Formative was disrupted due to conflict in the area (Joyce et al. 1995).

There is also evidence of obsidian trade in the Valley of Oaxaca during the Late Classic period. The obsidian from the sites of Ejutla, El Palmillo, and the Milta Fortress come from 11 different sources from Central Mexico, the surrounding areas, and from Guatemala, with the main source being Zaragoza (Feinman et al. 2013). This shows that during the Late Classic period, obsidian trade in Oaxaca was incorporating trade partners both to the north and to the east. It is interesting to note that each site had differing amounts of obsidian from these sources (Feinman et al. 2013).

In Western Mexico, obsidian sources are plentiful, with at least 26 sources known in the states of Jalisco, Nayarit, and Zacatecas (Glascock et al. 2010). Compared to the rest of Mesoamerica, West Mexico has not been extensively studied (Beekman 2010; Glascock et al. 2010; Pierce 2015). Prehispanic communities in Western Mexico appear primarily to have used obsidian sources based largely on proximity to their residential sites and loci of production. In the

Classic period occupations at the site of Teuchitlán, obsidian from La Mora-Teuchitlán was exploited heavily (Spence et al. 2002). An obsidian workshop (Feature 83) located in the precinct of Guachimonton (within the larger Teuchitlán site) primarily worked with obsidian from La Mora-Teuchitlán, with two artifacts coming from different sources (Spence et al. 2002:67).

During the Postclassic (900 – 1521 CE), the Aztatlán people constructed many regional centers in Western Mexico. These people mainly used the obsidian sources closest to them for most of their tools, while obsidian from further sources appear to have been used by elites as prismatic blades as there is some evidence of differential access to this imported obsidian (Pierce 2015, 2016). The two main sources of obsidian used by the Aztatlán people were the La Joya and the Volcán las Navajas sources. In the four Aztatlán sites examined by Pierce, San Felipe Aztatán, Chacalilla, Coamiles, and Amapa, both the La Joya and Volcán las Navajas sources accounted for 64% to 89% of the sourced obsidian (Pierce 2016:607).

Even on the edge of Mesoamerica obsidian trade was occurring over vast distances. At the Maya site of Tikal, Guatemala, about 2,283 obsidian artifacts and debitage were analyzed by the use of portable XRF and neutron activation analysis (Moholy-Nagy et al. 2013). Here it was found that a total of 11 different obsidian sources were used by the inhabitants of Tikal. Three of the obsidian sources were from Guatemala, which accounted for 98% of the artifacts, while the rest were from Central Mexico (Moholy-Nagy et al. 2013). The distance from

Tikal to Central Mexico is more than 1,000 km, which is much greater than the distance of from San Lorenzo to Central Mexico. This shows how highly valued certain types of obsidian were. Pachuca obsidian has been found as far north as Oklahoma and as far south as Honduras and El Salvador (Ponomarenko 2004). This strongly suggests that certain obsidian carried culturally-derived values beyond its basic physical properties and that various communities throughout Mesoamerica and beyond structured their exchange relations embedded within complex systems of value and meaning.

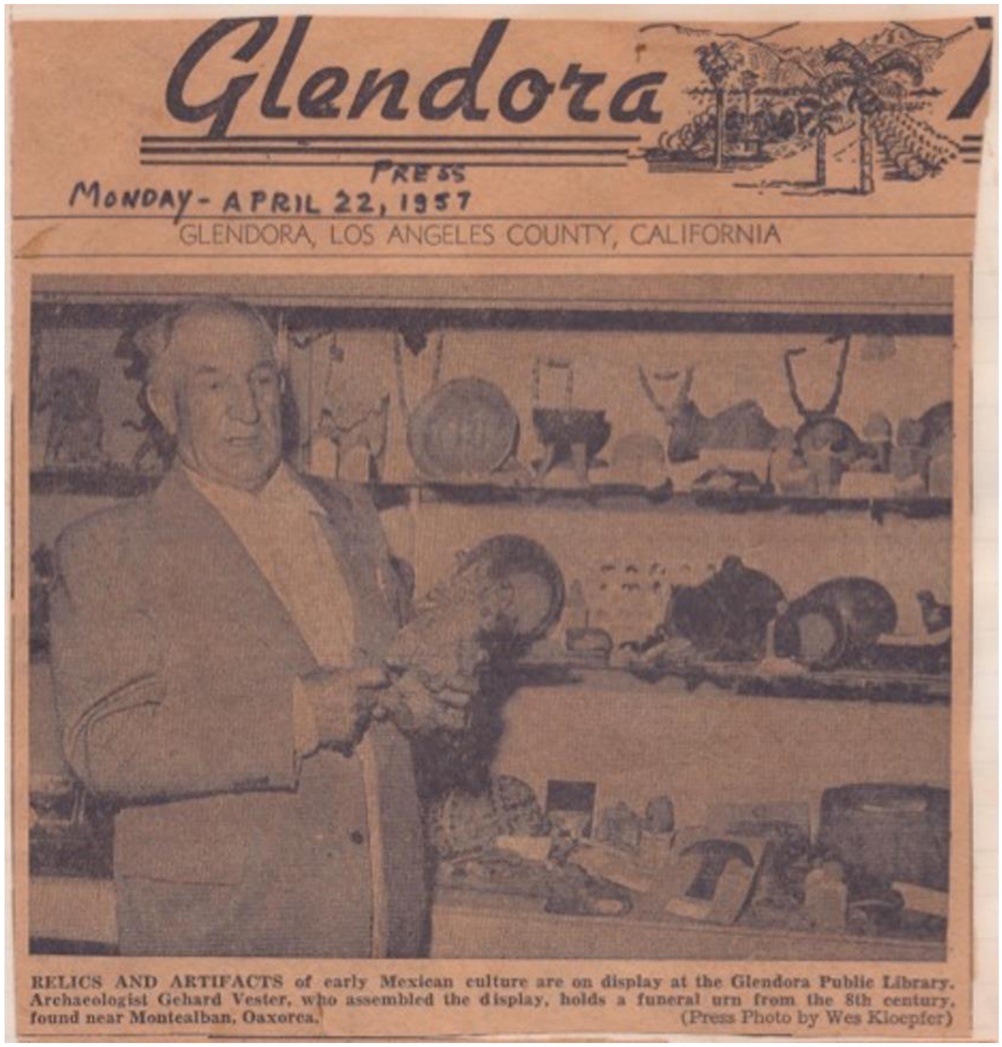
The Vester Collection

The Vester Collection is currently being held by the Anthropology Department at California State University, San Bernardino. Mr. Vester was a German-born immigrant who left Germany at the beginning of World War I and traveled to Mexico (Greno 1962). He spent the next ten years in Mexico until he moved to Los Angeles, California. The collection was obtained by Vester and his wife during his retirement in Mexico from 1946 – 1953 (Greno 1962). It was revealed during an interview with Mrs. Vester that the majority of the collection comes from Teotihuacán and the surrounding areas (Greno 1962). Looking through the collection, there is evidence that Vester traveled to Oaxaca and Lake Chapala (Greno 1962:2). According to Grider (1962), there is no evidence in his research that Gerhard Vester and his wife went past the Isthmus of Tehuantepec. In the later years of his life, Vester and his wife moved back to the

United States. After Vester died, Mrs. Vester moved to Redlands, California and in 1961 she donated the collection to the University of Redlands (Greno 1962; Grider 1962).

In 2004, the University of Redlands gave this collection to a Cultural Research Management (CRM) firm called Statistical Research Inc. SRI held the artifacts in their ASF office in Redlands, where they had various people look at the collection to determine where the artifacts came from and whether or not there were some forgeries. In 2008, the CRM firm gave the collection to the Anthropology Department at California State University San Bernardino. In 2017, the collection was examined and cataloged by graduate and undergraduate archaeology and anthropology students for a class project.

During an interview with Mrs. Vester in the 1960s, it was revealed how Mr. Vester obtained the artifacts in his collection. According to Mrs. Vester, her husband used bribery to dig in certain areas and even bought artifacts from locals (Grider 1962:2 – 3). She noted that buying artifacts from the locals "requires some skill, since many groups make copies of authentic ones" (Grider 1962:3). When they moved back to the United States Mrs. Vester implied that the artifacts were smuggled across the border.



Glendora Press

MONDAY - APRIL 22, 1957

GLENDORA, LOS ANGELES COUNTY, CALIFORNIA

RELICS AND ARTIFACTS of early Mexican culture are on display at the Glendora Public Library. Archaeologist Gehard Vester, who assembled the display, holds a funeral urn from the 8th century, found near Montealban, Oaxorca. (Press Photo by Wes Kloepfer)

Figure 1. 2 Mr. Vester in the Glendora Newspaper. April 22, 1957

These statements raise a few concerns with this collection. First, it is clear that Vester did not obtain permission to dig at sites while he was in Mexico. This means that the artifacts in this collection are looted. Second, there is no reliable provenience for these artifacts other than Mrs. Vester's statement that the majority of them were collected at Teotihuacán and the surrounding area. Third, with little paperwork detailing the collection's provenience, dating and sourcing these artifacts represents a significant challenge. One way to go about this is to relatively date the obsidian projectile points and some of the pottery and figurines, based on stylistic and diagnostic elements. Finally, it is likely that some of the artifacts in the collection are reproductions or are more recent than Vester believed. Even if Vester was as skilled in negotiating with the locals as Mrs. Vester stated, there is a strong probability that a few of the artifacts in the collection are reproductions.

Vester Collection Artifacts Examined for this Thesis

The Vester Collection contains a variety of artifacts including obsidian projectile points and prismatic cores, ceramic figurines and vessels, copper bells, aerophones, spindle whorls, lithic blades and hooks, and even a bone rasp. For this thesis research, I limited my focus to the obsidian artifacts. I examined a total of 81 artifacts. These include three earspools, an anthropomorphic figurine, ten “spokeshavers” or scrapers, five polyhedral cores, one piece of worked obsidian, and 61 projectile points (including two projectile points that have been labeled as spearpoints that are much larger than the rest of the projectile points). The majority of these artifacts have been tentatively dated to the Classic or Postclassic periods and are labeled as from either the Central Valley of Mexico generally or Teotihuacán specifically.

It should be noted that some of these artifacts have a type of glue on one surface, where they were placed on cardboard and put up for display at the

University of Redlands and at the Glendora Public Library. I removed much of this glue before I performed my analysis, as it may have interfered with the XRF analysis. I was careful not to damage the obsidian artifacts or create any new marks that could be mistaken for abrasion or any other wear during the later analysis of the artifacts.

CHAPTER THREE

ETHICAL CONSIDERATIONS

Working with the Vester Collection arguably raises a few ethical concerns. This is because the collection was looted and may be considered an "orphaned collection". An orphaned collection is "composed of excavated archaeological material that lost curatorial support or was abandoned" (MacFarland and Vokes 2016:162). There are many reasons for a collection to lose curatorial support, this can be from the closure of museums, the firing or retirement of the staff or faculty that was in charge of the collection, abandonment of the collection, or the accumulation of artifacts recovered during salvage operations (Voss 2012:147).

An 'orphaned' collection potentially raises a major issue concerning research potential, as there is often a large time gap between excavation and examination of the collection. Furthermore, 'orphaned' collections are usually separated from any field notes or any other documentation that may provide the artifacts with context (Voss 2012). This perfectly describes the Vester Collection. Gerhard Vester obtained the artifacts between 1946 – 1953 and the obsidian artifacts were examined for this project between 2019 and 2020. However, some of the field notes and documentation from Gerhard Vester were found. I was able to obtain additional documentation about the collection, which came from the CRM firm ASF and from CSUSB. Many archaeologists feel that any artifact that does not have any context is useless as it will not provide any information about the site or culture (Chase et al. 1988).

Despite this major issue with ‘orphaned’ collections, I believe that examining them is still a duty of archaeologists. One of the reasons for this position is the curation crisis that has been plaguing the archaeological field for some time now. The curation crisis has been described by Voss (2012:146) as “…a gross imbalance between the continued generation of archaeological collections through excavation, and a corresponding lack of resources and facilities devoted to accessioning, analyzing, reporting, curating and otherwise caring for these collections.” The curation crisis is the result of essentially all archaeological projects that collect large amounts of artifacts and the cultural resource laws that they follow (Bawaya 2007; Kersal 2015; Milanich 2005; Voss 2012). For example, in Florida CRM firms deposited collections in museums in perpetuity and these museums are running out of space (Milanich 2005). Another concerning issue raised by Milanich (2005:58) is that plenty of CRM bids do not include curation of the artifacts in the effort to have a lower bid. Many states in the USA face these same issues.

It is an archaeologist’s duty to examine the artifacts, publish in a timely manner, and to care, curate, and make accessible the collection for the public to examine (depending on the nature of the artifacts). These points are mentioned in the Society for American Archaeology’s Principles of Archaeological Ethics and the Archaeological Institute of America’s Code of Ethics. ‘Orphaned’ collections are not getting the attention they deserve from archaeologists. Barker (2003:71) believes that there is an ethical benefit to working with existing collections and that “curated collections, by contrast, represent a growing resource whose long term integrity and utility is enhanced rather than diminished by responsible use.”

There have been several projects that have worked with ‘orphaned’ collections and have produced new results. Voss (2012) has worked with the ‘orphaned’ collection from the Market Street Chinatown in San José, California. Voss showed that working with and curating an ‘orphaned’ collection resulted in artifact, context, catalog, and event inspired findings. Voss’s students designed research projects based on artifacts that were found during the cataloging process. Additionally, patterns of waste management activities and behavior in Market Street Chinatown were discovered while cataloging the artifacts obtained from middens.

Others have worked on rehabilitating ‘orphaned’ collections so that they can be combined to an institution to enhance the collections research potential. MacFarland and Vokes (2016) have created a seven-step procedure for rehabilitating ‘orphaned’ collections. These steps involve inspection of the collection, rehousing the collection, creating and validating digital database and validating the database, finalizing inventories and locations, and the creation of a summary document detailing what happened during the rehousing of the collection. The work of Voss (2012) and MacFarland and Vokes (2016) shows that work and research can be done on ‘orphaned’ collections and that valuable information can come these studies.

As mentioned previously, it is believed that Gerhard Vester obtained many of these artifacts through looting. Working with looted artifacts is contentious. Working with looted artifacts or working with data obtained from these artifacts may be perceived as directly or indirectly validating the act of looting (Chase et al. 1988; Lynott 1997).

I would like to make this statement clear; I do not endorse the act of looting archaeological sites. Many sites around the world have experienced looting and many of those sites have been destroyed as a result. In Belize, of 106 sites (that were included in the study), 60% had experienced looting and half of those sites are destroyed because of it (Proulx 2013). In Syria, looting of archaeological sites has increased in frequency in the Post-war years, 2012 – 2015 (Casana 2015). According to a study by Proulx (2013:119 – 120) on looting throughout the world, 78.5% of archaeologists have seen looting or the evidence of looting during field work, while 87.1% experienced looting or looters off site.

I believe that my work with the Vester Collection will do more good than harm by showing that 'orphaned' collections can and are a great resource of research for archaeologists, without endorsing or legitimizing the looting of artifacts.

CHAPTER FOUR

METHODOLOGY

Before the obsidian from the Vester Collection could be sourced, the artifacts were cleaned. During their time at the University of Redlands most of the obsidian artifacts, as well as some of the other lithics, were put on display or stored in a lab on the campus, as some of the artifacts had cardboard and glue on one surface. The cardboard and glue needed to be removed so that I could obtain accurate readings from the X-ray fluorescence (XRF) device. If the cardboard and glue were to be left on the artifacts, then the results would include the elemental composition of both of those and could quite possibly affect the parts per million (ppm) readings of a number of elements.

To remove the cardboard and glue residue, I used acetone and cotton swabs. The acetone was poured into a flask and placed under a fume hood along with the obsidian artifacts. One end of a cotton swab was dipped into acetone and then was rubbed over the section of the artifacts that had the foreign residue. This action was done carefully as to ensure that no damage would occur to the artifacts and no other marks were created on the surface. This was process was repeated multiple times for all of the artifacts as it took multiple passes of the Q-tip with nail polish remover to completely remove the glue and cardboard residue. Three artifacts (F.1386.T27.5861.55, F.1386.T27.5861.59, and F.1386.T27.5863.2) had some residue left after the removal process, but there was enough clean surface area to work with.

Once the obsidian artifacts were cleaned, they could be subjected to pXRF analysis. The sourcing of obsidian artifacts has been done by archaeologists and geochemists since the late 1960s, when it was discovered that different obsidian sources had different elemental compositions and archaeologists could use this information to determine where individual artifacts came from. Some of the sourcing techniques used for obsidian are neutron activation analysis, X-ray spectroscopy, and X-ray fluorescence (Gordus et al. 1968a; Griffin et al. 1969; Key 1969; Merrick and Brown 1984; Parks and Tieh 1966; Smith et al. 1977). Some of these techniques required the destruction of some of the obsidian to obtain the elemental results, but X-ray fluorescence is non-destructive.

In order to source the obsidian from the Vester Collection, I used an X-ray fluorescence (XRF) device. The XRF device uses short wavelength X-rays to bombard a sample with radiation. This radiation excites the atoms within the sample and then the sample becomes ionized. Once enough radiation is absorbed by the sample, the electrons in the inner electron shell will begin to dislodge themselves from the atom. Once this occurs, an outer shell electron replaces the inner shell electron. Energy is released by this exchange of electrons and is called fluorescence. Each element has a unique fluorescence level and this method can be used to detect elemental compositions in various materials (Shackley 2010:17).

This sourcing method works very well with obsidian, as each different obsidian source has a unique elemental fingerprint (Milić 2014; Nazaroff et al. 2010; Phillips and Speakman 2009; Sheppard et al. 2011). This allowed me to use an XRF machine to scan the obsidian artifacts in the Vester Collection and infer their possible origins. To conduct this research, I used the XRF device housed in the Geology Department at California State University San Bernardino. The XRF device in this lab is a Thermo Scientific Niton FXL Field X-ray Lab XRF and it is currently under the care of Dr. Erik Melchiorre. Due to this XRF device being a "Field" model, it is considered a portable XRF device (pXRF).

The Niton XRF is equipped with an Ag anode X-ray tube and is capable of 50 KV and 200 μA[1]. The Niton XRF is also capable of analyzing from an 8 mm to 1 mm area, so that specific areas of a sample can be targeted. The Niton XRF uses filters that are labeled as Light and Heavy. With both of these filters, the entire range of elements is being scanned, with each filter being used for roughly thirty seconds before they are switched out.

According to Dr. Melchiorre, the Niton XRF was set to the Mining Cu/Zn setting. Each obsidian artifact was examined independently for around 240 seconds to minimize the measurement fluctuations during the test period (Speakman 2012). The elements of primary focus were rubidium, strontium, yttrium, zirconium, and niobium as these elements are the main focus in XRF

[1] KV stands for Kilovolts and μA stands for microampere. These setting can be changed and certain settings are better for specific materials.

(Glascock et al. 1998). At Dr. Melchiorre's suggestion, readings were also taken of several other elements in case any unexpected signatures could help with the sourcing of the artifacts. The data were then converted to parts per million (ppm) using the in-house program in the Niton XRF device.

It should be stated that there is still a debate about the accuracy of the pXRF devices and their use in sourcing obsidian artifacts (Braswell 2013; Nazaroff et al. 2010; Shackley 2010, 2012). Braswell (2013:150), mentioned that the shape and the thickness of the obsidian artifact can lead to "variations and faulty measurements…" Shackley (2012) also discussed this issue and mentioned another problem, that of reliability and validity of measurements taken with a pXRF device.

Nazaroff and colleagues (2010:894) employed a pXRF device (a Bruker AXS Tracer 3-V) and demonstrated an "intra-instrument consistency." They showed this pXRF unit was capable of distinguishing between various different obsidian sources. However, they did find through a k-means cluster analysis that there was a systematic error in the data (Nazaroff et al. 2010:891). A systematic error, in statistics, is an error that is introduced by the inaccuracy of the measurement device. Due to this systematic error, the data from the pXRF could not be compared to the laboratory XRF, so there was no "inter-instrument consistency" between the two devices (Nazaroff et al. 2010:894). Despite these concerns there have been studies where both XRF and pXRF devices provided accurate measurements when sourcing obsidian artifacts (Millhauser et al. 2011; Pierce 2015; Speakman 2012).

Before the Vester Collection obsidian artifacts could be traced to their original sources, I needed to produce a large table of elemental data (primarily in ppm) of obsidian sources in Mexico and Mesoamerica is needed in order to source the obsidian artifacts from the Vester Collection. This is necessary due to the fact that the artifacts were not sent to an outside lab. The elemental data comprising this table come from scholarly journal articles and theses that either published the elemental ppm data and the source that the obsidian artifacts came from or provided a link to the supplementary data that contained the elemental information (Joyce et al. 1995; Lopez-García et al. 2019; Millhauser et al. 2011; Pierce 2015; Smith et al. 2007; Williams 2012). This data table (Appendix 1) contains the elemental readings of 616 obsidian artifacts (61 from Joyce et al. 1995; 109 from Lopez-García et al. 2019; 103 from Millhauser et al. 2011; 197 from Pierce 2015; 64 from Smith et al. 2007; and 82 from Williams 2012).

The obsidian sourcing data presented in Appendix 1 include elemental information obtained by both XRF and instrumental neutron-activation analysis (INAA). INAA elemental information was chosen for inclusion in the table as there is some crossover in the elements that are the focus of INAA sourcing and XRF sourcing. The table contains various obsidian sources from Mexico including Pachuca, Paredón, Otumba, Ucaréo, Zaragoza, and Guadalupe Victoria among many others. In total there are 27 obsidian sources characterized. To create this list, I compiled the elemental data and obsidian source from each journal article or thesis and recorded them in an Excel spreadsheet. Included in the spreadsheet is information about where each artifact was recovered, if that information was stated within the article.

The XRF elemental data obtained from the obsidian artifacts of the Vester Collection were compared to the elemental data collected from the scholarly sources mentioned above to determine where the Vester obsidian came from. To analyze all of these data, I used the statistical software JMP Pro 15. First, I conducted a principal component analysis (PCA) on the Vester elemental data (Figure 4.1). The elements I selected for this analysis were Rb, Zr, and Nb. Sr was not included because some of the artifacts did not have a detectable amount of that element. Y was not included because Dr. Melchiorre stated that the Niton XRF that was not calibrated properly to read that element. The PCA was conducted to see if there were any patterns or clusters in the Vester data set

(Figure 4.1)

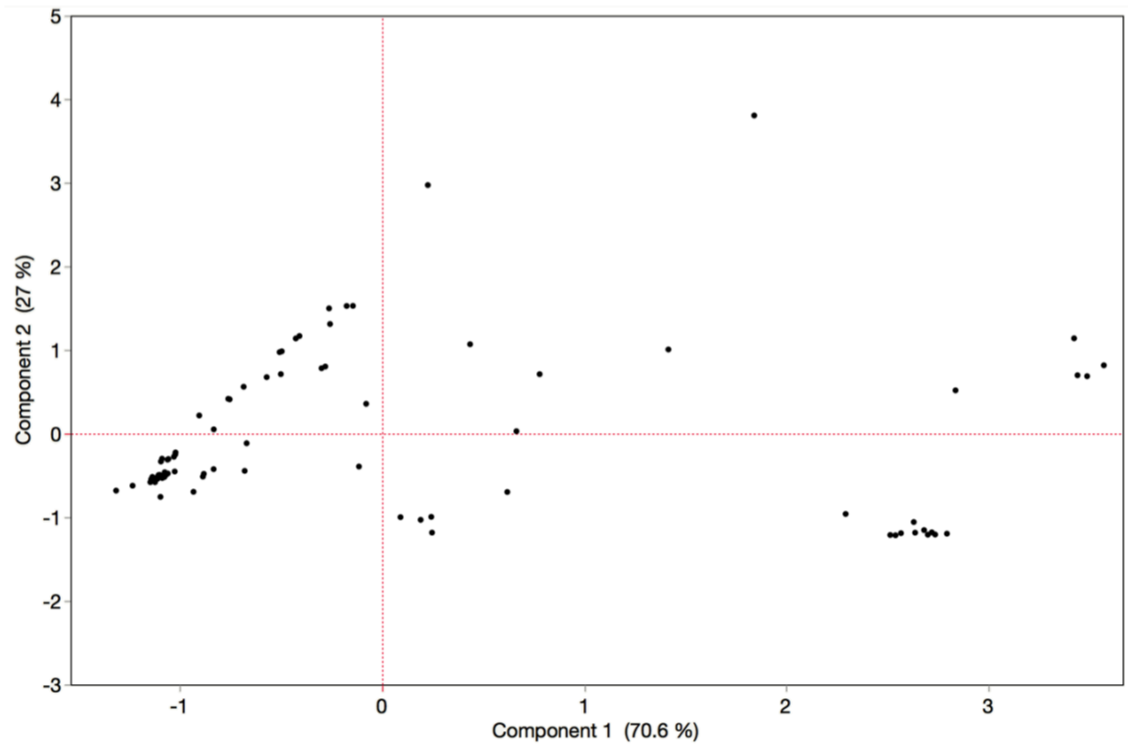


Figure 4. 1 Principal components analysis of Vester obsidian. Components chosen for the PCA were Rubidium, Zirconium, and Niobium.

After the PCA, I compared the elemental readings from the Vester obsidian to the elemental data from the previously mentioned scholarly sources. Zr and Rb were chosen as the x-axis and y-axis, respectively. The graph produced was quite large and needed to be split into two separate graphs for ease of analysis (Figures 4.2 & 4.3). Sources that were not near the readings of the Vester obsidian were removed from the graphs, a total of 17 sources. I then used the remaining elemental data to create 95% confidence ellipses, and these were used to source the Vester obsidian.

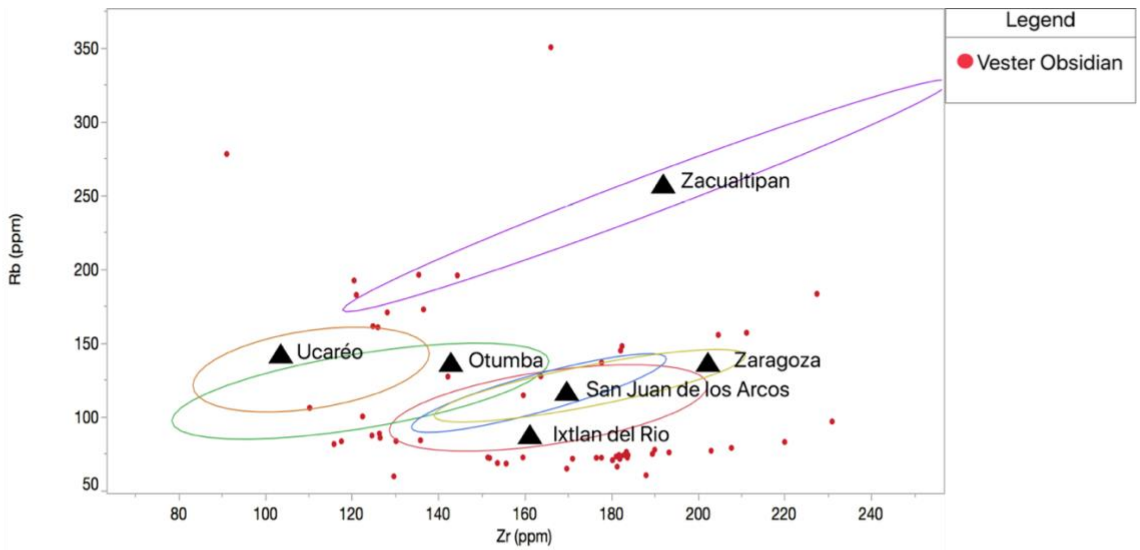


Figure 4. 2 Scatterplot of half of the Vester obsidian. This scatterplot shows the concentrations of Rb and Zr, in ppm, of half of the Vester obsidian. With 95% confidence intervals of the Ixtlán del Rio, Otumba, San Juan del los Arcos, Ucaréo, Zacualtipan, and Zaragoza obsidian sources.

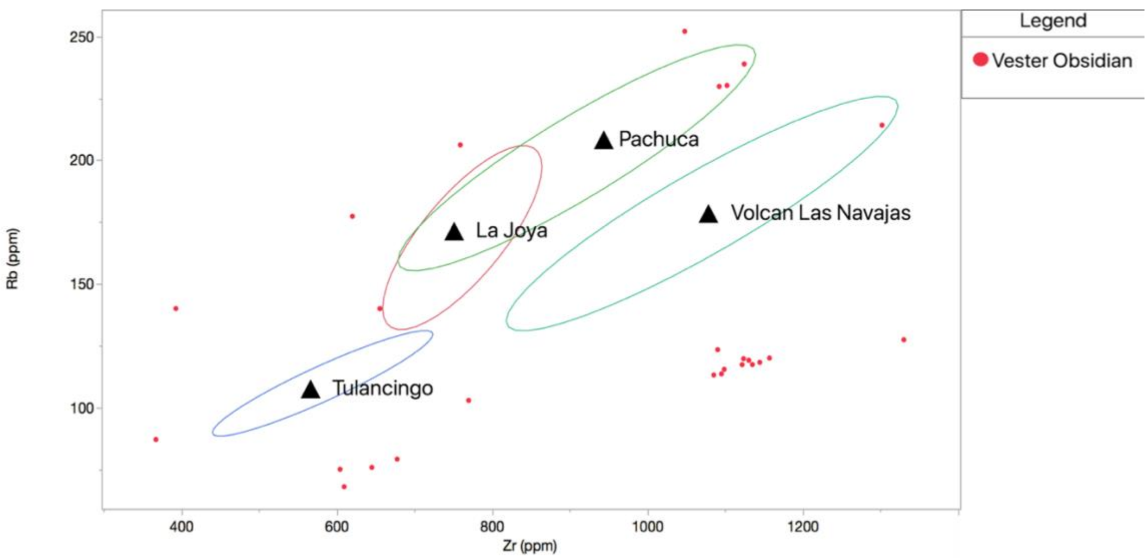


Figure 4. 3 Scatterplot of half of the Vester obsidian. This scatterplot shows the concentrations of Rb and Zr, in ppm, of the other half of the Vester obsidian. With 95% confidence intervals of the La Joya, Pachuca, Volcán las Navajas, and Tulancingo obsidian sources.

I then conducted a hierarchical clustering analysis to determine the sources of the four artifacts that were difficult to source using only confidence ellipses, as these ellipses overlapped (Figure 4.4). I completed this hierarchical clustering analysis using Rb, Zr, and Nb as variables and sorting the clusters based on Rb (Figure 4.4). For the sources, I determined the averages of each elemental reading were obtained for use in the hierarchical clustering analysis.

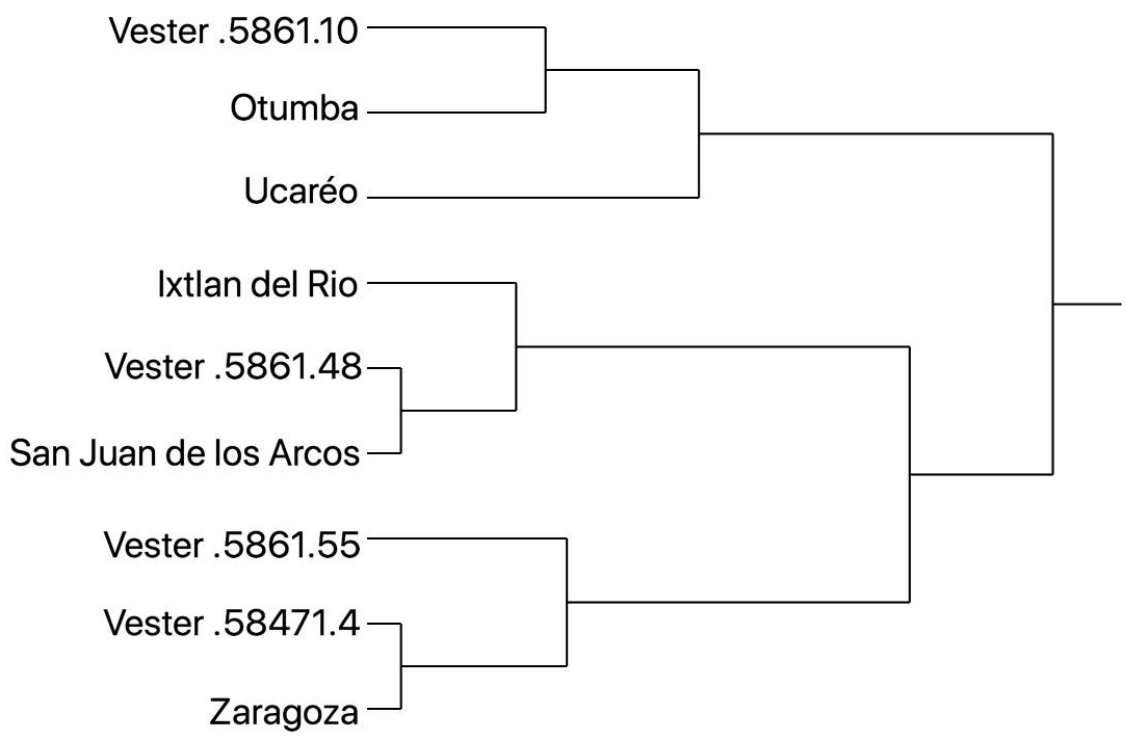


Figure 4. 4 Results of hierarchical clustering analysis. The HCA was done on four Vester artifacts that were difficult to source. The cluster analysis was based on Rb, Zr, and Nb, and were based on Rb. The values for the sources were averaged.

CHAPTER FIVE

RESULTS

This study of the Vester obsidian resulted in the sourcing total of 13 out of the 81 artifacts included in this study, or about 16% of the obsidian in the collection (Table 5.1). The sources that are represented among those artifacts are Ixtlán del Rio, Otumba, Pachuca, San Juan de los Arcos, Volcán las Navajas, Zacualtipan, and Zaragoza. The PCA proved somewhat useful but plotting the Vester obsidian elemental data to the sources in a scatterplot matrix was more effective in determining sources.

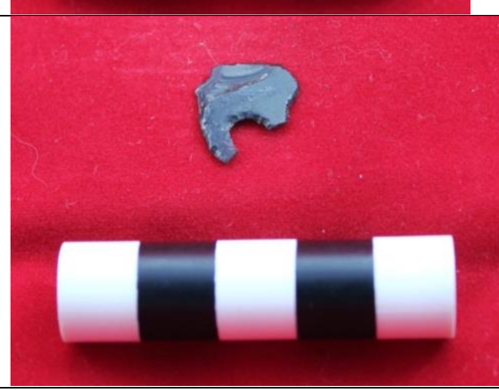
Artifact Number	**Source**	**Artifact Type**
F.1386.C25.5822.2	Volcán las Navajas	Ear Plug
F.1386.C25.5843.2	Pachuca	Polyhedral Core
F.1386.T27.5861.10	Otumba	Projectile Point
F.1386.T27.5861.11	Ixtlán del Rio	Projectile Point
F.1386.T27.5861.21	Otumba	Projectile Point
F.1386.T27.5861.25	Pachuca	Projectile Point
F.1386.T27.5861.26	Otumba	Projectile Point
F.1386.T27.5861.48	San Juan de los Arcos	Projectile Point
F.1386.T27.5861.55	Zaragoza	Projectile Point
F.1386.5841.1	Zacualtipan	Abrader/“Spokeshaver” Scraper
F.1386.58471.1	Zacualtipan	“Spokeshaver” Scraper
F.1386.58471.4	Zaragoza	“Spokeshaver” Scraper
F.1386.58471.5	Pachuca	“Spokeshaver” Scraper

Table 5. 1 Table of sourced Vester obsidian.

Plotting the obsidian readings allowed me to determine the sources of nine out of the 13 artifacts. These artifacts were located in areas of the confidence ellipses that were not overlapping with other ellipses (Figures 4.2 & 4.3) The last four artifacts (F.1386.T27.5861.10; F.1386.T27.5861.48; F.1386.T27.5861.55; and F.1386.58471.4) needed to go through another analysis to determine their most likely source. Following the example of Millhauser and colleagues (2011), I completed a hierarchical clustering analysis. This analysis, based the individual artifact readings and averages of the sources, determined that Otumba, San Juan de los Arcos, and Zaragoza were the most likely sources for these for artifacts (Figure 4.4).

Artifact Number	Photo
F.1386.C25.5822.2	
F.1386.C25.5843.2	

F.1386.T27.5861.10	
F.1386.T27.5861.11	
F.1386.T27.5861.21	
F.1386.T27.5861.25	
F.1386.T27.5861.26	

F.1386.T27.5861.48	
F.1386.T27.5861.55	
F.1386.5841.1	
F.1386.58471.1	

F.1386.58471.4	
F.1386.58471.5	

Table 5. 2 Photos of sourced Vester obsidian.

CHAPTER SIX

DISCUSSION

With this research, I sought to complete two related objectives. These were to prove that working with the ‘orphaned’ Vester Collection could provide the collection much needed context and demonstrate its research potential. I tried to accomplish that objective by sourcing the obsidian artifacts that were a part of the collection. As previously stated, 13 of the 81 total obsidian artifacts were sourceable by the methods employed in this research. Among these artifacts, a total of seven obsidian sources are represented (Figure 6.1). It is possible that if more elemental data on obsidian sources in Mesoamerica were easily accessible, I may have been able to source more of the artifacts. Or it may be possible that if obsidian sources from other areas of Mexico and Mesoamerica in general were included in the beginning of my research, more artifacts could have been sourced. The data that has been gathered does provide a good starting point for future research which may allow for more artifacts to be sourced.

Out of the 13 artifacts sourced, seven obsidian sources are represented. Three artifacts were sourced to Otumba, and another three were sourced to Pachuca. Zacualtipan and Zaragoza both produced two artifacts in the collection. Ixtlán del Rio, San Juan de los Arcos, and Volcán las Navajas each produced one artifact, according to this analysis (Figure 6.1). The furthest source from Teotihuacán and the surrounding area would be the Volcán de las Navajas, which is roughly 400 miles away in West Mexico (Figure 6.1). While there is little contextual information about where exactly these artifacts were taken, or what time period they are from, I believe that it the obsidian sources represented in the sourced Vester artifacts are accurate.

The number of obsidian sources represented in the sourced Vester obsidian is significant. While seven sources are currently identified, the majority of obsidian artifacts in the collection still need to be sourced. This suggests that even more sources are likely represented in this collection. There are two possibilities I can propose to explain this finding. First, it is possible that the number of obsidian sources show that there were complex trading and interaction networks involved within and around Teotihuacán, as Carballo and colleagues (2007) found in their sourcing of obsidian from the Sun Pyramid. Alternatively, the artifacts obtained by Mr. Vester may have been looted or purchased in more places than was previously believed.

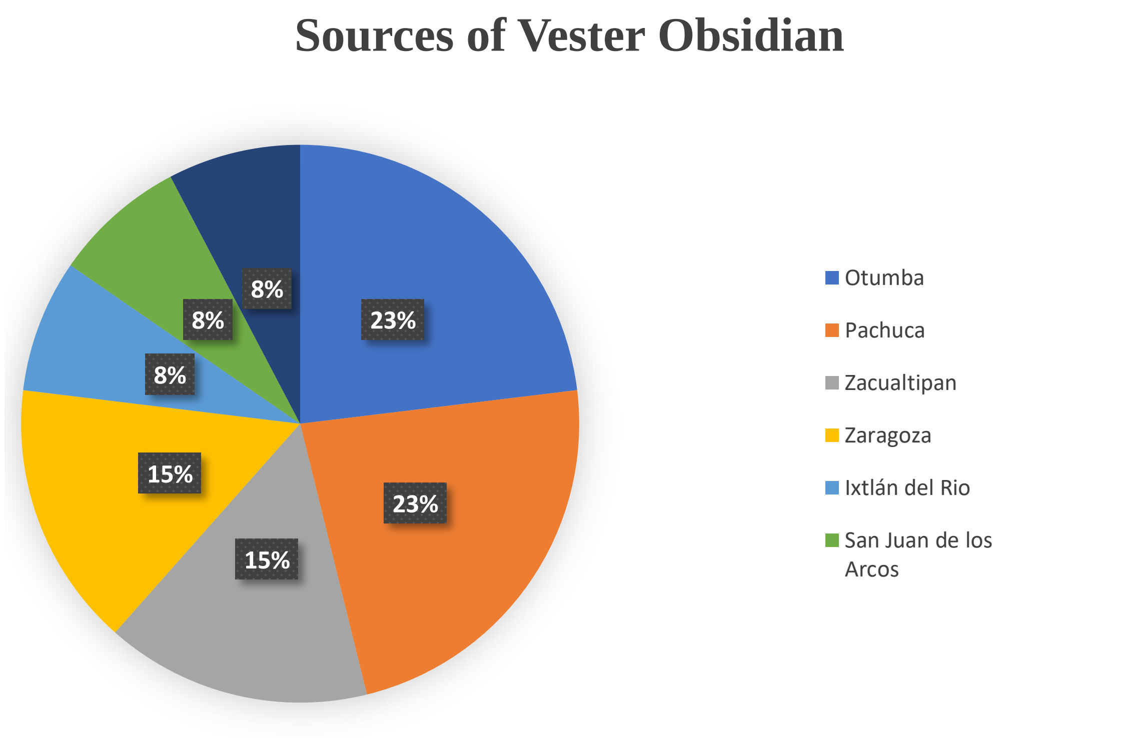


Figure 6.1 Pie-chart of obsidian sources in the Vester Collection.

Looking at Figure 6.2, the closest obsidian sources that are represented in the sourced Vester artifacts are Otumba, Pachuca, Zacualtipan and Zaragoza, and these sources are the most common. Both Otumba and Pachuca were sources that were used by Teotihuacán (Gazzola et al. 2010; Kwoka and Shackley 2019).

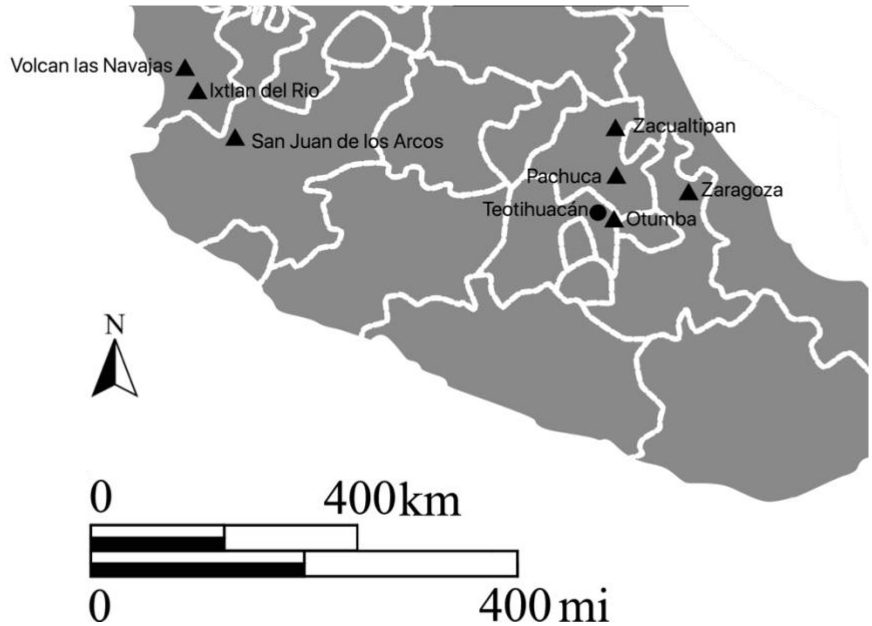


Figure 6.2 Map of Mexico with obsidian sources in Vester Collection. This map shows the locations of the obsidian sources that were identified in this research and Teotihuacán, the presumed area where the obsidian artifacts were collected by Gerhard Vester.

Kwoka and Shackley (2019), examined a cache of obsidian that was excavated in the Sun Pyramid. The cache was excavated by René Millon in 1965, and the cache has been dated to the first construction phase of the pyramid (Tzacualli phase, 1 – 150 CE). A total of 41 obsidian artifacts were sourced by XRF to a single source, the Otumba source. In Gazzola and colleagues work (2010), they examined 50 obsidian artifacts that were also a part of the oldest construction phases of Teotihuacán. Using particle-induced X-ray emission (PIXE) they sourced the artifacts to four sources. The sources are Otumba, Pachuca, Paredón, and Zacualtipan. The Zacualtipan source is unusual for a couple of reasons. One artifact was sourced to Zacualtipan and its presence "testifies to the use of a source never reported in connection with Teotihuacan obsidians" (Gazzola et al. 2010: 350). It is believed that the presence of the Zacualtipan source found in the early phases shows that the people from Teotihuacán controlled that source as well or that the obsidian from Paredón and Zacualtipan are evidence of commercial exchange (Gazzola et al. 2010: 352).

Carballo and colleagues (2007) analyzed the obsidian procurement patterns of four central Mesoamerican sites that spanned from the Formative period to the Classic period and also produced some surprising results. One of the sites they examined was Teotihuacán, and they specifically focused on workshops around the Moon Pyramid. They found that, during the Classic period at Teotihuacán obsidian from Zaragoza is present in small quantities and that its presence, along with obsidian from Paredón and Tulancingo, "indicates a more complex procurement system for the Teotihuacan lithic economy than the traditional emphasis in the literature on the Pachuca and Otumba sources." (Carballo et al. 2007:40).

Through my research I was unable to find previously-published evidence of obsidian from Ixtlán del Rio, San Juan de los Arcos, or Volcán las Navajas recovered at Teotihuacán. Pierce's (2015) work on the Aztatlán site in Northern Nayarit provided evidence of Pachuca obsidian. The site is called San Felipe Aztatán, and it was a Classic period site. The obsidian recovered at that site was sourced, visually and by using an XRF, to a total of seven sources, four of them being Pachuca, Ixtlán del Rio, San Juan de los Arcos, and Volcán las Navajas (Pierce 2015). One hundred and ninety-five artifacts were sourced, out of 1476, and 8% of the sourced artifacts came from Pachuca. This is possible evidence of a trade system that connected Western Mexico to Central Mexico. Eighty-four obsidian artifacts dated to the Amapa Phase (500 – 750 CE), while 29 pieces were dated to the Cerritos Phase (900 – 1100 CE) (Pierce 2015: 272). Based on this, I believe that if it is possible for Central Mexican obsidian to be found in West Mexico, it may be possible that the reverse could be true as well. This could indicate that interaction networks in Mesoamerica were more complex than previously believed and that the interaction networks in Teotihuacán were complex as well. Alternatively, as stated above it is possible that Mr. Vester obtained the obsidian artifacts in other areas besides Teotihuacán.

I believe that this research with the Vester Collection does show that there is some research potential within the collection. Obviously more work needs to be done with the rest of the unsourced obsidian artifacts. But there are other types of artifacts within the collection, as well. There are ceramic figurines and vessels, spindle whorls, and colonial artifacts. It is possible that research into the other artifacts in the collection could aid in determining where Gerhard Vester obtained them.

CHAPTER SEVEN

CONCLUSION

With this research, I sought to bring some context to the ‘orphaned’ Vester Collection by sourcing its obsidian artifacts and to prove that it is possible to work with an ‘orphaned’ collection. With only the words of Mrs. Vester to go on, it was assumed that the obsidian artifacts were taken from Teotihuacán and the surrounding area and there is little evidence for demonstrating the time period of the obsidian’s original use. Of the 81 artifacts examined, 13 of them were traced to specific obsidian sources in Mexico. These sources are Ixtlán del Rio, Otumba, Pachuca, San Juan de los Arcos, Volcán las Navajas, Zacualtipan, and Zaragoza. Looking at previous obsidian sourcing studies done on materials recovered from Teotihuacán (Carballo et al. 2007, Gazzola et al. 2010, Kwoka and Shackley 2019), the Otumba, Pachuca, Zacualtipan, and Zaragoza sources are found within various periods of the site. Finding these sources within the collection should be expected. The identification of obsidian from West Mexico (Ixtlán del Rio, San Juan de los Arcos, and Volcán las Navajas) is surprising, however. Perhaps this is evidence of West Mexican obsidian being traded to Central Mexico during the Classic period? Pierce (2015) revealed that Pachuca obsidian was present in Classic Period San Felipe Aztatán. If Central Mexico obsidian could be found in West Mexico, it should be possible that West Mexico obsidian could be found in Central Mexico.

I do believe that with the information obtained during this research, some context was returned to the Vester Collection. Although a modest start, this is the only new contextual information produced for this collection for a number of years. It is important to examine these ‘orphaned’ collections as they continue to sit in the various museums, storage units, universities, and garages. I argue that it is the responsibility of archaeologists to examine these artifacts and publish the information obtained from their study. We cannot let these collections to continue to sit in storage in perpetuity without being examined. Barker (2003) said that the examination of these collections “is additive, with research by successive generations of scholars increasing the utility of these portions of the archaeological record for future analysis” (71).

APPENDIX A

OBTAINED ELEMENTAL COMPOSITIONS OF MESOAMERICAN OBSIDIAN SOURCES

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
RV015	INAA	Guadalupe Victoria											940	604	1.37	3.44	521	3.23			Joyce et. Al 1995
RV033	INAA	Guadalupe Victoria											888	501	1.42	3.15	530	3.35			Joyce et. Al 1995
RV039	INAA	Guadalupe Victoria											915	427	1.17	3.43	520	3.26			Joyce et. Al 1995
RV049	INAA	Guadalupe Victoria											1147	439	1.58	3.78	531	3.33			Joyce et. Al 1995
RV053	INAA	Guadalupe Victoria											863	455	1.76	3.82	518	3.24			Joyce et. Al 1995
RV054	INAA	Guadalupe Victoria											835	375	2.24	3.48	529	3.33			Joyce et. Al 1995
RV004	INAA	Orizaba											582	333	2.31	3.69	567	3.23			Joyce et. Al 1995
RV020	INAA	Orizaba											733	309	1.78	3.49	557	3.17			Joyce et. Al 1995
RV021	INAA	Orizaba											806	330	2.64	3.07	570	3.24			Joyce et. Al 1995
RV022	INAA	Orizaba											761	310	1.68	3.14	566	3.19			Joyce et. Al 1995
RV023	INAA	Orizaba											732	339	1.95	3.15	571	3.21			Joyce et. Al 1995
RV024	INAA	Orizaba											666	350	1.74	3.67	572	3.24			Joyce et. Al 1995
RV027	INAA	Orizaba											640	303	1.77	3.66	576	3.22			Joyce et. Al 1995
RV028	INAA	Orizaba											668	325	2.22	3.28	571	3.22			Joyce et. Al 1995
RV034	INAA	Orizaba											638	269	1.81	3.29	574	3.26			Joyce et. Al 1995
RV036	INAA	Orizaba											783	284	2.15	3.46	559	3.16			Joyce et. Al 1995
RV040	INAA	Orizaba											713	263	1.94	3.28	565	3.18			Joyce et. Al 1995
RV005	INAA	Otumba											720	472	3.39	3.07	392	3.1			Joyce et. Al 1995
RV008	INAA	Otumba											863	435	3.63	3.35	388	3.03			Joyce et. Al 1995
RV042	INAA	Otumba											817	317	3.27	3.97	403	3.12			Joyce et. Al 1995
RV043	INAA	Otumba											827	355	3.07	3.76	402	3.1			Joyce et. Al 1995
RV045	INAA	Otumba											722	317	3.5	3.61	401	3.11			Joyce et. Al 1995

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
RV046	INAA	Otumba											758	458	3.36	3.7	393	3.09			Joyce et. Al 1995
RV052	INAA	Otumba											819	390	2.73	3.51	396	3.05			Joyce et. Al 1995
RV001	INAA	Pachuca											0	1552	16.6	3.26	1158	3.88			Joyce et. Al 1995
RV002	INAA	Pachuca											0	1392	16.4	3.76	1139	3.78			Joyce et. Al 1995
RV003	INAA	Pachuca											0	1624	16.8	4.19	1143	3.48			Joyce et. Al 1995
RV009	INAA	Pachuca											0	1525	16.9	3.29	1155	3.86			Joyce et. Al 1995
RV010	INAA	Pachuca											0	1460	16.8	3.88	1115	3.68			Joyce et. Al 1995
RV011	INAA	Pachuca											0	1424	15.4	3.86	1147	3.78			Joyce et. Al 1995
RV014	INAA	Pachuca											0	1566	16.8	3.61	1140	3.71			Joyce et. Al 1995
RV016	INAA	Pachuca											0	1401	16.1	4.04	1132	3.62			Joyce et. Al 1995
RV017	INAA	Pachuca											0	1471	16.5	3.64	1146	3.82			Joyce et. Al 1995
RV019	INAA	Pachuca											0	1360	15.6	3.74	1151	3.87			Joyce et. Al 1995
RV029	INAA	Paredón											0	827	7.53	4.02	372	3			Joyce et. Al 1995
RV030	INAA	Paredón											0	836	7.61	3.82	369	2.95			Joyce et. Al 1995
RV031	INAA	Paredón											0	905	7.79	3.89	362	2.94			Joyce et. Al 1995
RV032	INAA	Paredón											0	725	8.54	3.62	357	2.86			Joyce et. Al 1995
RV035	INAA	Paredón											0	918	7.93	4.18	367	2.96			Joyce et. Al 1995
RV037	INAA	Paredón											0	900	7.81	3.7	365	2.95			Joyce et. Al 1995
RV041	INAA	Paredón											0	883	7.6	3.89	366	2.96			Joyce et. Al 1995
RV047	INAA	Paredón											0	1006	7.73	4.91	363	3			Joyce et. Al 1995
RV048	INAA	Paredón											0	990	7.89	4.68	372	3.01			Joyce et. Al 1995
RV050	INAA	Paredón											0	895	8.13	4.82	371	2.72			Joyce et. Al 1995

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
RV051	INAA	Paredón											0	958	8.21	4.71	375	3.01			Joyce et. Al 1995
RV012	INAA	Ucaréo											164	369	3.59	4.04	167	2.8			Joyce et. Al 1995
RV013	INAA	Ucaréo											121	425	3.48	4.03	162	2.79			Joyce et. Al 1995
RV038	INAA	Ucaréo											237	393	3.61	3.51	166	2.83			Joyce et. Al 1995
RV044	INAA	Ucaréo											167	354	4.04	4.5	168	2.84			Joyce et. Al 1995
RV057	INAA	Ucaréo											173	335	3.47	4.35	167	2.81			Joyce et. Al 1995
RV058	INAA	Ucaréo											168	304	3.95	4.57	167	2.77			Joyce et. Al 1995
RV059	INAA	Ucaréo											242	458	7.72	4.97	171	2.55			Joyce et. Al 1995
RV060	INAA	Ucaréo											149	341	3.69	4.38	166	2.79			Joyce et. Al 1995
RV061	INAA	Ucaréo											115	354	4.14	4.32	164	2.77			Joyce et. Al 1995
RV006	INAA	Zaragoza											479	663	4.99	3.93	257	2.98			Joyce et. Al 1995
RV007	INAA	Zaragoza											446	670	4.95	3.82	254	2.99			Joyce et. Al 1995
RV018	INAA	Zaragoza											481	556	4.91	4.26	253	2.98			Joyce et. Al 1995
RV025	INAA	Zaragoza											434	507	4.74	3.79	241	2.94			Joyce et. Al 1995
RV026	INAA	Zaragoza											432	602	4.51	3.56	244	2.99			Joyce et. Al 1995
RV055	INAA	Zaragoza											426	549	4.82	4.52	252	3.06			Joyce et. Al 1995
RV056	INAA	Zaragoza											451	520	5.1	4.2	250	2.96			Joyce et. Al 1995
1	XRF	Ahuisculco			7469.5	46.02	15.1	110	41.1	19	141	19					382			10.1	Lopez-Garcia et al 2019
2	XRF	Ahuisculco			7339.1	40.68	15.8	109	41.6	20	141	20					382			10.3	Lopez-Garcia et al 2019
3	XRF	Ahuisculco			7211.1	41.1	18.1	105	42.3	20	138	18					382			8.93	Lopez-Garcia et al 2019
4	XRF	Ahuisculco			7799	58.94	21.2	116	46.9	21	154	21					382			11	Lopez-Garcia et al 2019
5	XRF	Ahuisculco			7418.6	39.4	16.8	109	40.9	19	138	20					382			11.6	Lopez-Garcia et al 2019

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
6	XRF	Ahuisculco			6976.3	43.07	16.1	103	38.9	17	133	19					382			9.71	Lopez-Garcia et al 2019
7	XRF	Ahuisculco			7649.9	38.9	17.6	115	42.4	19	141	21					382			11.2	Lopez-Garcia et al 2019
8	XRF	Ahuisculco			8752.3	830.1	23.4	128	65.6	22	151	23					382			9.08	Lopez-Garcia et al 2019
9	XRF	Ahuisculco			7468.2	46.86	18.2	109	44.6	20	143	19					382			9.53	Lopez-Garcia et al 2019
10	XRF	Ahuisculco			7888.7	165.7	19	113	50	19	146	21					382			8.82	Lopez-Garcia et al 2019
14	XRF	El Chayal			6199	45.91	16	139	132	19	107	9.9					657			10.4	Lopez-Garcia et al 2019
15	XRF	El Chayal			6335.7	48.67	18.6	145	139	23	110	11					614			10.2	Lopez-Garcia et al 2019
16	XRF	El Chayal			5677.1	42.52	15.9	135	129	18	105	10					517			9.62	Lopez-Garcia et al 2019
22	XRF	El Chayal			6184.1	43.03	18	141	137	20	110	10					681			10.8	Lopez-Garcia et al 2019
23	XRF	El Chayal			6254.9	50.19	14.9	139	137	18	106	9.5					647			11.1	Lopez-Garcia et al 2019
24	XRF	El Chayal			5957.2	41.12	15	140	131	17	102	9.3					574			10.2	Lopez-Garcia et al 2019
17	XRF	Ixtepeque			7312.1	11.53	19	68.2	99.8	12	117	10					211			1.6	Lopez-Garcia et al 2019
18	XRF	Ixtepeque			9024	35.57	14	97.6	143	17	156	8.8					392			7.54	Lopez-Garcia et al 2019
19	XRF	Ixtepeque			9159.3	49.39	18.8	99.4	148	19	163	8.4					422			6	Lopez-Garcia et al 2019
20	XRF	Ixtepeque			8659.3	39.23	14.6	92.6	138	17	154	9.4					403			7.09	Lopez-Garcia et al 2019
21	XRF	Ixtepeque			8571.7	32.53	14.6	93.3	138	19	153	9.1					410			5.86	Lopez-Garcia et al 2019
11	XRF	La Esperanza			7739.9	43.7	13.3	146	119	17	117	11					405			10.4	Lopez-Garcia et al 2019
12	XRF	La Esperanza			7267.4	32.32	13.2	137	113	16	113	9.4					409			10.2	Lopez-Garcia et al 2019
13	XRF	La Esperanza			7401.1	38.34	15.3	141	112	17	114	8.6					453			9.62	Lopez-Garcia et al 2019
28	XRF	Otumba			8580.4	36.78	17.5	102	109	18	122	10					382			10.2	Lopez-Garcia et al 2019
29	XRF	Otumba			8606.9	49.94	19.4	112	113	17	124	9.4					347			10.2	Lopez-Garcia et al 2019
30	XRF	Otumba			7641.8	42.85	14.6	86.3	92.7	14	89.1	6.9					312			6.43	Lopez-Garcia et al 2019

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
31	XRF	Otumba			8426.4	39.5	18.2	103	110	20	118	9.2					306			7.92	Lopez-Garcia et al 2019
32	XRF	Otumba			8333.2	46.94	15.8	107	111	19	120	12					280			8.39	Lopez-Garcia et al 2019
33	XRF	Otumba			8279.5	47.02	18.9	98	105	17	99.5	8.4					310			6.34	Lopez-Garcia et al 2019
34	XRF	Otumba			8203.1	44.61	17.5	104	103	17	106	9.5					329			10.4	Lopez-Garcia et al 2019
35	XRF	Otumba			8242.3	45.61	15.2	106	107	20	120	11					355			8.27	Lopez-Garcia et al 2019
36	XRF	Otumba			7390.3	48.24	13.3	87.9	93.9	15	92.6	7.6					323			6.3	Lopez-Garcia et al 2019
37	XRF	Otumba			7510.4	33.38	17	96.8	93.4	16	102	8.8					279			6.38	Lopez-Garcia et al 2019
38	XRF	Otumba			6936.1	44.18	16.2	106	68.9	19	96.1	12					363			9.68	Lopez-Garcia et al 2019
39	XRF	Otumba			6775	31.16	18.3	100	62.6	19	92.3	11					279			5.09	Lopez-Garcia et al 2019
40	XRF	Otumba			7556.7	46.34	15.8	116	76.6	22	106	11					398			10.2	Lopez-Garcia et al 2019
41	XRF	Otumba			7475	42.18	14.7	115	75.6	22	104	12					392			11.2	Lopez-Garcia et al 2019
42	XRF	Otumba			7508.9	49.22	15.1	121	73.7	22	102	11					378			11.4	Lopez-Garcia et al 2019
43	XRF	Otumba			7428	44.9	16.6	119	73.4	22	104	14					367			12.5	Lopez-Garcia et al 2019
44	XRF	Otumba			7405.5	44.12	17.9	118	72.4	21	101	13					468			11.4	Lopez-Garcia et al 2019
45	XRF	Otumba			7385.6	54.43	15.6	115	74	23	100	13					425			11	Lopez-Garcia et al 2019
46	XRF	Otumba			7846.6	48.53	20.9	125	79.8	22	107	14					392			12.1	Lopez-Garcia et al 2019
47	XRF	Otumba			7509	49.45	16.3	117	73.8	20	101	13					421			10.1	Lopez-Garcia et al 2019
48	XRF	Otumba			7502	46.25	16.6	114	75.5	23	103	13					485			10.5	Lopez-Garcia et al 2019
49	XRF	Otumba			7746.7	44.39	19.5	121	75.5	23	106	13					406			9.74	Lopez-Garcia et al 2019
50	XRF	Otumba			7168	49.28	15.1	109	71.6	21	97.6	14					385			10.1	Lopez-Garcia et al 2019
51	XRF	Otumba			7581.8	43.04	15	115	74.8	23	107	11					364			11.3	Lopez-Garcia et al 2019
52	XRF	Otumba			7202	39.07	14.2	114	72.3	21	100	12					396			10.2	Lopez-Garcia et al 2019

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
53	XRF	Otumba			7481.9	45.77	16.1	118	74.6	20	106	13					459			10.7	Lopez-Garcia et al 2019
54	XRF	Otumba			7590.7	43.98	16	119	75.2	22	104	12					437			10.3	Lopez-Garcia et al 2019
55	XRF	Otumba			7277.6	46.79	14.5	114	70.7	20	99.8	12					437			9.35	Lopez-Garcia et al 2019
56	XRF	Otumba			7602.6	37.96	15.3	116	79.7	22	106	13					432			9.81	Lopez-Garcia et al 2019
57	XRF	Otumba			7335	51.8	18.7	111	73.2	20	104	12					346			9.39	Lopez-Garcia et al 2019
58	XRF	Otumba			7471.9	44.65	16.5	117	74.1	24	104	13					402			12.6	Lopez-Garcia et al 2019
59	XRF	Otumba			7409.7	37.08	16.8	112	77.3	20	102	11					379			9.04	Lopez-Garcia et al 2019
60	XRF	Otumba			7659.1	45.02	14.4	117	75.4	21	107	13					361			12	Lopez-Garcia et al 2019
61	XRF	Otumba			7669.4	57.13	17.2	131	60.6	27	113	15					595			8.11	Lopez-Garcia et al 2019
62	XRF	Otumba			7365.3	60.91	14.7	127	60.8	25	109	14					628			7.1	Lopez-Garcia et al 2019
63	XRF	Oyameles			8969.6	43.82	18.1	131	26.7	32	176	16					251			18.8	Lopez-Garcia et al 2019
64	XRF	Oyameles			8580.6	42.05	17.5	131	25.5	29	181	17					255			16.4	Lopez-Garcia et al 2019
65	XRF	Oyameles			8189.4	35.01	19.9	119	22.4	26	162	16					138			13.7	Lopez-Garcia et al 2019
66	XRF	Oyameles			9544.8	46.12	17.8	130	24.8	30	180	17					307			17.4	Lopez-Garcia et al 2019
67	XRF	Oyameles			8962.1	44.68	18.9	132	25.6	31	176	15					275			15.9	Lopez-Garcia et al 2019
68	XRF	Oyameles			9212.5	44.66	19.6	132	23.9	32	181	18					231			16.6	Lopez-Garcia et al 2019
69	XRF	Oyameles			8911.9	46.21	17.7	132	25.2	31	181	17					294			17	Lopez-Garcia et al 2019
82	XRF	Pachuca			14574	195.6	20.9	165	5.68	92	719	66					975			15	Lopez-Garcia et al 2019
83	XRF	Pachuca			14162	195.3	22.7	159	6.91	86	686	65					942			13	Lopez-Garcia et al 2019
84	XRF	Pachuca			13905	173.5	21	159	7.44	85	665	62					861			15.4	Lopez-Garcia et al 2019
85	XRF	Pachuca			14565	183.9	21.6	172	4.25	95	743	70					1020			17.8	Lopez-Garcia et al 2019
86	XRF	Pachuca			13854	183.6	19.6	158	6.55	85	670	64					871			14.9	Lopez-Garcia et al 2019

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
87	XRF	Pachuca			14225	169.7	20.8	162	4.2	93	708	67					967			15.7	Lopez-Garcia et al 2019
88	XRF	Pachuca			13982	177.1	20.3	162	7.54	86	664	64					940			17	Lopez-Garcia et al 2019
89	XRF	Pachuca			13312	165	20.4	150	4.61	77	613	57					933			12.3	Lopez-Garcia et al 2019
90	XRF	Pachuca			13418	165.4	20.1	150	5.6	80	622	55					865			14.3	Lopez-Garcia et al 2019
91	XRF	Pachuca			13570	164.8	21.3	152	7.23	79	628	59					943			15.5	Lopez-Garcia et al 2019
70	XRF	Paredón			7745.7	53.3	20.4	132	14.3	35	149	28					252			10.6	Lopez-Garcia et al 2019
71	XRF	Paredón			7814.4	53.45	18.9	128	15.1	35	145	27					263			9.51	Lopez-Garcia et al 2019
72	XRF	Paredón			7516	49.44	17.4	127	9.69	35	152	27					279			11.4	Lopez-Garcia et al 2019
73	XRF	Paredón			7718.9	48.28	17.1	129	14.8	38	147	26					245			12.5	Lopez-Garcia et al 2019
74	XRF	Paredón			7761.3	54.24	16.7	136	8.2	39	159	30					351			12.2	Lopez-Garcia et al 2019
75	XRF	Paredón			7261.2	48.62	17.6	126	12.5	33	139	26					191			10.2	Lopez-Garcia et al 2019
76	XRF	Paredón			7736.7	57.72	17.2	138	4.99	41	164	32					182			11	Lopez-Garcia et al 2019
25	XRF	San Martin Jilotepeque			6136.4	36.67	13.7	104	166	15	103	8.7					527			8.05	Lopez-Garcia et al 2019
26	XRF	San Martin Jilotepeque			6266.7	40.44	15.6	107	167	16	109	10					617			11.4	Lopez-Garcia et al 2019
27	XRF	San Martin Jilotepeque			6302.1	41.01	15.9	110	167	16	107	8.2					562			8.88	Lopez-Garcia et al 2019
77	XRF	Tulancingo			16137	148.2	20.1	104	14.1	74	563	35					351			8.83	Lopez-Garcia et al 2019
78	XRF	Tulancingo			16181	154.7	20.5	105	12.9	76	559	35					295			9.07	Lopez-Garcia et al 2019
79	XRF	Tulancingo			16164	159.4	23.3	105	11.6	75	561	37					377			8.76	Lopez-Garcia et al 2019
80	XRF	Tulancingo			17111	173	22.7	111	14.4	77	560	35					347			11.7	Lopez-Garcia et al 2019
81	XRF	Tulancingo			16108	162.1	20.1	109	14.3	74	546	35					270			9.27	Lopez-Garcia et al 2019
92	XRF	Zacualtipan			11423	45.41	23.9	296	37.6	48	225	17					158			36.4	Lopez-Garcia et al 2019
93	XRF	Zacualtipan			10375	43.86	19.8	275	35.1	46	209	17					209			30.3	Lopez-Garcia et al 2019

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
94	XRF	Zacualtipan			9352.9	34.32	19.2	213	31.8	35	158	12					100			22.9	Lopez-Garcia et al 2019
95	XRF	Zacualtipan			8783.2	33.35	16	213	27.5	34	151	11					97.3			24.7	Lopez-Garcia et al 2019
96	XRF	Zacualtipan			10429	48.77	18.2	271	36.2	44	212	17					199			30.4	Lopez-Garcia et al 2019
97	XRF	Zacualtipan			9189.1	30.99	15.7	222	30.9	36	162	13					119			25.5	Lopez-Garcia et al 2019
98	XRF	Zacualtipan			9589.5	45.41	18.8	271	32	47	203	18					135			31.3	Lopez-Garcia et al 2019
99	XRF	Zacualtipan			10335	45.44	21.4	270	35.3	48	217	18					203			33.2	Lopez-Garcia et al 2019
100	XRF	Zacualtipan			9273.6	42.5	16.2	215	30.2	35	160	13					126			29	Lopez-Garcia et al 2019
101	XRF	Zacualtipan			9527.5	38.58	16	224	32.5	34	163	13					140			26.1	Lopez-Garcia et al 2019
102	XRF	Zinapécuaro			6662.2	45.09	19	173	4.88	33	105	17					222			17.7	Lopez-Garcia et al 2019
103	XRF	Zinapécuaro			5928.9	36.94	15.2	144	11.3	22	77.6	12					115			9.72	Lopez-Garcia et al 2019
104	XRF	Zinapécuaro			6598	32.04	18.5	150	7.53	22	85.4	13					144			14.8	Lopez-Garcia et al 2019
105	XRF	Zinapécuaro			6378.8	43.87	17.5	148	8.07	24	86.1	12					67.5			12.7	Lopez-Garcia et al 2019
106	XRF	Zinapécuaro			6987.9	45.71	16.9	179	3.82	30	105	16					171			16.9	Lopez-Garcia et al 2019
107	XRF	Zinapécuaro			6533.3	37.85	15.9	153	8.82	23	87.3	12					87.9			14.8	Lopez-Garcia et al 2019
108	XRF	Zinapécuaro			6274.7	35.57	15.6	144	5.45	23	82.8	12					92.8			11.2	Lopez-Garcia et al 2019
109	XRF	Zinapécuaro			5107.7	17.3	18.3	110	4.91	17	65.9	12					95.4			5.06	Lopez-Garcia et al 2019
ERA002	XRF	Otumba			7896	39		132	143		139	16					357				Millhauser et al. 2011
ERA005	XRF	Otumba			7708	53		146	152		154	18					326				Millhauser et al. 2011
ERA006	XRF	Otumba			7741	34		125	136		143	16					321				Millhauser et al. 2011
ERA007	XRF	Otumba			7480	35		116	125		127	10					313				Millhauser et al. 2011
ERA010	XRF	Otumba			8347	38		125	143		145	13					341				Millhauser et al. 2011
ERA011	XRF	Otumba			8393	42		131	148		140	11					332				Millhauser et al. 2011

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
ERA014	XRF	Otumba			7976	35		129	134		133	12					337				Millhauser et al. 2011
ERA020	XRF	Otumba			8308	37		130	148		145	14					328				Millhauser et al. 2011
ERA022	XRF	Otumba			7774	32		120	137		129	12					318				Millhauser et al. 2011
ERA023	XRF	Otumba			7913	35		119	132		131	14					336				Millhauser et al. 2011
ERA024	XRF	Otumba			8393	37		119	133		128	8					331				Millhauser et al. 2011
ERA025	XRF	Otumba			8182	27		117	137		129	9					350				Millhauser et al. 2011
ERA026	XRF	Otumba			8119	40		122	137		129	12					346				Millhauser et al. 2011
ERA027	XRF	Otumba			8094	36		129	148		142	17					318				Millhauser et al. 2011
ERA028	XRF	Otumba			7655	40		129	141		136	14					329				Millhauser et al. 2011
ERA037	XRF	Otumba			7581	38		140	133		137	18					366				Millhauser et al. 2011
ERA045	XRF	Otumba			8101	49		128	148		152	18					320				Millhauser et al. 2011
ERA046	XRF	Otumba			7974	39		119	127		130	10					329				Millhauser et al. 2011
ERA047	XRF	Otumba			8347	39		145	164		160	20					341				Millhauser et al. 2011
ERA048	XRF	Otumba			8349	43		142	157		154	19					341				Millhauser et al. 2011
ERA057	XRF	Otumba			7724	45		138	156		144	17					313				Millhauser et al. 2011
ERA058	XRF	Otumba			7895	39		121	141		134	11					326				Millhauser et al. 2011
ERA063	XRF	Otumba			8711	41		135	146		148	18					354				Millhauser et al. 2011
ERA065	XRF	Otumba			7312	34		125	131		129	14					327				Millhauser et al. 2011
ERA068	XRF	Otumba			7762	42		139	151		147	15					349				Millhauser et al. 2011

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
ERA070	XRF	Otumba			8029	31		113	131		128	9					309				Millhauser et al. 2011
ERA079	XRF	Otumba			7920	41		120	141		139	15					329				Millhauser et al. 2011
ERA083	XRF	Otumba			8471	36		127	140		136	14					341				Millhauser et al. 2011
ERA088	XRF	Otumba			8014	38		127	140		139	16					355				Millhauser et al. 2011
ERA089	XRF	Otumba			8467	32		118	134		129	11					361				Millhauser et al. 2011
ERA090	XRF	Otumba			8642	46		133	141		140	12					373				Millhauser et al. 2011
ERA102	XRF	Otumba			7846	47		142	144		134	14					325				Millhauser et al. 2011
ERA103	XRF	Otumba			7569	36		128	128		132	10					316				Millhauser et al. 2011
ERA004	XRF	Oyameles-Zaragoza			8500	37		154	35		212	23					227				Millhauser et al. 2011
ERA001	XRF	Pachuca			14,919	230		215	-		982	80					957				Millhauser et al. 2011
ERA003	XRF	Pachuca			15,222	219		215	-		965	80					995				Millhauser et al. 2011
ERA008	XRF	Pachuca			14,812	221		210	9		949	75					971				Millhauser et al. 2011
ERA012	XRF	Pachuca			15,376	212		207	-		936	77					1022				Millhauser et al. 2011
ERA013	XRF	Pachuca			15,489	217		221	-		988	81					1030				Millhauser et al. 2011
ERA015	XRF	Pachuca			15,202	220		217	-		998	78					977				Millhauser et al. 2011
ERA016	XRF	Pachuca			14,381	216		198	-		906	75					928				Millhauser et al. 2011
ERA017	XRF	Pachuca			15,624	238		211	7		962	83					985				Millhauser et al. 2011
ERA018	XRF	Pachuca			15,389	228		218	-		995	80					1003				Millhauser et al. 2011
ERA019	XRF	Pachuca			14,776	213		199	-		895	70					951				Millhauser et al. 2011
ERA021	XRF	Pachuca			15,251	205		200	-		923	78					977				Millhauser et al. 2011
ERA029	XRF	Pachuca			15,561	234		216	-		969	77					1013				Millhauser et al. 2011
ERA030	XRF	Pachuca			15,406	213		207	-		952	80					995				Millhauser et al. 2011

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
ERA031	XRF	Pachuca			15,110	214		201	-		951	76					977				Millhauser et al. 2011
ERA032	XRF	Pachuca			15,135	235		201	-		945	79					982				Millhauser et al. 2011
ERA033	XRF	Pachuca			15,236	214		211	-		984	81					980				Millhauser et al. 2011
ERA034	XRF	Pachuca			15,609	202		195	7		925	73					1004				Millhauser et al. 2011
ERA035	XRF	Pachuca			15,257	205		199	-		915	76					986				Millhauser et al. 2011
ERA036	XRF	Pachuca			15,634	213		210	-		953	76					958				Millhauser et al. 2011
ERA038	XRF	Pachuca			14,992	198		195	-		938	73					978				Millhauser et al. 2011
ERA039	XRF	Pachuca			15,433	219		213	-		981	80					1002				Millhauser et al. 2011
ERA040	XRF	Pachuca			15,791	217		201	-		954	73					1029				Millhauser et al. 2011
ERA041	XRF	Pachuca			15,689	232		221	-		987	83					1026				Millhauser et al. 2011
ERA043	XRF	Pachuca			15,269	208		209	-		938	75					979				Millhauser et al. 2011
ERA044	XRF	Pachuca			16,054	224		201	-		931	76					1063				Millhauser et al. 2011
ERA050	XRF	Pachuca			15,992	193		209	-		937	75					999				Millhauser et al. 2011
ERA051	XRF	Pachuca			15,034	219		217	-		970	82					993				Millhauser et al. 2011
ERA052	XRF	Pachuca			14,764	222		216	14		1017	84					913				Millhauser et al. 2011
ERA053	XRF	Pachuca			15,275	214		212	-		971	79					967				Millhauser et al. 2011
ERA054	XRF	Pachuca			14,826	225		205	-		967	77					944				Millhauser et al. 2011
ERA055	XRF	Pachuca			15,470	207		200	-		951	77					1003				Millhauser et al. 2011
ERA059	XRF	Pachuca			15,642	221		202	-		962	75					1005				Millhauser et al. 2011
ERA060	XRF	Pachuca			15,314	192		191	-		932	73					955				Millhauser et al. 2011
ERA061	XRF	Pachuca			15,018	204		198	-		936	79					957				Millhauser et al. 2011
ERA062	XRF	Pachuca			15,750	216		197	-		948	76					1028				Millhauser et al. 2011

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
ERA067	XRF	Pachuca			15,422	210		188	-		903	76					1002				Millhauser et al. 2011
ERA071	XRF	Pachuca			14,876	260		225	-		993	85					1006				Millhauser et al. 2011
ERA072	XRF	Pachuca			15,489	222		212	-		977	76					1006				Millhauser et al. 2011
ERA073	XRF	Pachuca			15,528	222		205	-		933	75					1027				Millhauser et al. 2011
ERA074	XRF	Pachuca			15,566	199		195	-		921	73					1023				Millhauser et al. 2011
ERA075	XRF	Pachuca			15,640	210		200	-		926	72					1016				Millhauser et al. 2011
ERA076	XRF	Pachuca			15,226	190		199	-		937	74					1003				Millhauser et al. 2011
ERA077	XRF	Pachuca			15,613	200		212	-		968	80					991				Millhauser et al. 2011
ERA080	XRF	Pachuca			15,412	208		205	-		892	73					1006				Millhauser et al. 2011
ERA081	XRF	Pachuca			15,369	212		197	-		925	75					1001				Millhauser et al. 2011
ERA082	XRF	Pachuca			14,675	202		189	-		895	71					966				Millhauser et al. 2011
ERA084	XRF	Pachuca			15,626	228		205	-		943	74					1033				Millhauser et al. 2011
ERA085	XRF	Pachuca			16,258	251		231	-		1009	84					1049				Millhauser et al. 2011
ERA086	XRF	Pachuca			15,836	217		208	-		936	78					1026				Millhauser et al. 2011
ERA087	XRF	Pachuca			15,543	230		205	-		953	80					995				Millhauser et al. 2011
ERA091	XRF	Pachuca			15,519	225		214	-		981	79					989				Millhauser et al. 2011
ERA092	XRF	Pachuca			14,546	220		201	-		944	76					919				Millhauser et al. 2011
ERA093	XRF	Pachuca			15,539	220		214	-		978	79					1010				Millhauser et al. 2011
ERA094	XRF	Pachuca			15,720	259		210	-		994	86					1065				Millhauser et al. 2011
ERA096	XRF	Pachuca			14,875	201		211	-		980	82					991				Millhauser et al. 2011
ERA097	XRF	Pachuca			15,059	239		228	-		1041	91					959				Millhauser et al. 2011
ERA098	XRF	Pachuca			15,578	216		213	-		965	79					999				Millhauser et al. 2011

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
ERA099	XRF	Pachuca			15,096	214		213	-		969	84					993				Millhauser et al. 2011
ERA100	XRF	Pachuca			14,996	243		217	-		1011	80					960				Millhauser et al. 2011
ERA101	XRF	Pachuca			15,503	260		216	-		1016	79					1027				Millhauser et al. 2011
ERA066	XRF	San Juan de los Arcos			7,423	29		112	59		167	16					247				Millhauser et al. 2011
ERA069	XRF	Tulancingo			17,303	179		127	14		699	38					379				Millhauser et al. 2011
ERA009	XRF	Ucareo			6510	33		152	15		117	14					158				Millhauser et al. 2011
ERA049	XRF	Ucareo			6609	28		159	13		115	17					158				Millhauser et al. 2011
ERA078	XRF	Ucareo			6382	24		156	16		107	14					149				Millhauser et al. 2011
ERA095	XRF	Ucareo			6507	32		139	15		109	13					150				Millhauser et al. 2011
ERA056	XRF	Unknown			14,564	46		130	185		255	14					276				Millhauser et al. 2011
ERA064	XRF	Unknown			18,201	179		211	-		995	69					350				Millhauser et al. 2011
ERA042	XRF	Zacualtipan			9525	33		281	39		210	17					172				Millhauser et al. 2011
dep154	XRF	Boquillas						73	54	13	136	11									Pierce 2015
dep175	XRF	Boquillas						78	58	16	139	12									Pierce 2015
dep004	XRF	Ixtlán del Rio						87	80	13	135	19									Pierce 2015
dep011	XRF	Ixtlán del Rio						107	101	21	162	25									Pierce 2015
dep012	XRF	Ixtlán del Rio						117	94	22	163	19									Pierce 2015
dep018	XRF	Ixtlán del Rio						104	99	19	166	20									Pierce 2015
dep019	XRF	Ixtlán del Rio						120	109	23	171	21									Pierce 2015
dep028	XRF	Ixtlán del Rio						109	97	18	172	20									Pierce 2015
dep036	XRF	Ixtlán del Rio						97	90	21	161	18									Pierce 2015
dep038	XRF	Ixtlán del Rio						103	83	26	172	20									Pierce 2015

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
dep050	XRF	Ixtlán del Rio						108	89	17	149	12									Pierce 2015
dep051	XRF	Ixtlán del Rio						115	104	21	175	20									Pierce 2015
dep052	XRF	Ixtlán del Rio						122	99	17	177	18									Pierce 2015
dep053	XRF	Ixtlán del Rio						100	93	20	162	17									Pierce 2015
dep054	XRF	Ixtlán del Rio						126	110	19	160	16									Pierce 2015
dep056	XRF	Ixtlán del Rio						111	101	20	176	18									Pierce 2015
dep057	XRF	Ixtlán del Rio						116	103	22	169	21									Pierce 2015
dep058	XRF	Ixtlán del Rio						72	60	18	120	10									Pierce 2015
dep059	XRF	Ixtlán del Rio						104	96	22	170	21									Pierce 2015
dep060	XRF	Ixtlán del Rio						84	76	15	139	16									Pierce 2015
dep061	XRF	Ixtlán del Rio						81	76	20	145	14									Pierce 2015
dep084	XRF	Ixtlán del Rio						124	24	20	121	17									Pierce 2015
dep085	XRF	Ixtlán del Rio						92	81	19	147	15									Pierce 2015
dep105	XRF	Ixtlán del Rio						99	93	21	167	18									Pierce 2015
dep107	XRF	Ixtlán del Rio						104	87	21	164	19									Pierce 2015
dep126	XRF	Ixtlán del Rio						111	102	23	180	20									Pierce 2015
dep127	XRF	Ixtlán del Rio						111	109	22	180	19									Pierce 2015
dep131	XRF	Ixtlán del Rio						130	118	18	180	19									Pierce 2015
dep135a	XRF	Ixtlán del Rio						97	88	21	159	19									Pierce 2015
dep135b	XRF	Ixtlán del Rio						111	92	18	174	21									Pierce 2015
dep142	XRF	Ixtlán del Rio						107	101	22	164	17									Pierce 2015
dep153	XRF	Ixtlán del Rio						107	98	21	179	16									Pierce 2015

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
dep169	XRF	Ixtlán del Rio						111	86	17	166	18									Pierce 2015
dep171	XRF	Ixtlán del Rio						97	89	24	170	18									Pierce 2015
dep176	XRF	Ixtlán del Rio						103	100	23	178	20									Pierce 2015
dep177	XRF	Ixtlán del Rio						106	90	19	162	20									Pierce 2015
dep188	XRF	Ixtlán del Rio						108	87	21	166	17									Pierce 2015
dep189	XRF	Ixtlán del Rio						121	99	22	182	21									Pierce 2015
dep190	XRF	Ixtlán del Rio						108	84	22	172	15									Pierce 2015
dep194	XRF	Ixtlán del Rio						122	97	21	171	22									Pierce 2015
dep195	XRF	Ixtlán del Rio						103	103	21	174	18									Pierce 2015
dep196	XRF	Ixtlán del Rio						104	97	19	175	20									Pierce 2015
dep197	XRF	Ixtlán del Rio						97	92	24	174	18									Pierce 2015
dep198	XRF	Ixtlán del Rio						114	104	18	186	20									Pierce 2015
dep199	XRF	Ixtlán del Rio						106	96	24	174	21									Pierce 2015
dep006	XRF	La Joya						169	4	74	762	66									Pierce 2015
dep007	XRF	La Joya						179	5	80	784	71									Pierce 2015
dep009	XRF	La Joya						174	9	76	795	70									Pierce 2015
dep010	XRF	La Joya						196	4	90	756	67									Pierce 2015
dep013	XRF	La Joya						157	3	63	721	61									Pierce 2015
dep014	XRF	La Joya						169	3	70	758	64									Pierce 2015
dep015	XRF	La Joya						177	6	80	786	68									Pierce 2015
dep016	XRF	La Joya						173	6	68	744	68									Pierce 2015
dep017	XRF	La Joya						167	5	80	781	69									Pierce 2015

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
dep025	XRF	La Joya						130	9	82	755	80									Pierce 2015
dep029	XRF	La Joya						172	5	75	790	65									Pierce 2015
dep030	XRF	La Joya						196	6	84	798	56									Pierce 2015
dep032	XRF	La Joya						152	3	84	683	60									Pierce 2015
dep037	XRF	La Joya						178	7	80	806	66									Pierce 2015
dep049	XRF	La Joya						160	4	74	762	63									Pierce 2015
dep062	XRF	La Joya						156	6	75	730	59									Pierce 2015
dep063	XRF	La Joya						172	8	78	783	65									Pierce 2015
dep065	XRF	La Joya						143	5	68	688	53									Pierce 2015
dep066	XRF	La Joya						180	6	75	788	71									Pierce 2015
dep068	XRF	La Joya						210	4	103	841	82									Pierce 2015
dep077	XRF	La Joya						148	7	83	654	66									Pierce 2015
dep079	XRF	La Joya						151	8	84	693	77									Pierce 2015
dep086	XRF	La Joya						170	5	76	741	60									Pierce 2015
dep088	XRF	La Joya						154	7	86	670	65									Pierce 2015
dep093	XRF	La Joya						162	5	88	703	67									Pierce 2015
dep095	XRF	La Joya						186	7	81	843	70									Pierce 2015
dep096	XRF	La Joya						164	3	72	745	60									Pierce 2015
dep097	XRF	La Joya						173	4	80	797	61									Pierce 2015
dep098	XRF	La Joya						186	7	84	807	72									Pierce 2015
dep100	XRF	La Joya						128	12	71	716	67									Pierce 2015
dep109	XRF	La Joya						153	7	70	736	62									Pierce 2015

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
dep128	XRF	La Joya						169	4	72	751	65									Pierce 2015
dep129	XRF	La Joya						192	7	79	795	63									Pierce 2015
dep136	XRF	La Joya						182	5	77	812	72									Pierce 2015
dep137	XRF	La Joya						184	5	78	808	70									Pierce 2015
dep138	XRF	La Joya						162	6	65	773	66									Pierce 2015
dep139	XRF	La Joya						176	3	68	766	72									Pierce 2015
dep140	XRF	La Joya						171	5	72	751	66									Pierce 2015
dep147	XRF	La Joya						179	5	75	738	65									Pierce 2015
dep148	XRF	La Joya						160	4	67	751	69									Pierce 2015
dep149	XRF	La Joya						179	4	75	784	71									Pierce 2015
dep151	XRF	La Joya						173	3	78	739	64									Pierce 2015
dep157	XRF	La Joya						166	7	64	762	62									Pierce 2015
dep158	XRF	La Joya						177	6	81	801	64									Pierce 2015
dep159	XRF	La Joya						172	7	78	781	68									Pierce 2015
dep160	XRF	La Joya						165	4	70	747	65									Pierce 2015
dep162	XRF	La Joya						188	5	82	805	72									Pierce 2015
dep163	XRF	La Joya						178	5	84	774	59									Pierce 2015
dep164	XRF	La Joya						156	3	64	709	61									Pierce 2015
dep166	XRF	La Joya						162	7	76	750	59									Pierce 2015
dep167	XRF	La Joya						158	4	73	740	63									Pierce 2015
dep172	XRF	La Joya						168	5	73	747	64									Pierce 2015
dep173	XRF	La Joya						169	5	72	773	65									Pierce 2015

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
dep178	XRF	La Joya						154	3	73	707	58									Pierce 2015
dep179	XRF	La Joya						181	4	73	809	72									Pierce 2015
dep180	XRF	La Joya						187	7	84	819	71									Pierce 2015
dep181	XRF	La Joya						157	5	73	732	63									Pierce 2015
dep185	XRF	La Joya						170	6	78	814	63									Pierce 2015
dep186	XRF	La Joya						158	5	68	741	69									Pierce 2015
dep187	XRF	La Joya						176	8	75	795	65									Pierce 2015
dep200	XRF	La Joya						142	6	65	687	60									Pierce 2015
dep201	XRF	La Joya						179	8	81	803	63									Pierce 2015
dep026	XRF	Macrogroup 2						126	4	64	550	40									Pierce 2015
dep040	XRF	Macrogroup 2						155	5	61	636	53									Pierce 2015
dep041	XRF	Macrogroup 2						118	3	49	518	45									Pierce 2015
dep064	XRF	Macrogroup 2						123	9	48	522	45									Pierce 2015
dep101	XRF	Macrogroup 2						99	7	70	556	56									Pierce 2015
dep106	XRF	Macrogroup 2						141	1	61	611	45									Pierce 2015
dep141	XRF	Macrogroup 2						113	4	45	494	44									Pierce 2015
dep161	XRF	Macrogroup 2						134	6	56	569	45									Pierce 2015
dep165	XRF	Macrogroup 2						110	4	48	502	38									Pierce 2015
dep168	XRF	Macrogroup 2						103	5	51	522	41									Pierce 2015
dep174	XRF	Macrogroup 2						129	3	68	648	49									Pierce 2015
dep182	XRF	Macrogroup 2						121	2	56	575	53									Pierce 2015
dep035	XRF	Osotero						115	86	19	183	14									Pierce 2015

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
dep150	XRF	Osotero						113	104	21	187	13									Pierce 2015
dep202	XRF	Osotero						112	85	18	186	14									Pierce 2015
dep005	XRF	Pachuca						209	6	111	895	92									Pierce 2015
dep027	XRF	Pachuca						226	6	117	945	101									Pierce 2015
dep031	XRF	Pachuca						225	7	116	947	98									Pierce 2015
dep069	XRF	Pachuca						210	7	103	873	93									Pierce 2015
dep074	XRF	Pachuca						205	8	117	924	95									Pierce 2015
dep075	XRF	Pachuca						192	7	107	856	91									Pierce 2015
dep076	XRF	Pachuca						202	6	105	871	88									Pierce 2015
dep078	XRF	Pachuca						204	8	114	907	94									Pierce 2015
dep080	XRF	Pachuca						186	7	106	845	85									Pierce 2015
dep081	XRF	Pachuca						178	5	96	832	87									Pierce 2015
dep082	XRF	Pachuca						191	7	96	830	77									Pierce 2015
dep083	XRF	Pachuca						202	7	110	871	91									Pierce 2015
dep087	XRF	Pachuca						202	8	102	883	100									Pierce 2015
dep089	XRF	Pachuca						195	6	107	873	90									Pierce 2015
dep090	XRF	Pachuca						210	6	102	844	89									Pierce 2015
dep091	XRF	Pachuca						198	6	107	876	85									Pierce 2015
dep092	XRF	Pachuca						199	6	105	892	86									Pierce 2015
dep094	XRF	Pachuca						215	5	111	896	83									Pierce 2015
dep116	XRF	Pachuca						195	7	110	902	89									Pierce 2015
dep118	XRF	Pachuca						231	10	122	965	97									Pierce 2015

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
dep119	XRF	Pachuca						224	9	120	963	93									Pierce 2015
dep120	XRF	Pachuca						216	6	111	916	96									Pierce 2015
dep121	XRF	Pachuca						212	7	119	937	95									Pierce 2015
dep123	XRF	Pachuca						190	8	103	843	88									Pierce 2015
dep192	XRF	Pachuca						207	10	110	903	90									Pierce 2015
dep003	XRF	San Juan de los Arcos						120	55	19	162	20									Pierce 2015
dep055	XRF	San Juan de los Arcos						123	51	19	169	20									Pierce 2015
dep112	XRF	San Juan de los Arcos						116	48	16	153	18									Pierce 2015
dep113	XRF	San Juan de los Arcos						103	44	21	149	16									Pierce 2015
dep114	XRF	San Juan de los Arcos						106	45	21	157	17									Pierce 2015
dep117	XRF	San Juan de los Arcos						135	60	23	185	21									Pierce 2015
dep115	XRF	unassigned						155	16	31	149	14									Pierce 2015
dep152	XRF	unassigned						198	10	33	139	18									Pierce 2015
dep001	XRF	Volcán las Navajas						215	12	132	1182	122									Pierce 2015
dep002	XRF	Volcán las Navajas						180	11	119	1056	118									Pierce 2015
dep008	XRF	Volcán las Navajas						207	18	142	1217	133									Pierce 2015
dep020	XRF	Volcán las Navajas						191	15	133	1100	122									Pierce 2015
dep021	XRF	Volcán las Navajas						177	14	122	1104	114									Pierce 2015
dep022	XRF	Volcán las Navajas						183	17	141	1157	134									Pierce 2015
dep023	XRF	Volcán las Navajas						167	13	118	1010	118									Pierce 2015
dep024	XRF	Volcán las Navajas						163	15	110	964	109									Pierce 2015
dep033	XRF	Volcán las Navajas						199	14	140	1174	123									Pierce 2015

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
dep034	XRF	Volcán las Navajas						191	14	139	1098	117									Pierce 2015
dep039	XRF	Volcán las Navajas						165	13	120	1019	126									Pierce 2015
dep042	XRF	Volcán las Navajas						181	12	126	1089	118									Pierce 2015
dep044	XRF	Volcán las Navajas						176	14	121	1047	120									Pierce 2015
dep045	XRF	Volcán las Navajas						162	14	113	952	103									Pierce 2015
dep046	XRF	Volcán las Navajas						182	10	126	1050	116									Pierce 2015
dep047	XRF	Volcán las Navajas						169	20	129	1097	128									Pierce 2015
dep048	XRF	Volcán las Navajas						211	17	152	1236	125									Pierce 2015
dep070	XRF	Volcán las Navajas						181	13	133	1055	122									Pierce 2015
dep071	XRF	Volcán las Navajas						186	16	129	1108	129									Pierce 2015
dep072	XRF	Volcán las Navajas						143	11	95	902	96									Pierce 2015
dep073	XRF	Volcán las Navajas						145	11	111	899	98									Pierce 2015
dep099	XRF	Volcán las Navajas						224	11	156	1273	144									Pierce 2015
dep102	XRF	Volcán las Navajas						155	30	98	905	110									Pierce 2015
dep103	XRF	Volcán las Navajas						205	19	143	1217	142									Pierce 2015
dep108	XRF	Volcán las Navajas						188	14	146	1167	133	133								Pierce 2015
dep110	XRF	Volcán las Navajas						176	15	122	1097	120									Pierce 2015
dep122	XRF	Volcán las Navajas						205	12	152	1294	132									Pierce 2015
dep124	XRF	Volcán las Navajas						184	12	123	1020	97									Pierce 2015
dep125	XRF	Volcán las Navajas						175	11	115	973	97									Pierce 2015
dep132	XRF	Volcán las Navajas						200	9	141	1198	126									Pierce 2015
dep133	XRF	Volcán las Navajas						169	15	124	1041	113									Pierce 2015

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
dep134	XRF	Volcán las Navajas						161	12	129	1067	129									Pierce 2015
dep143	XRF	Volcán las Navajas						168	15	122	1019	113									Pierce 2015
dep144	XRF	Volcán las Navajas						162	14	127	990	108									Pierce 2015
dep145	XRF	Volcán las Navajas						192	17	132	1141	125									Pierce 2015
dep146	XRF	Volcán las Navajas						171	15	109	967	105									Pierce 2015
dep155	XRF	Volcán las Navajas						183	15	116	1043	120									Pierce 2015
dep156	XRF	Volcán las Navajas						143	15	112	927	98									Pierce 2015
dep170	XRF	Volcán las Navajas						159	15	109	954	106									Pierce 2015
dep183	XRF	Volcán las Navajas						182	12	129	1078	129									Pierce 2015
dep184	XRF	Volcán las Navajas						176	18	129	1108	124									Pierce 2015
dep191	XRF	Volcán las Navajas						152	13	105	931	103									Pierce 2015
OB1-10	INAA	El Paraiso											-	1194	33.4	3.68	234	3.56			Smith et. Al 2007
OB1-11	INAA	El Paraiso											-	1196	33.3	3.64	234	3.61			Smith et. Al 2007
OB1-18	INAA	El Paraiso											-	1233	33.1	3.43	237	3.62			Smith et. Al 2007
OB1-20	INAA	El Paraiso											-	1205	32.8	3.35	235	3.58			Smith et. Al 2007
OB8-142	INAA	El Paraiso											-	1193	30.5	3.7	230	3.56			Smith et. Al 2007
OB1-19	INAA	Fuentezuelas											37	899	18	3.63	232	3.33			Smith et. Al 2007
OB8-55	INAA	Fuentezuelas											-	701	14.9	3.46	202	2.92			Smith et. Al 2007
OB8-128	INAA	Fuentezuelas											-	743	16.5	3.8	220	3.2			Smith et. Al 2007
OB9-98	INAA	Fuentezuelas											-	851	17.3	3.91	234	3.38			Smith et. Al 2007
OB1-1	INAA	Otumba											773	406	3.47	3.14	395	3.05			Smith et. Al 2007
OB1-2	INAA	Otumba											828	401	3.71	3.09	387	2.99			Smith et. Al 2007

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
OB1-3	INAA	Otumba											819	442	3.21	3.41	389	2.99			Smith et. Al 2007
OB1-5	INAA	Otumba											705	409	4.09	3.18	390	3.05			Smith et. Al 2007
OB1-8	INAA	Otumba											818	442	3.09	3.12	390	2.99			Smith et. Al 2007
OB1-13	INAA	Otumba											823	471	2.66	3.33	393	3.06			Smith et. Al 2007
OB1-14	INAA	Otumba											817	416	2.88	3.21	396	3.08			Smith et. Al 2007
OB1-15	INAA	Otumba											652	407	3.81	3.21	389	3.02			Smith et. Al 2007
OB1-21	INAA	Otumba											656	349	3.22	3.14	393	3.03			Smith et. Al 2007
OB1-25	INAA	Otumba											800	361	2.94	3.1	387	3.03			Smith et. Al 2007
OB1-27	INAA	Otumba											765	340	3.56	3.06	390	3.02			Smith et. Al 2007
OB1-29	INAA	Otumba											686	525	3.73	3.26	385	2.96			Smith et. Al 2007
OB1-30	INAA	Otumba											754	377	3.38	3.28	386	2.97			Smith et. Al 2007
OB8-16	INAA	Otumba											701	349	2.88	3.31	380	2.94			Smith et. Al 2007
OB8-36	INAA	Otumba											709	384	3.26	3.33	384	2.98			Smith et. Al 2007
OB8-112	INAA	Otumba											728	416	3.19	3.29	379	2.97			Smith et. Al 2007
OB9-34	INAA	Otumba											726	357	3.6	3.55	390	2.97			Smith et. Al 2007
OB9-77	INAA	Otumba											790	349	3.4	3.58	404	3.12			Smith et. Al 2007
OB9-90	INAA	Otumba											781	380	3.18	3.58	398	3.08			Smith et. Al 2007
OB9-145	INAA	Otumba											866	433	2.8	3.4	401	3.13			Smith et. Al 2007
OB9-197	INAA	Otumba(?)											133	188	2.48	3.72	362	2.96			Smith et. Al 2007
OB1-6	INAA	Paredón											-	1061	8.52	3.91	363	2.93			Smith et. Al 2007
OB1-7	INAA	Paredón											63	906	8.3	3.9	362	2.91			Smith et. Al 2007
OB1-16	INAA	Paredón											-	920	9.05	3.87	361	2.89			Smith et. Al 2007

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
OB1-22	INAA	Paredón											96	1123	8.81	3.73	364	2.93			Smith et. Al 2007
OB1-26	INAA	Paredón											-	956	8.43	3.99	363	2.83			Smith et. Al 2007
OB8-31	INAA	Paredón											-	851	7.82	3.91	351	2.86			Smith et. Al 2007
OB8-69	INAA	Paredón											84	837	7.74	4.26	356	2.89			Smith et. Al 2007
OB8-136	INAA	Paredón											149	1028	8.13	4.35	368	2.99			Smith et. Al 2007
OB9-80	INAA	Paredón											-	946	7.86	4.16	367	2.98			Smith et. Al 2007
OB9-156	INAA	Paredón											-	1004	7.57	4.09	360	2.92			Smith et. Al 2007
OB9-96	INAA	Paredón(?)											284	570	6.74	4.16	334	3.56			Smith et. Al 2007
OB1-4	INAA	Sierra de Pachuca											-	1282	17.5	3.41	1164	3.93			Smith et. Al 2007
OB1-12	INAA	Sierra de Pachuca											-	1267	16.1	3.83	1145	3.85			Smith et. Al 2007
OB1-24	INAA	Sierra de Pachuca											-	1478	17.9	3.61	1144	3.79			Smith et. Al 2007
OB8-89	INAA	Sierra de Pachuca											-	1302	14.8	3.63	1107	3.71			Smith et. Al 2007
OB9-178	INAA	Sierra de Pachuca											-	1118	15	3.6	1057	3.54			Smith et. Al 2007
OB1-9	INAA	Ucaréo											133	331	4.5	3.94	166	2.72			Smith et. Al 2007
OB1-23	INAA	Ucaréo											131	326	4.72	4	166	2.64			Smith et. Al 2007
OB1-28	INAA	Ucaréo											140	355	4.64	3.93	167	2.77			Smith et. Al 2007
OB8-14	INAA	Ucaréo											98	277	3.83	3.84	155	2.66			Smith et. Al 2007
OB8-98	INAA	Ucaréo											137	322	3.5	4.08	156	2.73			Smith et. Al 2007
OB9-43	INAA	Ucaréo											127	393	4.19	4.08	176	2.85			Smith et. Al 2007
OB9-58	INAA	Ucaréo											125	348	3.82	4.12	175	2.82			Smith et. Al 2007
OB9-60	INAA	Ucaréo											168	348	3.85	4.11	171	2.8			Smith et. Al 2007
OB9-129	INAA	Ucaréo											171	328	3.91	4.08	172	2.79			Smith et. Al 2007

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
OB9-165	INAA	Ucaréo											156	338	3.78	4.1	165	2.83			Smith et. Al 2007
OB9-195	INAA	Ucaréo											200	387	3.67	4.53	169	2.86			Smith et. Al 2007
OB9-216	INAA	Ucaréo											113	353	3.86	4.05	177	2.87			Smith et. Al 2007
OB9-83	INAA	Zacualtipan											334	400	7.94	4.94	160	2.57			Smith et. Al 2007
OB1-17	INAA	Zaragoza											444	574	5.53	3.99	250	2.95			Smith et. Al 2007
OB8-85	INAA	Zaragoza											398	533	4.62	3.9	253	2.9			Smith et. Al 2007
OB9-14	INAA	Zaragoza											431	490	4.74	4.34	249	2.95			Smith et. Al 2007
OB9-57	INAA	Zaragoza											451	505	4.96	4.03	250	2.95			Smith et. Al 2007
OB9-132	INAA	Zaragoza											428	604	4.86	4.07	254	3			Smith et. Al 2007
LAC-01	XRF	Guadalupe Victoria	34694	752	6497	26	14	90	76	12	67	7					514				Williams 2012
LAC-02	XRF	Guadalupe Victoria	35629	519	4526	15	13	82	81	12	68	9					416				Williams 2012
LAC-12	XRF	Guadalupe Victoria	33151	684	4805	19	14	89	82	11	63	8					345				Williams 2012
LAC-18	XRF	Guadalupe Victoria	34722	398	4793	17	13	80	71	10	64	5					339				Williams 2012
LAC-25	XRF	Guadalupe Victoria	35677	568	4546	16	14	81	76	15	78	8					326				Williams 2012
LAC-26	XRF	Guadalupe Victoria	36284	643	3953	12	14	72	75	13	65	7					333				Williams 2012
LAC-29	XRF	Guadalupe Victoria	39171	760	4759	19	14	82	69	13	63	8					388				Williams 2012
LAC-31	XRF	Guadalupe Victoria	35880	592	4045	17	13	79	50	11	55	8					418				Williams 2012
DTW030	XRF	Guadalupe Victoria	33884	304	3953	15	12	70	67	10	58	7					288		22	6	Williams 2012
DTW034	XRF	Guadalupe Victoria	34325	317	4797	15	12	71	70	12	60	6					295		23	7	Williams 2012
DTW036	XRF	Guadalupe Victoria	33666	460	5046	16	14	79	69	10	66	6					301		24	7	Williams 2012
LAC-28	XRF	Malpais	35514	712	7382	31	15	99	90	20	94	12					278				Williams 2012
LAC-11	XRF	Otumba	34475	892	7472	38	14	114	161	13	117	10					221				Williams 2012

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
LAC-13	XRF	Otumba	35593	849	8684	31	15	110	137	22	132	13					187				Williams 2012
LAC-36	XRF	Otumba	34250	545	9998	32	14	114	146	15	133	9					89				Williams 2012
DTW008	XRF	Otumba	34621	744	7726	28	15	110	129	19	130	11					222		22	8	Williams 2012
DTW029	XRF	Otumba	34859	534	8716	26	14	96	128	17	126	8					161		25	9	Williams 2012
DTW032	XRF	Otumba	35111	498	8056	24	14	96	132	19	126	10					216		24	8	Williams 2012
DTW037	XRF	Otumba	33632	406	8635	24	14	104	139	16	129	7					101		24	7	Williams 2012
DTW038	XRF/NAA	Otumba	32628	370	10378	27	14	94	96	20	134	8					0		25	7	Williams 2012
DTW041	XRF	Otumba	32682	315	10573	24	14	89	100	19	122	6					87		21	7	Williams 2012
DTW035	XRF	Pachuca	25546	220	14210	112	23	150	6	86	784	66					520		29	16	Williams 2012
LAC-05	XRF	Paredón	38010	374	7911	37	16	89	32	12	50	8					165				Williams 2012
LAC-14	XRF	Paredón	35852	537	7822	34	16	141	9	37	177	31					203				Williams 2012
LAC-17	XRF	Paredón	35586	611	7813	41	17	148	11	43	186	32					250				Williams 2012
LAC-03	XRF	Pico de Orizaba	35735	374	5056	16	14	94	29	11	47	8					323				Williams 2012
LAC-04	XRF	Pico de Orizaba	35814	556	3928	17	14	89	32	12	50	8					343				Williams 2012
LAC-06	XRF	Pico de Orizaba	37995	523	3817	18	13	81	31	12	50	9					320				Williams 2012
LAC-07	XRF	Pico de Orizaba	34695	654	3925	17	13	94	33	12	54	8					416				Williams 2012
LAC-08	XRF	Pico de Orizaba	37179	542	4170	16	14	83	32	12	47	6					470				Williams 2012
LAC-09	XRF	Pico de Orizaba	37052	768	3053	19	14	82	30	17	51	9					424				Williams 2012
LAC-15	XRF	Pico de Orizaba	35998	443	4870	20	13	104	33	10	47	9					429				Williams 2012
LAC-19	XRF	Pico de Orizaba	36303	512	3569	16	13	91	31	14	52	9					412				Williams 2012
LAC-20	XRF	Pico de Orizaba	35638	454	3755	13	13	91	32	13	51	8					404				Williams 2012
LAC-21	XRF	Pico de Orizaba	35391	457	4747	18	13	88	43	12	54	8					401				Williams 2012

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
LAC-22	XRF	Pico de Orizaba	36214	411	4818	19	14	104	41	13	58	7					288				Williams 2012
LAC-23	XRF	Pico de Orizaba	33888	456	4403	17	13	91	30	12	59	8					261				Williams 2012
LAC-24	XRF	Pico de Orizaba	36838	760	3941	13	13	88	36	13	62	9					463				Williams 2012
LAC-27	XRF	Pico de Orizaba	34459	550	4326	17	14	97	32	9	55	9					478				Williams 2012
LAC-30	XRF	Pico de Orizaba	36063	386	4069	16	13	82	34	12	50	9					358				Williams 2012
LAC-32	XRF	Pico de Orizaba	36032	602	339	16	14	87	34	12	50	10					366				Williams 2012
LAC-33	XRF	Pico de Orizaba	35586	373	4526	20	14	101	32	13	50	8					471				Williams 2012
LAC-34	XRF	Pico de Orizaba	33841	608	3676	15	13	94	35	13	50	8					370				Williams 2012
LAC-35	XRF	Pico de Orizaba	36879	757	3248	16	14	85	36	12	58	8					409				Williams 2012
LAC-37	XRF	Pico de Orizaba	36493	519	4134	16	13	91	36	12	49	8					348				Williams 2012
LAC-39	XRF	Pico de Orizaba	36011	550	3626	16	13	94	35	20	53	11					396				Williams 2012
LAC-40	XRF	Pico de Orizaba	34768	507	4225	17	13	91	39	22	57	7					381				Williams 2012
DTW040	XRF	Pico de Orizaba	33268	367	5474	14	13	90	14	11	71	5					82		21	9	Williams 2012
LAC-16	XRF	PT	35070	524	9114	36	15	128	155	18	129	12					187				Williams 2012
DTW002	XRF	Ucaréo	35535	532	7686	24	15	134	18	21	118	9					71		23	10	Williams 2012
DTW003	XRF	Ucaréo	34571	466	7470	26	14	140	17	20	112	9					87		27	13	Williams 2012
DTW004	XRF	Ucaréo	35126	491	7520	24	15	129	17	22	108	9					85		26	12	Williams 2012
DTW006	XRF	Ucaréo	35095	563	7143	24	15	133	20	21	116	11					127		23	13	Williams 2012
DTW007	XRF	Ucaréo	35772	436	7641	22	14	130	21	18	114	10					0		25	13	Williams 2012
DTW009	XRF	Ucaréo	35024	447	8119	28	15	134	17	19	105	11					131		26	11	Williams 2012
DTW010	XRF	Ucaréo	36278	447	7478	25	15	129	20	23	113	10					154		22	11	Williams 2012
DTW012	XRF	Ucaréo	35476	630	7809	27	15	131	16	21	123	12					112		22	9	Williams 2012

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
DTW013	XRF	Ucaréo	35624	508	7198	25	14	141	15	22	105	9					134		24	13	Williams 2012
DTW015	XRF	Ucaréo	37393	482	6830	22	14	136	19	20	106	8					62		23	13	Williams 2012
DTW016	XRF	Ucaréo	36823	338	7329	31	15	135	18	19	104	10					53		24	12	Williams 2012
DTW017	XRF/NAA	Ucaréo	34809	560	7655	24	14	132	17	20	150	9					67		24	11	Williams 2012
DTW018	XRF	Ucaréo	36986	510	7223	31	15	140	23	20	117	12					112		27	13	Williams 2012
DTW019	XRF	Ucaréo	36991	509	8042	33	15	151	23	19	117	9					86		26	15	Williams 2012
DTW020	XRF	Ucaréo	36210	585	7227	25	15	128	24	25	118	10					46		23	11	Williams 2012
DTW021	XRF	Ucaréo	34472	725	7466	28	14	128	21	19	120	9					126		29	13	Williams 2012
DTW022	XRF	Ucaréo	36464	482	7577	27	14	122	18	24	107	9					180		27	9	Williams 2012
DTW023	XRF	Ucaréo	35341	427	7344	23	14	128	18	20	105	10					55		26	10	Williams 2012
DTW024	XRF	Ucaréo	34909	403	7240	24	14	124	16	20	106	10					192		26	12	Williams 2012
DTW025	XRF	Ucaréo	35224	445	7146	20	12	123	18	19	106	9					198		23	9	Williams 2012
DTW026	XRF	Ucaréo	36280	269	7330	21	13	117	18	20	109	8					86		26	10	Williams 2012
DTW027	XRF	Ucaréo	35742	243	6684	21	14	117	12	19	96	11					42		24	10	Williams 2012
DTW028	XRF	Ucaréo	35760	285	7399	20	14	120	20	19	101	10					2		24	10	Williams 2012
DTW031	XRF	Ucaréo	36154	360	6509	18	14	118	25	16	95	9					88		23	10	Williams 2012
DTW042	XRF	Ucaréo	33945	245	7983	21	13	112	13	14	86	7					0		23	8	Williams 2012
LAC-10	XRF	Zaragoza	36743	664	8452	30	15	123	28	25	174	14					85				Williams 2012
LAC-38	XRF	Zaragoza	35607	573	10351	36	15	131	37	25	201	13					157				Williams 2012
DTW001	XRF	Zaragoza	35618	626	8583	37	15	130	31	27	175	13					214		27	16	Williams 2012
DTW005	XRF	Zaragoza	35423	698	8116	27	15	121	33	27	184	13					157		26	16	Williams 2012
DTW011	XRF	Zaragoza	36798	739	8150	32	16	121	40	30	174	13					234		26	16	Williams 2012

Sample Artifact #	XRF/ INAA	Source	K	Ti	Fe	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Cl	Dy	K(%)	Mn	Na(%)	Pb	Th	Article Source
DTW014	XRF	Zaragoza	36875	528	9167	38	16	131	31	30	178	15					106		26	12	Williams 2012
DTW033	XRF	Zaragoza	36929	350	9080	28	15	111	24	28	162	14					101		25	10	Williams 2012
DTW039	XRF	Zaragoza	33648	345	8866	27	14	103	26	22	151	10					3		29	11	Williams 2012

APPENDIX B

VESTER COLLECTION OBSIDIAN ELEMENTAL READINGS

Artifact Number	Artifact Type	K	Ti	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Cl	Mn	Pb	Th
F.1386.T27.5863.2	Projectile Point	31478.83	738.61	16279.77	214.01	113.69	2.15	122.09	1095.13	97	< LOD	1368.49	1267.49	26.67	19.62
F.1386.T27.5878.1	Worked Fragment	48477.69	721.28	15557.84	216.45	115.53	2.16	118.98	1098.73	97.38	< LOD	1093.45	1207.67	27.25	21.23
F.1386.C25.5843.4	Polyhedral Core	43555.59	< LOD	11561.23	51.26	155.36	28.06	37.11	204.69	19.49	233.17	1299.58	< LOD	19.08	20.43
F.1386.C25.5843.2	Polyhedral Core	38200.64	< LOD	19981.43	272.52	229.82	< LOD	134.69	1092.28	101.33	< LOD	2258.7	1339.36	34.43	< LOD
F.1386.C25.5843.3	Polyhedral Core	32964.13	750.99	16994.94	228.63	119.84	2	121.99	1123.58	99.39	< LOD	1441.65	1151.38	30.17	19.24
F.1386.C25.5843.5	Polyhedral Core	32023.75	693.38	16003.12	217.79	113.25	1.88	117.73	1085.27	96.7	< LOD	1688.51	1123.1	26.19	20.46
F.1386.C25.5843.1	Polyhedral Core	36135.52	433.07	8382.12	48.92	96.78	4.79	49.08	230.98	45.9	< LOD	999.9	373.7	17.19	18.68
F.1386.T27.58112.1	Figurine (Anthropomorphic)	42626.47	< LOD	11190.75	32.07	156.85	26.61	34.01	211.22	19.35	< LOD	585.09	< LOD	17.4	19.71
F.1386.5841.1	Abrader/"Spokeshaver" Scraper	82248.12	< LOD	8942.01	36.16	195.66	12.59	25.27	144.41	16.81	< LOD	969.73	554.01	13.31	12.97
F.1386.5841.2	Abrader/Scraper	48511.84	< LOD	11596.43	83.74	350.11	6.04	63.31	166.01	59.7	< LOD	1410.24	716.59	34.29	36.78
F.1386.5841.3	Scraper	30709.4	< LOD	13207.03	54.61	147.85	120.84	29.21	182.46	14.18	224.45	658.36	< LOD	20.94	< LOD
F.1386.C25.58471.1	"Spokeshaver" Scraper	42952.53	< LOD	9265.24	32.26	196.08	11.44	29.9	135.49	18.88	< LOD	922.7	830.1	18.36	17.31
F.1386.58471.2	"Spokeshaver" Scraper	47538.26	< LOD	7876.19	25.5	161.28	11.02	25.57	124.92	14.58	< LOD	582.79	< LOD	19.01	7.22
F.1386.58471.3	"Spokeshaver" Scraper	66225.83	< LOD	8289.78	30.27	192.24	11.86	24.1	120.55	15.73	< LOD	2817.3	592.69	20.04	16.01
F.1386.58471.4	"Spokeshaver" Scraper	39423	< LOD	12119.2	54.66	136.72	112.97	28.17	177.74	9.5	481.07	1797.6	< LOD	20.34	< LOD
F.1386.58471.5	"Spokeshaver" Scraper	37667.48	< LOD	19615.83	258.52	230.22	< LOD	136.84	1102.27	102.66	< LOD	2768.96	1514.23	34.14	< LOD
F.1386.58471.6	"Spokeshaver" Scraper	36276.79	< LOD	8836.77	44.64	172.63	13.94	24.54	136.59	14	< LOD	1605.93	497.97	16.24	15.27
F.1386.58471.7	"Spokeshaver" Scraper	76426.45	< LOD	15063.13	192.14	252.06	2.8	122.56	1047.86	96.66	< LOD	1516.85	1070.93	29.49	< LOD
F.1386.T27.5861.1	Projectile Point	56305.75	< LOD	10530.15	37.49	71.59	107.68	22.52	171.03	10.64	503.61	< LOD	< LOD	13.51	10.5
F.1386.T27.5861.2	Projectile Point	46607.12	626.29	8698.73	48.07	68.63	128.05	18.13	153.68	13.34	469.51	452.54	< LOD	23.26	10.92
F.1386.T27.5861.3	Projectile Point	35418.98	536.95	9213	27.87	78.92	27.62	30.73	207.73	17.04	314.46	586.82	< LOD	16.67	19.67
F.1386.T27.5861.4	Projectile Point	31325.83	< LOD	19114.18	240.09	127.48	< LOD	189.28	1329.92	61.45	< LOD	1116.83	364.65	42.4	26.47

Artifact Number	Artifact Type	K	Ti	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Cl	Mn	Pb	Th
F.1386.T27.5861.5	Projectile Point	34217.72	457.11	8382.12	26.49	66.21	53.6	16.85	181.33	21.01	377.58	427.4	< LOD	14.14	13.47
F.1386.T27.5861.6	Projectile Point	33887.21	790.89	16618.38	231.79	118.35	2.21	127.01	1144.44	100.81	< LOD	1869.53	1196.48	33.71	20.55
F.1386.T27.5861.7	Projectile Point	29879.43	< LOD	11756.83	45.03	73.14	112.69	24.16	181.12	11.8	458.65	380.28	< LOD	13.77	10.02
F.1386.T27.5861.8	Projectile Point	58572.34	< LOD	6710.79	28.92	85.76	11.67	22.03	126.56	14.26	50.26	177.94	< LOD	16.5	11.45
F.1386.T27.5861.9	Projectile Point	29693.72	571.55	12911.31	48.89	77.68	120.2	25.09	190.01	12	411.2	398.18	< LOD	38.31	10.32
F.1386.T27.5861.10	Projectile Point	33620.26	< LOD	6767.08	27.25	106.06	3.88	29.29	110.28	18.21	< LOD	525.79	362.7	17.1	14.55
F.1386.T27.5861.11	Projectile Point	34176.55	< LOD	7819.8	30.5	84.04	13.05	21.39	135.9	12.77	77.88	197.07	< LOD	17.08	12.3
F.1386.T27.5861.12	Projectile Point	29645.37	543.93	12047.77	42.86	74.07	116.87	25.6	183.83	10.97	395.26	1424.24	< LOD	15.02	9.85
F.1386.T27.5861.13	Projectile Point	53430.01	566.41	12225.05	46.18	76.28	115.91	24.86	183.47	10.64	368.49	264.37	< LOD	15.91	9.89
F.1386.T27.5861.14	Projectile Point	33402.04	741.79	16622.87	229.51	119.2	1.81	122.56	1130.34	100.88	< LOD	1196.39	1254.66	27.49	26.28
F.1386.T27.5861.15	Projectile Point	42138.08	< LOD	12711.21	107.54	75.17	< LOD	85.97	604.3	32.62	< LOD	1109.42	346.97	19.05	16.08
F.1386.T27.5861.16	Projectile Point	32281.41	< LOD	10139.08	69.04	140.09	< LOD	64.56	392.99	19.87	< LOD	540.39	< LOD	15.73	< LOD
F.1386.T27.5861.17	Projectile Point	27011.66	< LOD	13518.92	109.29	140.05	< LOD	98.79	655.52	34.12	< LOD	825.85	< LOD	23.98	< LOD
F.1386.T27.5861.18	Projectile Point	34153.65	< LOD	14490.46	147.7	102.98	< LOD	107.3	769.75	35.11	< LOD	1480.95	364.49	24.83	24.09
F.1386.T27.5861.19	Projectile Point	32129.63	506.57	11774.07	44.35	71.48	113.32	25.44	181.97	10.65	533.47	1305.57	< LOD	18.26	6.55
F.1386.T27.5861.20	Projectile Point	23866.18	< LOD	17287.02	65.9	87.17	97.14	48.2	367.29	10.96	605.75	537.65	< LOD	9.74	< LOD
F.1386.T27.5861.21	Projectile Point	40983.23	< LOD	7838.98	42.66	127.16	117.41	18.37	142.22	11.95	607.8	1103.42	< LOD	17.39	< LOD
F.1386.T27.5861.22	Projectile Point	59484.36	< LOD	13850.91	61.49	144.79	119.78	29.81	182.13	11.89	338.08	266.44	< LOD	16.15	8.06
F.1386.T27.5861.23	Projectile Point	36477.55	< LOD	7436.26	27.71	88.62	11.16	21.8	126.4	13.7	< LOD	832.26	403.68	16.34	11.08
F.1386.T27.5861.24	Projectile Point	37656.64	< LOD	17309.01	186.17	206.18	< LOD	116.35	759.12	39.47	< LOD	2478.03	< LOD	30.17	< LOD
F.1386.T27.5861.25	Projectile Point	39678.94	1613.9	20831.79	292.69	238.88	2.38	141.17	1124.42	101.91	< LOD	1463.15	1729.56	76.37	< LOD
F.1386.T27.5861.26	Projectile Point	14831.31	5408.7	29853.09	185.7	100.22	316.99	27.65	122.52	26.96	640.29	266.74	< LOD	33.26	11.74

Artifact Number	Artifact Type	K	Ti	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Cl	Mn	Pb	Th
F.1386.T27.5861.27	Projectile Point	43046.68	< LOD	9668.04	35.08	182.45	11.56	23.69	121.07	19.21	< LOD	483.11	< LOD	19.2	15.77
F.1386.T27.5861.28	Projectile Point	44781.89	644.85	9025.51	38.31	72.47	123.92	19.69	151.46	12.93	599.85	882.26	< LOD	19.74	9.78
F.1386.T27.5861.29	Projectile Point	29957.1	< LOD	7934.3	19.32	60.41	92.51	13.08	188.01	14.59	525.91	2177.9	< LOD	15.35	9.74
F.1386.T27.5861.30	Projectile Point	37921	549.76	9603.68	30.25	82.95	28.01	32.23	220.03	17.01	266.2	390.29	< LOD	17.31	22.09
F.1386.T27.5861.31	Projectile Point	30877.36	539.59	16530.3	125.51	68.1	< LOD	60.03	609.62	42.03	< LOD	4074.14	488.82	20.75	12.08
F.1386.T27.5861.32	Projectile Point	54791.16	634.36	14933.33	202	123.46	< LOD	119.85	1090.26	98.44	< LOD	946.87	1237.51	25.3	16.78
F.1386.T27.5861.33	Projectile Point	33463.86	778.05	16384.81	215.13	117.45	< LOD	123.72	1121.72	98.22	< LOD	1140.49	1264.12	27.59	17.95
F.1386.T27.5861.34	Projectile Point	33873.5	766.52	16484.72	216.77	117.48	< LOD	126.31	1135	100.14	< LOD	1658.09	1416.44	27.73	17.82
F.1386.T27.5861.35	Projectile Point	32665.35	< LOD	13689.48	114.66	75.91	< LOD	87.68	645.21	33.82	< LOD	1403.37	475.91	19.11	16.36
F.1386.T27.5861.36	Projectile Point	40950.12	< LOD	7092.64	27.38	83.49	11.09	20.82	130.24	13.21	46.58	54.86	< LOD	16.22	11.69
F.1386.T27.5861.37	Projectile Point	35798.25	< LOD	7265.55	21.56	87.3	10.4	21.22	124.68	14.22	< LOD	881.15	299.31	15.6	13.21
F.1386.T27.5861.38	Projectile Point	33728.46	421.73	14087.08	124.51	79.27	< LOD	90.12	677.77	32.55	< LOD	892.4	450.91	21.31	21.11
F.1386.T27.5861.40	Projectile Point	32782.63	< LOD	6624.14	26.12	81.5	9.26	21	115.92	13.48	< LOD	619.16	361.24	15.73	12.39
F.1386.T27.5861.41	Projectile Point	29624.18	< LOD	11778.68	45.06	72.22	112.09	24.21	176.52	12.06	518.7	140.15	< LOD	14.47	11.42
F.1386.T27.5861.42	Projectile Point	55179.6	< LOD	7453.84	23.71	170.62	12.73	28.41	128.22	14.49	< LOD	679.32	640.22	20.49	13.96
F.1386.T27.5861.43	Projectile Point	36518.93	< LOD	8161.26	20.37	160.6	11.07	23.07	126.05	14.2	< LOD	310.31	< LOD	21.73	12.84
F.1386.T27.5861.44	Projectile Point	36275.23	< LOD	9314.28	53.88	183.18	4.13	56.93	227.49	43.48	< LOD	2100.74	577.66	22.85	11.36
F.1386.T27.5861.45	Projectile Point	46384.55	763.09	16580.32	215.67	120.1	1.58	126.97	1156.93	102	< LOD	1027.26	1445.55	26.76	19.32
F.1386.T27.5861.46	Projectile Point	39350.51	487.53	11740	45.4	74.12	115.93	23.98	181.76	10.34	478.3	328.97	< LOD	15.22	7.68
F.1386.T27.5861.48	Projectile Point	22304.93	< LOD	9511.93	21.35	114.57	96.68	27.66	159.65	7.89	482.37	284.02	< LOD	14.01	< LOD
F.1386.T27.5861.49	Projectile Point	41441.16	516.42	11785.99	62.28	72.3	114.37	26.53	183.69	9.03	494.33	616.29	< LOD	22.41	9.25
F.1386.T27.5861.50	Projectile Point	29841.79	607.52	8634.27	32.69	68.28	127.64	19.77	155.69	12.18	509.07	723.23	< LOD	16.15	9.17

Artifact Number	Artifact Type	K	Ti	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Cl	Mn	Pb	Th
F.1386.T27.5861.51	Projectile Point	25678.34	< LOD	10115.77	46.37	64.85	102.69	21.94	169.68	7.99	475.2	1096.85	< LOD	17.09	7.08
F.1386.T27.5861.52	Projectile Point	30228.97	670.51	13222.61	58.92	75.89	120.5	25.08	193.32	10.69	386.21	565.43	< LOD	19.68	7.02
F.1386.T27.5861.53	Projectile Point	29526.54	633.55	12508	59.99	74.81	116.7	23.64	189.47	10.94	456.14	434.56	< LOD	21.25	10.46
F.1386.T27.5861.54	Projectile Point	29602.17	< LOD	11532.42	41.86	72.3	114.28	23.82	177.71	11.86	400.85	127.02	< LOD	14.16	8.47
F.1386.T27.5861.55	Projectile Point	50397.64	< LOD	9950.14	32.58	127.37	101.84	26.53	163.7	10.47	512.73	364.75	< LOD	16.44	< LOD
F.1386.T27.5861.56	Projectile Point	30170.86	< LOD	12106.92	42.25	73.99	115.34	25.95	182.86	10.01	556.19	108.95	< LOD	18.09	8.58
F.1386.T27.5861.57	Projectile Point	31020.83	< LOD	9067.76	33.69	59.63	79.48	29.45	129.74	9.09	378.91	519.91	< LOD	14.25	10.02
F.1386.T27.5861.58	Projectile Point	48637.82	< LOD	6496.77	21.97	83.39	9.83	20.64	117.62	12.97	< LOD	228.54	290.84	14.61	11.04
F.1386.T27.5861.59	Projectile Point	43768.64	808.18	9637.64	59.75	72.09	126.3	19.54	151.86	13.83	513.08	862.44	< LOD	28.31	10.16
F.1386.T27.5861.60	Projectile Point	29437.01	536.22	11821.53	40.76	70.6	111.66	24.63	180.26	9.59	537.4	414.38	< LOD	15.54	9.9
F.1386.T27.5861.61	Projectile Point	38754.33	600.65	9223.65	41.41	72.48	135.32	19.69	159.56	12.65	530.47	119.52	< LOD	18.77	11.39
F.1386.C25.5822.2	Ear Plug	43626.87	< LOD	30476.74	256.38	214.16	< LOD	140.71	1301.73	60.65	< LOD	1492.31	723.62	30.88	< LOD
UR 42-22	Ear Plug	32341.18	< LOD	7039.85	< LOD	277.83	< LOD	20.16	91.13	12.77	< LOD	1461.27	< LOD	32.83	32.07
UR 42-25	Ear Plug	46375.98	1593.6	30139.19	205.03	177.36	< LOD	94.14	620.17	29.96	< LOD	1389.88	1088.72	28.97	10.31
F.1386.T27.5863.1	Projectile Point	26660.87	678.69	9363.28	41.38	77	30.02	29.16	203.04	17.85	143.48	1652.54	237.32	22.46	19.52

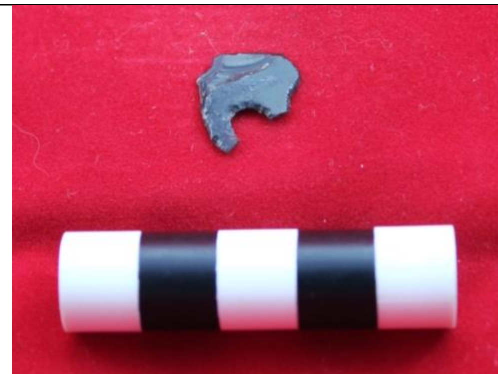
APPENDIX C

VESTER OBSIDIAN PICTURES

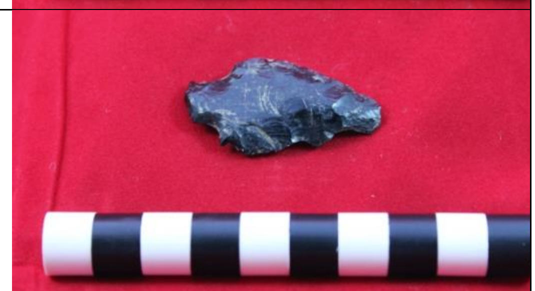
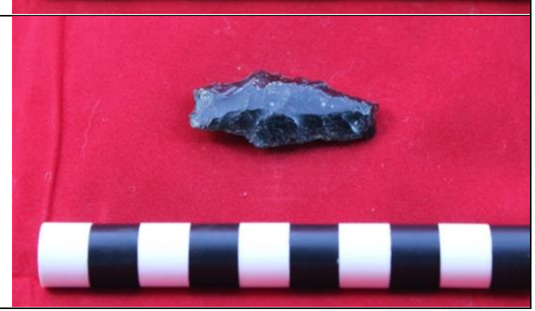
Artifact Number	Artifact Type	Photo
F.1386.T27.5863.1	Projectile Point	
F.1386.T27.5863.2	Projectile Point	
F.1386.T27.5878.1	Worked Fragment	
F.1386.C25.5843.1	Polyhedral Core	

F.1386.C25.5843.2	Polyhedral Core (Pachuca)	
F.1386.C25.5843.3	Polyhedral Core	
F.1386.C25.5843.4	Polyhedral Core	
F.1386.C25.5843.5	Polyhedral Core	

F.1386.T27.58112.1	Anthropomorphic Figurine	
F.1386.5841.1	Abrader/"Spokeshaver" Scraper (Zacualtipan)	
F.1386.5841.2	Abrader/Scraper	
F.1386.5841.3	Scraper	

F.1386.58471.1	"Spokeshaver" Scraper (Zacualtipan)	
F.1386.58471.2	"Spokeshaver" Scraper	
F.1386.58471.3	"Spokeshaver" Scraper	
F.1386.58471.4	"Spokeshaver" Scraper (Zaragoza)	

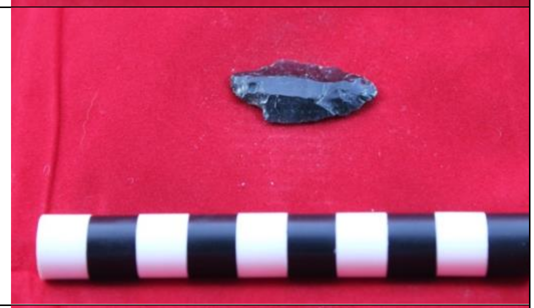
F.1386.58471.5	"Spokeshaver" Scraper (Pachuca)	
F.1386.58471.6	"Spokeshaver" Scraper	
F.1386.58471.7	"Spokeshaver" Scraper	
F.1386.T27.5861.1	Projectile Point	

F.1386.T27.5861.2	Projectile Point	
F.1386.T27.5861.3	Projectile Point	
F.1386.T27.5861.4	Projectile Point	
F.1386.T27.5861.5	Projectile Point	
F.1386.T27.5861.6	Projectile Point	

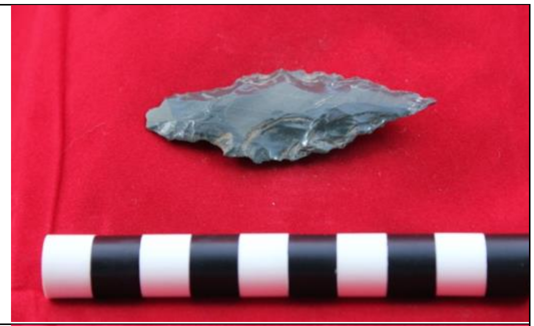
F.1386.T27.5861.7	Projectile Point	
F.1386.T27.5861.8	Projectile Point	
F.1386.T27.5861.9	Projectile Point	
F.1386.T27.5861.10	Projectile Point (Otumba)	
F.1386.T27.5861.11	Projectile Point (Ixtlán del Rio)	

F.1386.T27.5861.12	Projectile Point	
F.1386.T27.5861.13	Projectile Point	
F.1386.T27.5861.14	Projectile Point	
F.1386.T27.5861.15	Projectile Point	
F.1386.T27.5861.16	Projectile Point	

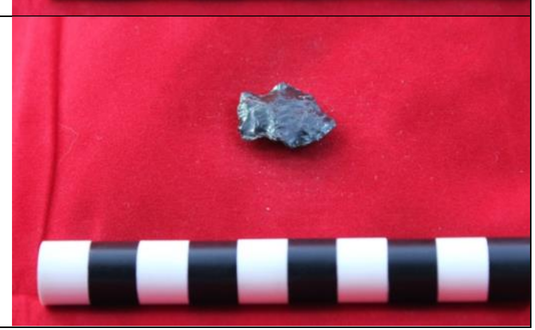
F.1386.T27.5861.17	Projectile Point	
F.1386.T27.5861.18	Projectile Point	
F.1386.T27.5861.19	Projectile Point	
F.1386.T27.5861.20	Projectile Point	
F.1386.T27.5861.21	Projectile Point (Otumba)	

F.1386.T27.5861.22	Projectile Point	
F.1386.T27.5861.23	Projectile Point	
F.1386.T27.5861.24	Projectile Point	
F.1386.T27.5861.25	Projectile Point (Pachuca)	
F.1386.T27.5861.26	Projectile Point (Otumba)	

F.1386.T27.5861.27	Projectile Point	
F.1386.T27.5861.28	Projectile Point	
F.1386.T27.5861.29	Projectile Point	
F.1386.T27.5861.30	Projectile Point	

F.1386.T27.5861.31	Projectile Point	
F.1386.T27.5861.32	Projectile Point	
F.1386.T27.5861.33	Projectile Point	
F.1386.T27.5861.34	Projectile Point	
F.1386.T27.5861.35	Projectile Point	

F.1386.T27.5861.36	Projectile Point	
F.1386.T27.5861.37	Projectile Point	
F.1386.T27.5861.38	Projectile Point	
F.1386.T27.5861.40	Projectile Point	
F.1386.T27.5861.41	Projectile Point	

F.1386.T27.5861.42	Projectile Point	
F.1386.T27.5861.43	Projectile Point	
F.1386.T27.5861.44	Projectile Point	
F.1386.T27.5861.45	Projectile Point	
F.1386.T27.5861.46	Projectile Point	

F.1386.T27.5861.48	Projectile Point (San Juan del los Arcos)	
F.1386.T27.5861.49	Projectile Point	
F.1386.T27.5861.50	Projectile Point	
F.1386.T27.5861.51	Projectile Point	
F.1386.T27.5861.52	Projectile Point	

F.1386.T27.5861.53	Projectile Point	
F.1386.T27.5861.54	Projectile Point	
F.1386.T27.5861.55	Projectile Point (Zaragoza)	
F.1386.T27.5861.56	Projectile Point	
F.1386.T27.5861.57	Projectile Point	

F.1386.T27.5861.58	Projectile Point	
F.1386.T27.5861.59	Projectile Point	
F.1386.T27.5861.60	Projectile Point	
F.1386.T27.5861.61	Projectile Point	
F.1386.C25.5822.2	Ear Plug (Volcán las Navajas)	

UR 42-22	Ear Plug	
UR 42-25	Ear Plug	

REFERENCES

Archaeological Institute of America
2016 Code of Professional Standards, Electronic document. https://www.archaeological.org/wp-content/uploads/2019/05/Code-of-Professional-Standards.pdf, accessed January 29, 2020.

Barker, Alex W.
2003 Archaeological Ethics: Museums and Collections. In *Ethical Issues in Archaeology*, edited by Larry J. Zimmerman, Karen D. Vitelli, and Julie Hollowell-Zimmer, pp. 71–83. AltaMira Press, Lanham.

Bawaya, Michael
2007 Curation in Crisis. *Science* 317(5841):1025–1026. DOI:10.1126/science.317.5841.1025.

Beekman, Christopher S.
2010 Recent Research in Western Mexican Archaeology. *Journal of Archaeological Research* 18(1):41–109. DOI:10.1007/s.

Blomster, Jeffrey P., and Michael D. Glascock
2010 Procurement and Consumption of Obsidian in the Early Formative Mixteca Alta: A View from the Nochixtlan Valley, Oaxaca, Mexico. In *Crossing the Straits: Prehistoric Obsidian Source Exploitation in the North Pacific Rim*, edited by Yaroslav V. Kuzmin and Michael D. Glascock, pp. 183–200. British Archaeological Reports, Oxofrd.

Braswell, Geoffrey E
2013 Ancient Obsidian Procurement and Production in the Peten Campechano : Uxul and Calakmul During the Early Classic to Terminal Classic Periods. *Indian* 30:149–171.

Carballo, David M., Jennifer Carballo, and Hector Neff
2007 Formative and Classic Period Obsidian Procurement in Central Mexico: A Compositional Study Using Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry. *Latin American Antiquity* 18(1):27–43. DOI:10.2307/25063084.

Casana, Jesse
2015 Satellite Imagery-Based Analysis of Archaeological Looting in Syria. *Near Eastern Archaeology* 78(3):142–152. DOI:10.5615/neareastarch.78.3.0142.

Chase, Arlen F., Diane Z. Chase, and Harriot W. Topsey
1988 Archaeology and the Ethics of Collecting. *Archaeology* 41(1):56–60, 87.

Ebert, C. E., M. Dennison, K. G. Hirth, S. B. McClure, and D. J. Kennett
2015 Formative Period Obsidian Exchange along the Pacific Coast of Mesoamerica. *Archaeometry* 57(1):54–73. DOI:10.1111/arcm.12095.

Feinman, Gary M., Linda M. Nicholas, and Mark Golitko
2013 Exchange in the Valley of Oaxaca, Mexico: Late Classic Obsidian Procurement. *Mexicon* 35(3):60–68.

Forster, Nicola, and Peter Grave
2012 Non-Destructive PXRF Analysis of Museum-Curated Obsidian from the Near East. *Journal of Archaeological Science* 39(3):728–736. DOI:10.1016/j.jas.2011.11.004.

Gay, Brandon M., Christopher Brito, and Ian Weir
2017 Portable XRF Analysis of Obsidian Projectile Points and Debitage from Paipai Territory , Northern Baja California. *Pacific Coast Archaeological Society Quarterly* 53(2 and 3):87–102.

Gazzola, J., M. Sánchez Del Río, C. Solís, and T. Calligaro
2010 Particle-Induced X-ray Emission (PIXE) Analysis of Obsidian from Teotihuacan. *Archaeometry* 52(3):343–354. DOI:10.1111/j.1475-4754.2009.00483.x.

Glascock, Michael D., Geoffrey E Braswell, and Robert Cobean
1998 A Systematic Approach to Obsidian Source Characterization. In *Archaeological Obsidian Studies: Method and Theory*, edited by M. Steven Shackley, pp. 15–65. 1st ed. Springer US.

Glascock, Michael D., Phil C. Weigand, Rodrigo Esparza López, Michael A. Ohnersorgen, Mauricio Garduño Ambriz, Joseph B. Mountjoy, and J. Andrew Darling 2010 Geochemical Charactisation of Obsidian in Western Mexico: The Sources in Jalisco, Nayarit, and Zacatecas. In *Crossing the Straits: Prehistoric Obsidian Source Exploitation in the North Pacific Rim*, edited by Yaroslav V. Kuzmin and Michael D. Glascock, pp. 201–217. BAR Intern. Archeopress.

Golitko, Mark, and Gary M. Feinman
2015 Procurement and Distribution of Pre-Hispanic Mesoamerican Obsidian 900 BC–AD 1520: a Social Network Analysis. *Journal of Archaeological Method and Theory* 22(1):206–247. DOI:10.1007/s10816-014-9211-1.

Gordus, Adon A, Gary A Wright, and James B Griffin
1968 Obsidian Sources Chracterized by Neutron-Activation Analysis. *American Association for the Advancement of Science* 161(3839):382–384.

Greno, Anthony E.
1962 *The Vester Collection (At the University of Redlands): A Preliminary Generalized Report*. Redlands.

Grider, Rollin
1962 *The Teotihuacan Complex of The Redlands Collection*. Redlands.

Griffin, James B, A A Gordus, and G A Wright
1969 Identificaiton of the Sources of Hopewellian Obsidian in the Middle West. *American Antiquity* 34(1):1–14.

Hepp, Guy D.
2019 Interaction and Exchange in Early Formative Western and Central Mesoamerica: New Data from Coastal Oaxaca. In *Interregional Interaction in Ancient Mesoamerica*, edited by Joshua D. Englehardt and Michael D. Carrasco, pp. 51–82. University Press of Colorado, Louisville.

Hirth, Kenneth, Ann Cyphers, Robert Cobean, Jason De Leon, and Michael D. Glascock 2013 Early Olmec Obsidiain Trade and Economic Organization at San Lorenzo. *Journal of Archaeological Science* 40:2784–2798.

Joyce, Arthur A., J. Michael Elam, Michael D. Glascock, Hector Neff, and Marcus Winter 1995 Exchange Implications of Obsidian Source Analysis from the Lower Rio Verde Valley, Oaxaca, Mexico. *Latin American Antiquity* 6(1):3–15. DOI:10.2307/971597.

Kersal, Morag M.
2015 Storage Wars: Solving the Archaeological Curation Crisis? *Journal of Eastern Mediterranean Archaeology and Heritage Studies* 3(1):42–54.

Key, C. A.
1969 The Identification of New Guinea Obsidians. *Archaeology & Physical Anthropology in Oceania* 4(1):47–55.

Kwoka, Joshua J., and M. Steven Shackley
2019 Technological Analysis and Source Provenance of Obsidian Artifacts from a Sun Pyramid Substructure Cache, Teotihuacan, Mexico. *Latin American Antiquity* 30(1):205–210. DOI:10.1017/laq.2018.71.

Lopez-García, Pedro, Denisse L. Argote, and Charlie Beirnaert
2019 Chemometric Analysis of Mesoamerican Obsidian Sources. *Quaternary International* 510(December 2018):100–118. DOI:10.1016/j.quaint.2018.12.032.

Lynott, Mark J.
1997 Ethical Principles and Archaeological Practice: Development of an Ethics Policy. *American Antiquity* 62(2):589–599.

MacFarland, Kathryn, and Arthur W. Vokes
2016 Dusting Off the Data and Rehabilitating Archaeological Legacy and Orphaned Collections. *Advances in Archaeological Practice* 4(2):161–175. DOI:10.7183/2326-3768.4.2.161.

Merrick, Harry V, and Francis H Brown
1984 Obsidian Sources and Patterns of Source Utilization in Kenya and Northern Tanzania : Some Initial Findings. *The African Archaeological Review* 2:129–152.

Milanich, Jerald T.
2005 Homeless Collections. *Archaeology* 58(6):57-60,62,64. DOI:10.1057/978-1-349-95988-4_102.

Milić, Marina
2014 PXRF Characterisation of Obsidian from Central Anatolia, the Aegean and Central Europe. *Journal of Archaeological Science* 41(1):57–66. DOI:10.1016/j.jas.2013.08.002.

Millhauser, John K, Enrique Rodríguez-alegría, and Michael D Glascock
2011 Testing the Accuracy of Portable X-ray Fluorescence to Study Aztec and Colonial Obsidian Supply at Xaltocan, Mexico. *Journal of Archaeological Science* 38:3141–3152. DOI:10.1016/j.jas.2011.07.018.

Moholy-Nagy, Hattula, James Meierhoff, Mark Golitko, and Caleb Keslte
2013 An Analysis of pXRF Obsidian Source Attributions from Tikal, Guatemala. *Latin American Antiquity* 24(1):72–97.

Nazaroff, Adam J., Keith M. Prufer, and Brandon L. Drake
2010 Assessing the Applicability of Portable X-ray Fluorescence Spectrometry for Obsidian Provenance Research in the Maya Lowlands. *Journal of Archaeological Science* 37(4):885–895. DOI:10.1016/j.jas.2009.11.019.

Parks, G. A., and T. T. Tieh
1966 Identifying the Geographical Source of Obsdiain Artifacts. *Nature* 211(5046):289–290.

Phillips, S. Colby, and Robert J. Speakman
2009 Initial Source Evaluation of Archaeological Obsidian from the Kuril Islands of the Russian Far East Using Portable XRF. *Journal of Archaeological Science* 36(6):1256–1263. DOI:10.1016/j.jas.2009.01.014.

Pierce, Daniel E.
2016 Volcán las Navajas: The chemical characterization and usage of a West Mexican obsidian source in the Aztatlán tradition. *Journal of Archaeological Science: Reports* 6(April 2016):603–609. DOI:10.1016/j.jasrep.2016.03.041.

Pierce, Daniel E
2015 Visual and Geochemical Analyses of Obsidian Source Use at San Felipe. *Journal of Anthropological Archaeology* 40:266–279.

Ponomarenko, Alyson Lighthart
2004 The Pachuca Obsidian Source, Hidalgo, Mexico: A Geoarchaeological Perspective. *Geoarchaeology* 19(1):71–91. DOI:10.1002/gea.10104.

Shackley, M. Steven
2010 Is there Reliability and Validity in Portable X-ray Fluorescence Spectrometry (PXRF)? *The SAA Archaeological Record* 10(5):17–20.

Shackley, M Steven
2012 Portable X-ray Fluorescence Spectrometry (pXRF): The Good, the Bad, and the Ugly. *Archaeology Southwest Magazine* 26(2).

Sheets, Payson, Kenneth Hirth, Fred Lange, Fred Stross, Frank Asaro, and Helen Michel
1990 Obsidian Sources and Elemental Analyses of Artifacts in Southern Mesoamerica and the Northern Intermediate Area. *American Antiquity* 55(1):144–158.

Sheppard, Peter J., Geoff J. Irwin, Sam C. Lin, and Cameron P. McCaffrey
2011 Characization of New Zealand Obsidian using PXRF. *Journal of Archaeological Science* 38:45–56.

Smith, I. E. M., G. K. Ward, and W. R. Ambrose
1977 Geographic Distribution and the Characterization of Volcanic Glasses in Oceania. *Archaeology & Physical Anthropology in Oceania* 12(3):173–201.

Smith, Michael E., Adrian L. Burke, Timothy S. Hare, and Michael D. Glascock
2007 Sources of Imported Obsidian at Postclassic Sites in the Yautepec Valley, Morelos: A Characterization Study Using XRF and INAA. *Latin American Antiquity* 18(4):429–450.

Speakman, Robert J
2012 Evaluation of Bruker's Tracer Family Factory Obsidian Calibration for Handheld Portable XRF Studies of Obsidian(August):The University of Georgia.

Spence, Michael W., Phil C. Weigand, and Maria de los Dolores Soto de Arechavaleta
2002 Production and Distribution of Obsidian Artifacts in Western Jalisco. In *Pathways to Prismatic Blades: A Study in Mesoamerican Core-Blade Technology*, edited by Kenneth Hirth and Bradford Andrews, pp. 61–79. Cotsen Institute of Archaeology, Los Angeles.

Stross, Fred H., Payson Sheets, Frank Asaro, and Helen V. Michel
1983 Precise Characterization of Guatemalan Obsidian Sources, and Source Determination of Artifacts from Quirigua. *American Antiquity* 48(2):323–346.

Voss, Barbara L.
2012 Curation as Research. A Case Study in Orphaned and Underreported Archaeological Collections. *Archaeological Dialogues* 19(2):145–169. DOI:10.1017/S1380203812000219.

Williams, David Thomas
2012 Typological and Geochemical Analysis of Obsidian Artifacts: A Diachronic Study from the Lower Rio Verde Valley, Oaxaca, Mexico. University of Colorado.