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Jaina Figurines: The Survey, Characterization of Materials, and Treatment of Figures from the Fowler Museum Collection

A thesis submitted in partial satisfaction
of the requirements for the degree Master of Arts
in Conservation of Archaeological and Ethnographic Materials

by

Carinne Chava Tzadik

2014

ABSTRACT OF THE THESIS

Jaina Figurines: The Survey, Characterization of Materials, and Treatment of Figures from the Fowler Museum Collection

By

Carinne Chava Tzadik

Master of Arts in Conservation of Archaeological and Ethnographic Materials
University of California, Los Angeles, 2014
Professor Christian Fischer, Chair

The ancient Maya civilization, inhabiting a territory that spanned through the Yucatán peninsula, Guatemala, Belize, and parts of Honduras and El Salvador, for over three millennia is responsible for great artistic and architectural achievements. Their legacy includes the production of ceramic figurines, some of the most famous being those known as Jaina figurines, and the invention of a blue pigment called Maya blue. The aim of this study was to view and organize a full holding of Jaina figurines within a museum collection while assessing their condition, evaluate the potential of non-invasive analytical techniques, and provide examples of treatment types that are required by the current condition of figurines in the collection. Using x-ray fluorescence (XRF), Ultraviolet/Visible/Near Infrared reflectance spectroscopy (UV/Vis/NIR) and x-ray diffraction (XRD), analysis was conducted on the clay body and pigments utilized in the

manufacture of 92 Jaina figurines from the Fowler Museum collection. Treatment protocols were also established based on the needs of the figurines studied in order to facilitate the expedient stabilization of the collection.

The thesis of Carinne Chava Tzadik is approved.

Ioanna Kakoulli

Richard Lesure

Vanessa Muros

Christian Fischer, Committee Chair

University of California, Los Angeles

2014

Table of Contents

List of Tables and Figures 3

1. Introduction 4

1.1 The Maya 4

1.1.1 Historical Overview 4

1.1.2 Maya Burial Practices 5

1.2. Jaina Island 7

1.2.1 Site Information 7

1.2.2 Archaeological Record 9

1.3 Maya and Jaina Figurines 11

1.3.1 Jaina vs. Jaina-style 13

1.3.2 Styles, Function and Variation 15

1.3.3 Maya Blue Pigment 18

1.4 Project Goals 21

2. Characterization of Materials 21

2.1 Experimental Procedures 21

2.1.1 X-Ray Fluorescence (XRF) Spectroscopy 21

2.1.2 Ultraviolet/Visible/Near infrared (UV/Vis/NIR) Spectroscopy 22

2.1.3 X-Ray Diffraction (XRD) 23

2.2 Results and Discussion 23

2.2.1 Clay Body 23

2.2.2 Pigments 31

2.2.3 Maya Blue 33

3. Condition Survey 35

3.1 Nature of The Fowler Museum and Its Collection 35

3.2 Aims of the Survey 36

3.3 Methodology 36

3.4 Creation of Database and Survey Form 38

3.5 Results and Discussion 38

4. Conservation of Five Selected Figurines 40

4.1 Selection of Objects 40

4.2 Desalination Treatments 42

4.3 Retreatment of Objects 45

5. Conclusion 46

6. Appendices 49

Appendix A: X-ray diffraction spectra 49

Appendix B: X-ray fluorescence data 53

Appendix C: Table of prominent Maya blue UV/Vis/NIR absorptions 65

Appendix D: Survey Forms 67

Appendix E: Treatment Reports 69

7. References 108

.

List of Tables and Figures

Figure 1: Map of major sites in the Maya area including Jaina island, Campeche, and Jonuta…… 8

Figure 2: Graph showing the three distinct groups of chromium levels in the ceramic body…… 24

Figure 3: 3D plot showing groupings based on calcium, iron, and silicon contents in the ceramic body…… 25

Figure 4: Si-Cr bivariate plot showing 3 distinct groups based on Cr levels in ceramic body…….. 26

Figure 5: Graph showing the relationship between the calcium content and potassium content in the ceramic paste …… 27

Figure 6: Example of a figurine with elevated mercury levels and no red pigment …… 29

Figure 7: XRF data showing the percentage of chlorine and sulfur present in the clay body of each sample…….. 30

Table 1: Results of XRD analysis…… 33

Figure 8: UV/Vis/NIR spectra of reference and sample Maya blue…… 35

Table 2: Table defining the condition issues of the figurines as applied to the survey…… 39

Figure 9: Before treatment images of object X76.722 and X91.2269…….. 41

1. Introduction

1.1 The Maya

1.1.1 Historical Overview

The Maya, one of the great cultures of Mesoamerica, has fascinated the world since the sixteenth century when the Spanish first came to Central America. Although referred to under the umbrella term ”Maya”, the group is actually an ethnic complex of different languages, customs, and historical contexts; however, they do share certain characteristics that allow them to be considered a single culture (de la Garza 1998).

The Maya territory extended between 300,000 and 400,000 square kilometers, covering the modern day Mexican states of Yucatán, Campeche, Quintana Roo, and parts of Tabasco and Chiapas, as well as Guatemala and Belize, and the western portions of Honduras and El Salvador (de la Garza 1998). It is composed of two main natural settings, the highlands and the lowlands, each of which is further divided into a northern and southern region (Sabloff 1998). The lowlands, which predominately spans over the Petén-Yucatán peninsula, is a single limestone shelf that juts up in the Gulf of Mexico (Coe 2005), while the highlands are composed of a series of large mountains, with some of the highest peaks reaching over 4,000 meters (Sabloff 1998).

The first inhabitants of the Maya territories came soon after the end of the last Ice Age and have carried their culture on through to the present time, though the current Maya culture has been somewhat modified from its ancient roots (de la Garza 1998, Sabloff 1998). The ancient society had a social organization, which consisted of distinct hierarchical groups of noblemen (rulers, priests, war chiefs, and perhaps merchants), and commoners (farmers, builders, and other professions that focused on group survival) (de la Garza 1998). The Maya cities had relatively low population densities, and as a whole lacked any type of grid plan for the

organization of residences, though thought and purpose is clearly seen in the layout of monumental architecture and sculpture (Nalda 1998).

The most common method to describe chronology of the ancient Maya has been to divide it into three sections: the Preclassic (ca. 1800 B.C.E. – 250 C.E.), the Classic, and the Postclassic (900 – 1524 C.E.). The Classic period lasted from 250-900 CE with some unexplained event, or series of events, causing most of the Classic sites to be abandoned. This shift brought us to the Postclassic period at which point outside influence played a larger role in Maya culture (de la Garza 1998, Coe 2005). Though this chronology has been used, and continues to be used in the literature and most discussions of the Maya, Sabloff (1998) suggests that the correct chronology should be: Early Phase (2000 – 300 B.C.E.), Middle Phase (300 B.C.E. – 1200 C.E.), and Late Phase (1200 – 1540s C.E.). He argues for this change in chronology because many of the advancements that signal the Classic period, i.e. long count calendar, writing, monumental art and architecture, etc., actually started in the later years of the Preclassic. Additionally, the great collapse that is said to have ushered in the Postclassic era may have actually been more of a shift of power similar to those that had been going on for centuries[1].

1.1.2 Maya Burial Practices

One of the largest problems with identifying the role of ceramic figurines in Maya society is the nature and the circumstances of their discovery within the burial context. Finding funerary goods as part of the death ritual is often helpful in assigning meaning and context for objects of an ancient culture, however the Maya seem to lack one comprehensive set of burial practices within the larger society. This difficulty is often due to the seemingly contradictory burials that are found between Maya sites and even in some cases within the same site.

[1] Though the theory holds extreme merit and would indeed be a more logical approach to the management of time in the Maya world, the majority of scholars still refer to the designations Preclassic, Classic, and Postclassic, and as such, so will I in order to ensure a consistent jargon.

The Maya did not have cemeteries or burial grounds as we think of them today, resulting in the somewhat random recovery of burials at various sites (Becker 1993). These unconnected discoveries make forming broad characterizations a difficult task. Further, the variety of burial types and grave goods that have been found, has led to a number of theories regarding what burial meant to the Maya and how the objects buried within them should be understood. In most cases, the objects found alongside the human remains are made from precious materials and are clearly markers of rank, power, and prestige. Therefore the internment of ceramic figurines, whose role in Maya society is less clearly demarcated, makes the purpose behind their burial slightly more puzzling.

Although there is some variation across the Maya area, the Pre-Hispanic Maya typically buried their dead within or adjacent to the residential compound. By burying the dead in residential spaces the descendents of the dead were able to preserve ownership of the valuable, intangible property that was the soul. This practice varied in the cases of lords and high-esteemed persons, who were cremated and their ashes put in large ceramic vessels (Gillespie 2002). However, due to modifications and refurbishments made to buildings found at Maya sites, it is sometimes difficult to assign terms or functions to the structures present (Folan et al. 1995) and as such, when burials are exhumed assigning meaning to the burial location becomes convoluted. For instance, the location where a temple currently stands in a Maya site may have at one time held a residential compound or vice versa. Centers of power often shifted in the Maya world even within the same site causing the building or destruction of temples as time passed. Burial locations are further complicated by secondary burials, in which remains are moved purposely or by accidental disruption of the gravesite, common within Maya society, especially during an activity such as building a temple site (Becker 1993).

Another complexity when reviewing the burial practices of the Maya is, as Rathje (1970) suggests, that burial location was dependent on age, sex, and wealth. These three qualities would determine if the burial was in the house platform or along ceremonial centers. However, these trends reversed themselves as a shift was made from the Early Period to the Late Period of the individual site (Rathje 1970). That is to say that even within a larger Maya time period (Late Classic for instance) each site would have different dates on what the Early and Late Periods could be described as.

Beyond differences in burial locations, many extant examples of internments demonstrate different funerary preparation practices. According to the archaeological record, the site of Calakmul had different burial preparations under different structures. In Structure VII, a tomb was found with a secondary burial interred under the central passageway, the defleshed remains having been wrapped in cloth, then in a mat, and exposed to fire. Conversely, primary burials were found in tombs found under Structure III and VII, the remains having been subjected to various rites, including the application of a red pigment, identified as cinnabar (Folan et al. 1995).

1.2. Jaina Island

1.2.1 Site Information

Jaina Island is a small islet located a few meters off of the coast of Campeche on the Yucatan Peninsula, in part of what was once the Maya Empire. The island covers approximately 42 hectares (1,000 meters long by 750 meters at its widest point) and is no more than 20 meters above sea level. Both the nearby coast and the island itself have mazes of mangroves and brackish swamps and marshes. It is possible that the islet was in fact part of the coastline at one point, but due to hard rains and the currents of rivers that were along the coast, it has been modeled into what now appears to be an island (Piña Chan 1948). There has previously also

been discussion about the possibility of the existence of a passageway that would have once connected the island to the mainland, most likely manmade though there is really no archaeological evidence for this type of bridge (McVicker 2012).

Figure 1 Map of major sites in the Maya area including Jaina island, Campeche, and Jonuta (Miller 1975)

The ceremonial center of Jaina runs northwest to southeast and covers an area of 600 meters by 175 meters with two principal architectural groups, the Zayosal and the Zacpool (also known as 'cabeza blanca'). The Zayosal is composed of four structures that form a small plaza. Structure A, the main structure, is composed of four platforms that are set on a slope with buildings set on each platform. The structures are made of a cut stone and covered in stucco. Structure B of the Zayosal has six stepped platforms and evokes the old architectural style of Petén. The other two constructions are of smaller size and scale, and seem to be civil buildings (Piña Chan 1983). Much of the building material for the buildings of the ceremonial center would have had to have been brought from the mainland and would have included tons of calcareous earth called *sahcab*, as well as hundreds of stones in order to raise the level of its surface and form a platform for the structures of the civic-religious center (Piña Chan 1998). The island has a narrow stream that flows into the sea and that may have allowed for access by canoe to the

ceremonial center (Piña Chan 1983). The ceremonial nucleus was surrounded by common dwellings, which were made of wooden trunks, mud, and palm, and is where the most burials have been found (Piña Chan 1998). It is unclear if these humble structures are still in existence and if so whether or not they were from later inhabitants of the island.

1.2.2 Archaeological Record

The archaeological record of Jaina Island is somewhat incomplete due to the large amount of looting that has taken place at the site (O'Neil 2012). Since the end of the 19th century the island has been looted for use of both building materials that were repurposed for use in Campeche, and lime production. Later, at the start of the 20th century, looters ravaged the site and took figurines and vessels to be sold on the antiquities market in America and Europe. This looting has led to an unclear and incomplete archaeological record, resulting in murky provenance for many of the sold objects (Benavides 2005). As such, many artifacts in collections have been reexamined, especially ceramics and ceramic figurines. This research has caused many so-called Jaina and Jaina-style figurines in various collections which were once thought to be ancient examples, to be reassigned a more modern production date through the materials analysis, specifically Neutron Activation Analysis (INAA) testing (O'Neil 2012, Von Winning 1986).

In 1941 and 1942, the National Institute of Anthropology and History supported explorations of Jaina Island by M.A. Fernandez, H. Modeno, F. Montemayor, and R. Pavón, which was followed by a comprehensive study of the landscape and sites of the Campeche region by Alberto Ruz Lhuillier (Ruz Lhuillier 1945). Then in September of 1947, the National Institute sent Román Piña Chan and the Director of the State Museum, Raúl Pavón Abreu to do a third exploration of the site (Piña Chan 1948). A fourth season of excavation was carried out in 1957 by Carmen Cook de Leonard and Ceasar Saenz in which much of the site was excavated

though very few of the results were published (Corson 1976). These were the official state run digs, though prior to 1941 cursory excavations were performed by Waldeck in 1838, B.M. Norman in 1843, Charnay in 1886, and Morley and Rickertson in 1924 (Ruz Lhuillier 1945, Piña Chan 1948, Corson 1976).

Similar to the site of Campeche, Jaina was not occupied during the pre-Maya horizon and flourished along other sites in the Yucatan (Ruz Lhuillier 1945). The site seems to have passed through two periods of occupation, the first from 500 – 800 CE and the second from 800 – 1000 CE. During this first period, Jaina was an important center and port of coastal trade, which appears to have declined in the second period (Piña Chan 1998, McVicker 2012, O'Neil 2012).

The burials on Jaina were described by the archaeologist Piña Chan (1998) as varying between 60 centimeters to almost 3 meters in depth and often accompanied by an offering for the next life in the underworld. The deceased were placed directly in the earthen pits with the most common positioning of the body in the fetal position on the right or left side with arms crossed often holding one or more clay figurines. Burials in dorsal and ventral decubitus position are rarely found on the island (Piña Chan 1948, Piña Chan 1998). There are both primary and secondary burials found on Jaina and in the surrounding landscape. The primary burials are generally as those described above, while secondary burials could have one or many remains in the same pit. Children were buried in urns both as primary and secondary burials, though some have been cremated prior to their placement in the urn. The deceased have shown no evidence of being buried in an orientation that corresponds to the monumental structures that remain on the island nor to the cardinal points (Piña Chan 1948). Because of the density of burials on the island, stratigraphic interpretation is extremely difficult to obtain, causing difficulty in the dating of finds and burial types (Piña Chan 1948, Corson 1976).

Due to the large amount of untouched burials found on the island and its position as western point "where the sun goes to its underworld home" (Coe 1975, 24), many scholars have conceived Jaina Island as a necropolis assigning solely funerary provenance to the figurines and grave goods (Miller 1975, Coe 1975, Corson 1976, Piña Chan 1983, Von Winning 1986, Kelker 2010). However, in more recent scholarship as discussed above, this theory has been refuted, indicating the ancient Maya did not bury their dead in cemeteries, but instead under homes, residential units or palaces. This knowledge would suggest that the island's role in the empire was not strictly symbolic and shamanistic.

1.3 Maya and Jaina Figurines

One of the most important concepts to keep in mind when discussing Maya art in the general sense is that in actuality Maya art is composed of many separate traditions, which together characterize the artistic output of Maya culture (Corson 1976). Meaning ceramic figures from Highland Maya sites may share qualities and stylistic similarities with those from another site or region, but will most likely also have unique meanings that are associated with only the original manufacture site. Even so, there are some qualities that are common to most Maya figurines.

When speaking of Maya ceramic figurines, it is paramount to understand that it was the advent of firing clay that has created a study set of these objects, and it is equally possible that there is a large section of the history of Maya figurine making that is missing from the archaeological record in the form of unfired clay figures or figures made of organic materials that have since deteriorated (Joyce 2009). The studies that are conducted now are obviously based on having present examples and therefore may be limited in scope. What does remain in the archaeological record demonstrates that Mesoamericans produced figurines of clay, stone, and other media by the millions, which testifies to their important status within the social and

cosmological worlds of their producers (Faust et al. 2009). However, whereas the monumental structures, sculpture, and stele expressed the nature of political and religious life, the figurines could also capture the more secular and common life of the wider society (Taube et al. 2009). This focus on the common, however, did not exclude the elite and ruling class from being depicted. Maya figurines can provide an understanding for the reach of the state to household contexts among common peoples. During the Late Classic period, state symbols and meanings similar to those found on monuments were disseminated widely through molded figurines (Halperin 2009).

Many Maya ceramic figurines have a commonality in their size and shape which is a slightly shorter proportional system than that used in two-dimensional art, with most figures standing about six or seven head lengths high. The faces and heads would often receive the greatest emphasis, along with headdress, and some bodies are very simply rendered in comparison (Miller 1999). Ceramic figurines have an advantage over monumental art in that they allow for increased experimentation and ease of manipulation of the material. Because of the plasticity of clay artists have a great deal of choice in rendering expressive facial characteristics, and in the case of many Maya figurines, what appear to be individualized features. The creation of molds then allowed for the mass production of images (Corson 1976, Taube et al. 2009). The plasticity and ease of use may explain why some figures reveal expressions and actions that are rarely seen elsewhere in Maya art (Miller 1999, Corson 1976).

The study of Jaina figurines has been a difficult endeavor from the discovery of the first burial through the present time. Performing a comprehensive study on an art type, especially archaeological in nature, requires correct dating to place the art object within the context in which it should be understood, the location and placement in which it was discovered and therefore most likely used, and finally as much of the original piece as still exists. In some cases

throughout the course of Jaina archaeological excavations, it has been possible to establish the association of separate figurines in one grave lot. However, the data on absolute depth and stratigraphic context have been mostly unattainable. Additionally, many of the figurines in American museums lack archaeological context and for most, even site provenience is conjectural. Most were acquired through purchase or donation, and the attribution of a Jaina origin was made subsequent to the acquisition of the specimen (Corson 1976).

Beyond the somewhat questionable archaeology, looting, which was largely responsible for creating a market in the ceramic figurine area, led to an influx of forged examples into the market. Often many of the 'complete' figurines are pastiches made up of real parts, especially the solid heads, which are more resistant to destruction, and often boast new torsos limb or two, and additional post-fired paint to cover the cracks (Kelker et al. 2010). These forged examples make an accurate study of Maya figurines more difficult and introduces a subjective element into classification and conclusions that may be erroneous (Butler 1935).

1.3.1 Jaina vs. Jaina-style

In much of the literature discussing Maya figurines, Jaina figurines are often referred to as Jaina-style figurines. These two terms are also often used interchangeably within museum classification systems as well. This nomenclature stems from an attempt at understanding the complexity and variety of problems dealing with the lack of properly excavated sites in the early history of the figurines, and looted objects with no clear provenance. Many figurines of this type were in fact found in Jaina, while similar objects were discovered in other Campeche coast sites, meaning that currently the term "Jaina-style" encompasses a broad range of figurines found over a vast geography of present day Mexico including Campeche, Veracruz, Tabasco, and Chipas (O'Neil 2012, Butler 1935, Corson 1976, Miller 1975). The Jaina figurines are part of a larger tradition and similar style as those of West Mexico. Many of these tomb figures are

stylistically similar to Jaina figurines, but belong to regions and groups extremely distant geographically (Kelker et al. 2010, Benavides 2005).

This phenomenon was noted first by Butler (1935) who discovered that there was a style from the Campeche region that showed apparently no outside influence, and that the majority of these unique figurines came from the island of Jaina. Butler suggested an indigenous origin, in a cult centering in Jaina, for this Campeche style and type, in which the two subsequently spread together, with the style being modified in each place diffused to by the style predominant there. The theory was furthered by Corson (1976) who argued that the distribution of related styles along the gulf coast argues for an exchange of ideas and goods in a late Classic – early Postclassic period. This distribution also suggested that Jaina maintained more extensive contacts to the north and south along the coast than eastward to the interior, contact, which could easily have been maintained by water travel, which is still the most practical means of travel through the lagoons and backwaters of the Campeche coast.

Many scholars have examined Jaina figurines from specific collections (O'Neil 2012, Von Winning 1986, Miller 1975), some have looked at a larger sampling across collections (Butler 1935, Corson 1976), and very few have had the opportunity to study them on site (Piña Chan 1948) to determine overarching themes and ideas about Jaina figurines. However, aside from these visual examinations, not many scholars have undertaken scientific and archaeological investigations. In part because of this lack of systematic exploration, even with the existing scholarship on the subject, so much about these figures remains unknown. For example, the exact nature of the manufacture of these clay figurines still remains uncertain. Though it is apparent through visual examinations that the figures are mold cast, hand-modeled, or in some cases a combination of both, the method of firing is less apparent. There is no clear evidence whether the figurines were placed directly into open fire pits or whether they were first placed

in a sagger, a large vessel or chamber that would have protected the vessels from fire clouds (O'Neil 2012). Also largely missing from the literature are studies on the clay types used[2], provenance, and pigment analysis (with the exception of Maya blue, see section 3.2.3)

1.3.2 Styles, Function and Variation

Frequently, scholarship that addresses the topic of Mesoamerican figurines, especially Maya figurines, focuses on the characters being represented. Often the issue of the represented figure is one that has been repeated many times in the Maya canon. Those found on Jaina can be classified into the groups which include human beings, animals, temple-deities, and figurines of the central Veracruz type, many of which would have been based on archetypes of the society in which they were found, i.e. ballplayers, nobles, priests, women at work etc. (Piña Chan 1998, O'Neil 2012). It is often assumed that these figures were portraits of real people, though Coe (1975) asserts that this is an erroneously held belief due to the tendency for the surface realism of Maya art to incite that feeling. This concept has been confirmed though excavations which have revealed that the figures found in burials do not correspond with the skeletons found within them, and moreover, the multiplicity of figures with similar features and characteristics, suggest that the figures were types that may have represented a larger value in Maya culture (O'Neil 2012). Theories of what the figures do represent have ranged from images of Gods and underworld characters, whose representations would have been fitting for their funerary context (Coe 1975), to portraits of rulers and members of the elite. In the course of her study for a small exhibition at Princeton, Mary Miller (1975) studied nearly three hundred Jaina figurines and came to the conclusion that the figurines were based on characters from the *Popol Vuh.* By studying the costuming represented as well as the postures, and subjects represented, it

[2] Halperin et al. (2009) did publish the results of clay analysis from a site in Guatemala entitled "Late Classic (AD 600-900) Maya market exchange: analysis of figurines from Motul de San José region, Guatemala" in Journal of Field Archaeology, vol. 34, pg. 457-480.

was clear to her that the figures did not depict everyday Maya nor the simple deities of a folk culture.

According to the archaeological record, Jaina seems to have passed through two periods of occupation. The first, 500 – 800 C.E., is the peak period of solid hand modeled figurines and the beginning of molded, hollow figurines; the second period, A.D. 800 – 1000 C.E., corresponds to the end of molded hollow figurines and the central Veracruz-type (Ruz Lhuillier 1945, Piña Chan 1998). However, the exact nature in which Jaina figurines would have been used is extremely unclear. Even though there is a large group of the figurines that have physical indications as to their use and/or purpose, the larger context of their purposes is unknown. Of those figures that have physical indications of their use there are figurines of the hollow, mold-cast variety and are often described as whistles, rattles, and whistle-rattles (Piña Chan 1998, Coe 1975). However even though the figurines contain small pellets that rattle when the figure is moved or handled, or they have a component that could be the mouthpiece of a whistle on the side or bottom of the object, it is not clear that these features mean that the figurines should be assigned the function of musical instrument and are described primarily as being a 'rattle' or 'whistle'. This simple classification divorces any other meanings that the figurines may have had (von Winning 1986). Additionally, the indicators that point to the function of whistle, specifically the vents or holes and the mouthpieces may have primarily been developed as a byproduct of the mold making technique, and not meant to have an intentional function (Butler 1935). If this is indeed the case then it would change the meaning of many interpretations regarding the use of these figures, such as Coe's (1975) assertion that the whistles were perhaps sounded during the funerary ceremony.

The function of the modelled figurines is a larger mystery than those that are perceived musical instruments. Due to the variety of subjects that they depict, ranging from the divine to

the mundane, ascribing one meaning to the diverse group can be almost impossible. The task is made especially difficult by the fact that we only have their final context (their entombment), and their final disposition clearly does not mark their meaning as participants in daily rituals (McVicker 2012). These objects are often meant to be understood in the funerary context and would depict a representative character corresponding to an element of the burial ritual. However, it is understood that, a person's close contact with a figurine may infuse the object with some essential part of the individual simply by having been within such personal space. In this case, figurines can embody personal powers, histories, accomplishments, and losses, which would make the object's style, function, depicted character almost incidental to its presence in the context (Faust et al. 2009). In this case, what the figurine appears to represent is largely irrelevant to its function in the grave, as it may only be a placeholder for a part of the deceased's spirit (McVicker 2012).

Another suggestion is that the figures are not meant to be understood individually, but instead given the array of figures and the variety of activities and postures, perhaps they should be understood as a part of a tableaux of some sort (O'Neil 2012). Furthermore, while the predominate study of Jaina figurines seems to focus on the funerary aspects due to the location in which the majority have been unearthed, and meanings assigned to what is being represented in them along the lines of fitting them into the role of object of death it is possible that the location is merely coincidental. According to a study of Maya glyphs, Houston et al. (1998) deemed that 'head' and 'face' were synonymous with one's personhood, and therefore portraits contained the essence of the represented person. Thus, if the figurines were in fact representations of rulers, then it is possible that they were used to multiply the ruler's presence within the extended territory and used to combat against the threat of opposing rulers. It is also possible that prior to burial the figurines would have been used to learn social statuses in both

the social and supernatural world, becoming a part of household shrines and rituals. This sacredness, which would have been ascribed to the objects, would then be transferred to the grave with the deceased (McVicker 2012).

1.3.3 Maya Blue Pigment

The blue pigment found on Maya figurines is a brilliant blue known as Maya blue. The pigment is one that has only been observed in Mesoamerican art, specifically of the Maya, until post-Spanish contact when there is scattered evidence of use by Mexican artists (Cabrera Garrido 1969) and continued evidence of use in Cuba between the seventeenth and nineteenth centuries (Delamare 2013). Maya blue was rediscovered in modernity on the Chichen Itza murals by Merwin in 1931 (Merwin et al. 1931), and has fascinated scholars since. The pigment itself is a remarkably stable one that is resistant to fading, heat, fluctuations in pH, and solvents. Its rediscovery caused a surge in theories and explorations to explain the mysterious pigment and its remarkable qualities. It is now known that Maya blue is an organic-inorganic complex that is composed of indigo and palygorskite. Palygorskite, $(Mg,Al)_5[(Si,Al)_8O_{20}](OH)_2(OH_2)_4 \cdot 4 H_2O$, is a clay that has open channels which contain zeolite water molecules. Fe^{3+} may also be present, replacing Al^{3+} in the octahedral sites (Reinen 2003). Sepiolite, $Mg_4Si_6O_{15}(OH)_2 \cdot 6 H_2O$, also has a channel formation, though the channels are approximately twice the size of those found in palygorskite and can also be used in the synthesis of the pigment (Chiari 2003).

In the past, theories were posited in which the blue color of Maya blue was ascribed to ferrous iron or silicates of a chlorite group which are colored blue or greenish-blue, however, when examined by Gettens (1962) it was discovered that there was not enough iron present in the samples to make this a plausible explanation. He further examined the pigment's reaction with multiple acid types which led to the conclusion that the blue was an integral part of the mineral base, which through XRD analysis was determined to be palygorskite, or as it was known

then attapulgite, and also sepiolite, but it was assumed that the identification of these traditionally colorless clays meant that there was a blue version of these inorganic materials. Following Gettens discovery, it was thought that a similar pigment was discovered among the Seri Indians of Sonora, Mexico, who use a blue pigment in face painting. This blue known as Seri Blue was composed of three ingredients including the root bark of *Franseria dumosa*, mixed clay composed mainly of montmorillonitic layers, and sap of the *Guaiacum coulteri* (Moser 1964). The bark was made into a pulp with added water and squeezed out, so that the water could be added and ground with the clay and sap. Seri blue was determined to be stable in the presence of water, but not when in the presence of concentrated nitric acid (Peirce 1964) and therefore could not have been the same compound as Maya blue.

Later, Van Olphen (1966) discovered that the presence of indigo accounted for the blue color of the pigment, and found that he could obtain a blue attapulgite-indigo complex by combining synthetic indigo and attapulgite in a slightly alkaline solution, however it would only remain stable to acids if the material was moderately heated (between 75-150˚C) for several days. He concluded that the key to the stability of the complex was the channel structure of attapulgite and sepiolite, though he denied that the indigo molecules could fit into the channels. Instead he proposed that the molecules would get stuck in the grooves of the surface instead.

The presence of indigo in Maya blue has been mostly undisputed from that time on aside from one study conducted by José-Yacamán et al. (1996). Based on their study, they concluded that the blue color in the Maya blue compound comes from the nanoparticle iron impurities trapped in the palygorskite and the diffusion of the light based on the particle size (José-Yacamán et al. 1996) and not from bonding with indigo.

Subsequent studies of the pigment's structure presented the possibility that the indigo molecules are located within the clay channels. Reinen (2003) hypothesizes that due to the

differing optical spectra between heated mixtures of indigo and palygorskite and non-reacted mixtures the indigo molecules transform from a cluster to isolated color centers, hydrogen-bonded to the matrix of the palygorskite and become incorporated into the lattice. Another study by Chiari et al. (2003) showed that the indigo molecule is inserted into the palygorskite channels (or alternately those in sepiolite) once the temperature reaches approximately 100˚C at which point part of the zeolitic water trapped in the channels starts to be lost (Chiari 2003).

Another theory has been put forth by Doménech et al. (2009), who believe that the indigo molecules attach to multiple places on the clay structure and that the bonds present are not all identical, but vary based on the orientation of the indigo molecule and possibly other colorants present in the indigo dye bath. The exact location of the bonds between the clay substrate and the indigo molecules is still uncertain, though it is accepted that both are present in the pigment and are bound to one another in some capacity.

Regardless of the structure of the organic-inorganic complex, experimentation with synthesizing Maya blue has shown that the pigment will yield different tones of blue on heating at different time intervals and at different temperatures. The lower the temperature and time for which it is heated, the brighter the blue tone that was achieved, though these brighter pigments were less stable (Saliya 2004). The pigment changed to more greenish grayish and a more stable compound on heating at higher temperature and for a longer time most likely due to the faster rate of reaction (Saliya 2004, Delamare 2013).

It has been thought that the creation of Maya Blue was most likely the domain of ritual specialists who may have unknowingly created the pigment in rituals of healing in which the two known medicinal elements were combined and heated (Arnold 2005, Arnold 2012). It has also been argued that the pigment would have been created during the indigo production process, by the introduction of clay, possibly suspended in the water used, to the indigo dyestuff and the

subsequent heating through extended exposure to the tropical environment (Torres 1988, Reyes-Valerio 1993).

Analysis of more Maya blue samples indicate that the pigment was made beyond the Yucatán region, it extended into Petén at least due to a clay source in the area. This demonstrates that Maya blue was not made from a single clay source but that it was made in the lowlands and highlands, pointing to a system of knowledge sharing and not good trading (Cecil 2010). This proves that the knowledge for the creation of the pigment was widespread.

1.4 Project Goals

Over the years, many attempts have been made to understand the various elements of Maya culture, spanning studies on their artistic traditions, political climate, language, etc. In an effort to add to the knowledge of Maya artistic traditions in general and Jaina figurines specifically, the focus of the project has been the examination of 92 figurines from the UCLA Fowler Museum with attribution to Jaina Island. For the purposes of this study, the aim was to (1) view and organize a full holding of Jaina figurines within a museum collection while determining their condition, (2) determine what, if any, materials could be identified using non-invasive analytical techniques, and (3) provide examples of treatment types required by the collection of figurines.

2. Characterization of Materials

2.1 Experimental Procedures

2.1.1 X-Ray Fluorescence (XRF) Spectroscopy

The primary analysis of the figurine clay body, and subsequent analysis of surface details was conducted using a Niton XLt3 portable XRF equipped with a silver anode. Clay body readings were taken in both mining mode and soil mode, whereas pigments and accretions

were only read in soil mode. Readings were taken at all four settings within the mode (main, high, low and light) for 30 seconds each totaling a collection time of 120 seconds. Soil mode readings optimize the trace element found in the ceramic material (specifically the silicate matrix of the soils). Readings were taken in all three setting within the mode (main, high and low) for 30 seconds each, totaling a collection time of 90 seconds.

It is important to note that many studies have been done researching the validity of provenancing ceramics based on the data obtained from XRF, and many if not all agree that it is not a reliable method of provenancing (Bishop et al. 1990, Cariati et al. 2003, Forster 2011, Hein 2002, Padilla et al. 2006, Speakman et al. 2011). However, in this study we are not attempting to provenance as such, as much as we are attempting to determine helpful patterns that may indicate authenticity and identify materials. While those patterns may provide clues for future provenancing studies, those issues are not addressed in this discussion.

2.1.2 Ultraviolet/Visible/Near infrared (UV/Vis/NIR) Spectroscopy

Reflectance spectra of pigments, clay body and various accretion found on the objects' surface were collected using a LabSpec 4 Benchtop Analyzer equipped with a high intensity contact probe. The Instrument contains three detectors, which enable the acquisition of spectral data between 350-2500 nanometers (nm). The size of the analyzed surface is determined by the instrument's probe, which has a measuring spot size of 10 mm in diameter[3]. Readings were taken with the probe in contact with the object surface where possible, and held at the angle that would provide maximum contact[4]. Some supplemental spectra were also taken with the Fieldspec® 3 (ASD), which is a portable and rugged version of Labspec 4. These measurements

[3] http://www.asdi.com/products/labspec

[4] Due to the varied and irregular surfaces' of the figurines, some readings were taken that did not allow for optimal contact between the probe and material being analyzed.

were done as part of a preliminary study focusing on the clay body of selected figurines from the same collection.

2.1.3 X-Ray Diffraction (XRD)

Because X-Ray Diffraction is an invasive analytical technique, which requires the removal of materials from the object, it was only carried out on a few microsamples taken from specific areas on the surface of the figurines. Samples were chosen in order to clarify and confirm results from the non-invasive testing methods. Powder samples taken from the objects were analyzed using a Rigaku Micro-Diffraction System equipped with a 2-D detector.

2.2 Results and Discussion

2.2.1 Clay Body

The major elements present in the XRF data of the ceramic paste used for the manufacture of the analyzed Jaina figurines are silicon (Si), calcium (Ca), potassium (K), and iron (Fe). Other major elements that are often found in clays, such as sodium (Na), and magnesium (Mg), cannot be detected or in the case of aluminum (Al) are largely underestimated, using portable XRF. Although Al and Mg in octahedral sites bonded to hydroxyls can be detected in the UV/Vis/NIR spectra, this information is qualitative and provides only insight into their presence or lack thereof.

Of the elements that can be detected accurately using the pXRF, we do observe a number of trends within the data. The potassium content has a direct correlation to iron levels in the ceramic body, meaning that samples with high levels of iron have also a higher level of potassium. In addition, iron and silicon allow us to differentiate two main groups for which higher levels of silicon are usually associated with lower levels of iron (fig. 2). Because pXRF analyzes the bulk of the ceramic, which includes temper and clay, the potassium and iron

contents may be indicative of both clay type and temper though iron can reasonably be associated with clay.

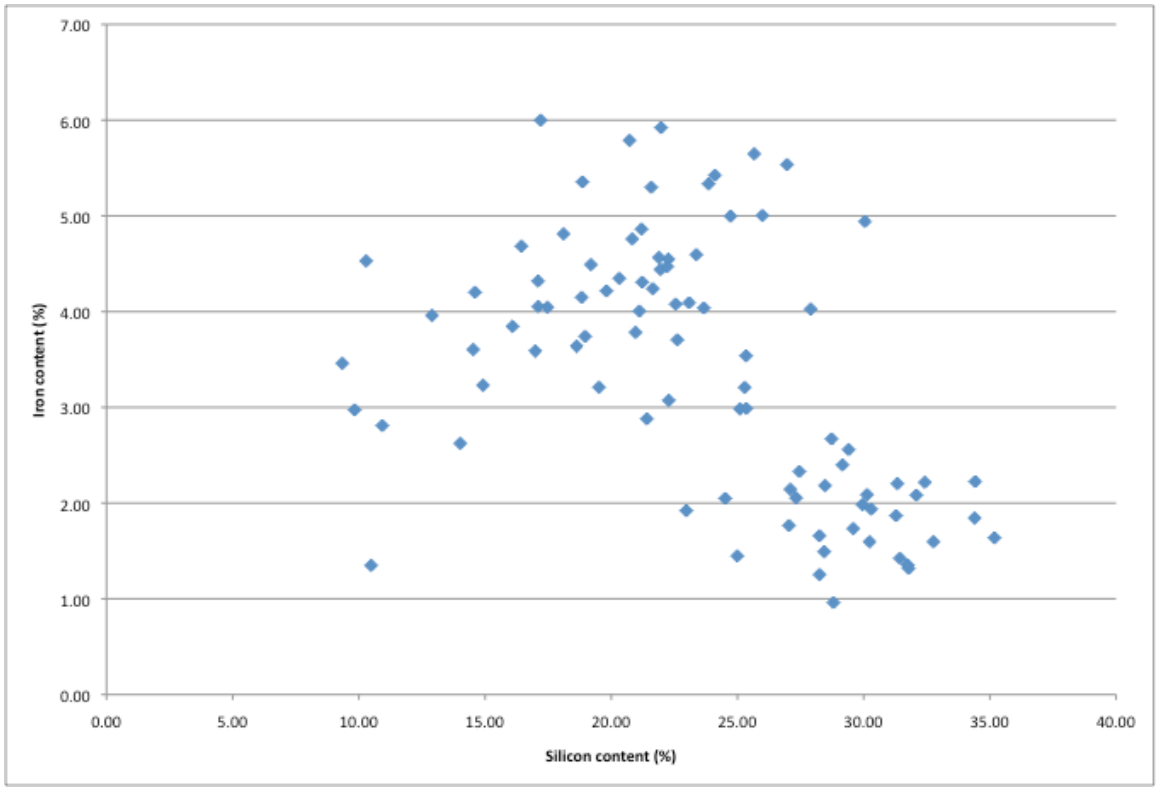

Figure 2 Graph showing levels of iron content (%) and silicon content (%) in the clay body

The groupings that follow the iron and silicon content within the ceramic body can be expanded to include calcium, which further highlights compositional variations. Three groups can be distinguished, one that has low Ca, low Fe and high Si, another with intermediate Si and Fe and low Ca, and a final group with high Ca and low Si and Fe (fig. 3).

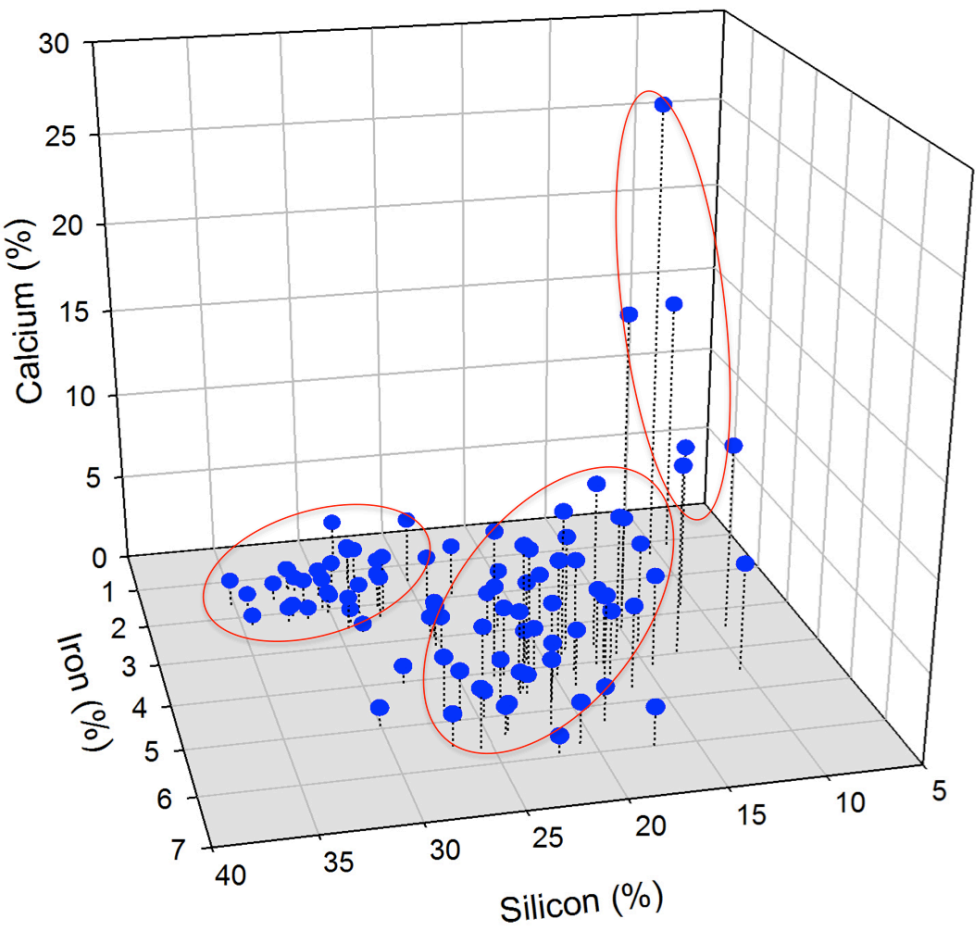

Figure 3: 3D plot showing groupings based on calcium, iron, and silicon contents in the ceramic body (%).

In their study of Maya figurines from the Motul de San José region, Guatemala, Halperin et al. (2009) discovered that the most important distinguishing factor between the pastes used in their study figures was the iron content (Fe). Based on the percentage of iron in the petrographic samples, the figurine could be described as being of local production or foreign production, and thus routes and direction of trade were determined. In the present case, the results are not as discriminating though the iron concentration variations might reflect different clay sources.

Among the trace elements, the levels of chromium (Cr) showed interesting variations and patterns. Based on chromium values in the clay body, the figurines can be split into three

groups, those with a chromium value higher than 600 ppm, those with a value between 46-600 ppm and those with values close or below the detection limit of the instrument, which is in the range of a few tenths of ppm (fig. 4). In previous research done by Torres et al. (1984), it was discovered that, using both neutron activation analysis (NAA) and atomic absorption spectroscopy (AAS), levels of chromium in ceramics from the nearby city of Jonuta were higher than those found in Jaina ceramics. Though the concentrations obtained in our analysis are higher than those reported by these authors, it can be assumed that there is some correlation between the amount of chromium in the clay body and the type of raw material and location of manufacture.

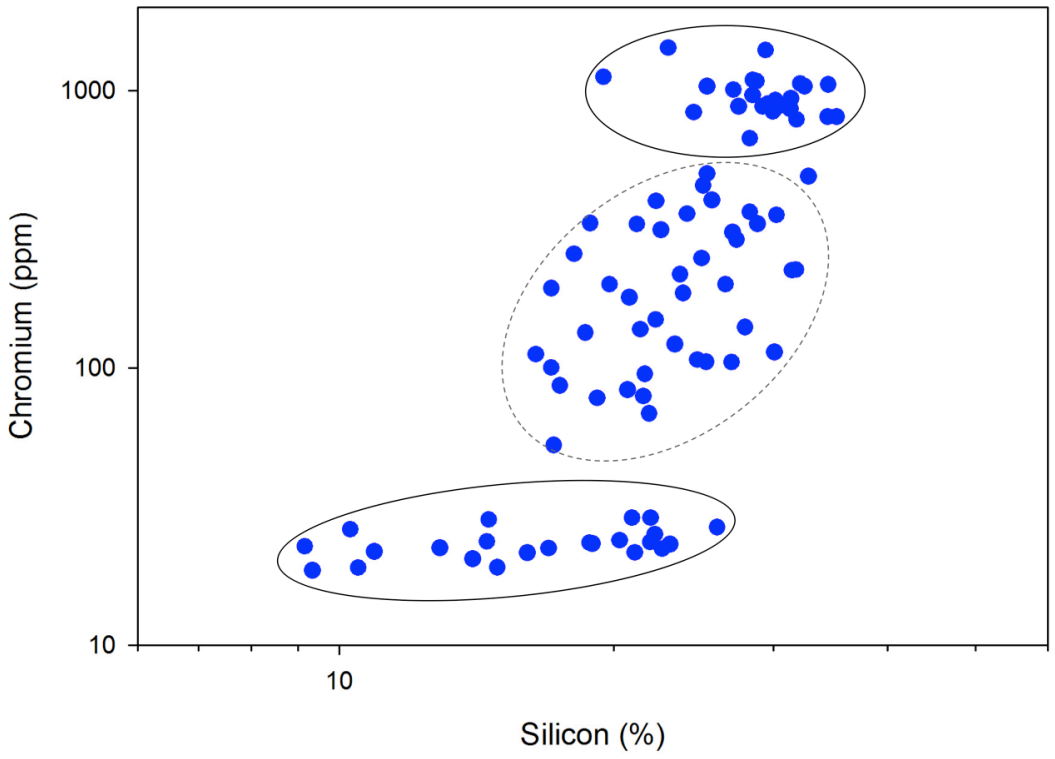

Figure 4: Si-Cr bivariate plot showing three distinct groups based on chromium levels in the ceramic body

Another possible indication of the temper used is the scattered values of potassium content in the figures (fig. 5). Examples of ceramic body that show a high concentration of

potassium (K) may be indicative of ceramics that have a high percentage of a glassy temper. These glassy tempers can be related to tuff tempers or rhyolitic glass inclusions. High values of chromium also are generally associated with low levels of potassium in the data, which would indicate that in objects utilizing a palygorskite-rich temper, glassy temper was either not used or in lesser amounts. Potassium is also found in volcanic ash, which would have been present in certain parts of Maya territories (mainly the highlands) due to the eruption of the Ilopango volcano around 250 B.C.E. (Sabloff 1998). If in fact used, natural concentrations of these materials may help to discover areas where manufacture had taken place.

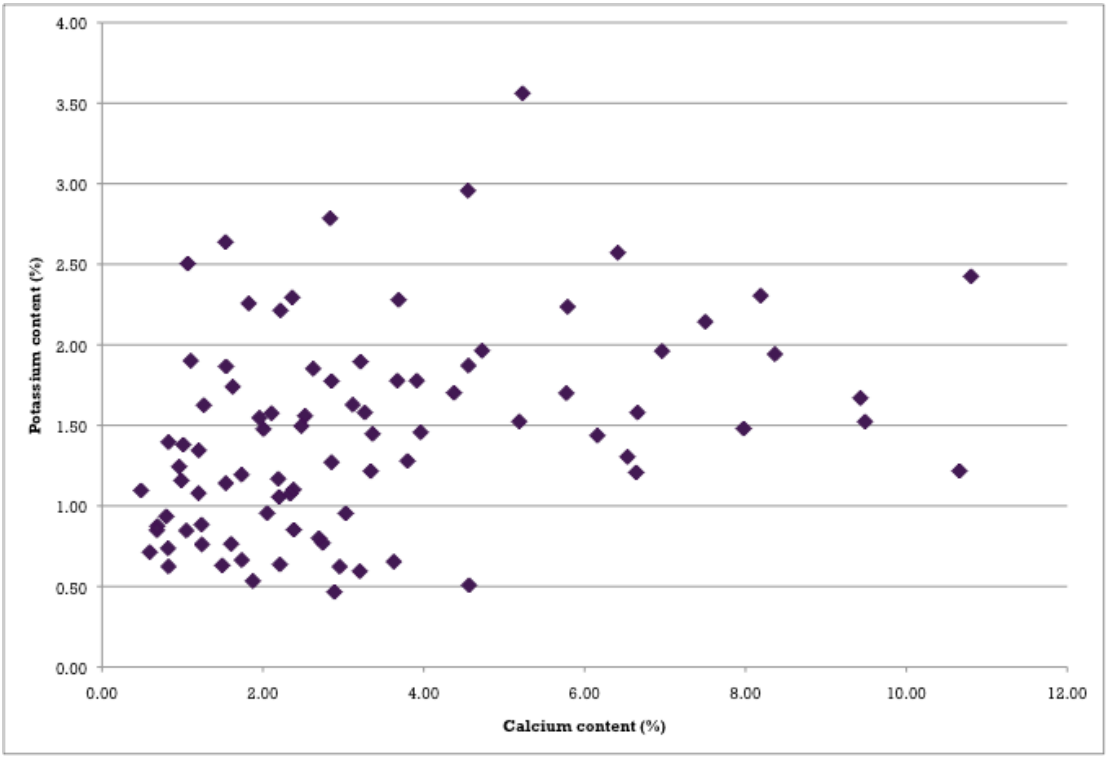

Figure 5: Graph showing the relationship between the calcium and potassium contents (%) in the ceramic paste.

On Jaina Island itself, no evidence of a ceramic workshop has been discovered in the form of dumps of molds and fragments in any of the many excavations (Miller 1975, McVicker 2012). There is also no natural plastic clay material to use as a molding material on the island itself. However, it is possible that the figures discovered on the island, which very much

resemble those found in Jonuta, a town 300 km away, were manufactured there, as Jonuta has been recognized as a center of manufacture for fine orange ware (Torres et al. 1984). There is also evidence that ceramic figurines were manufactured at many sites distributed along a 700 kilometers long Classic-Post Classic trade circuit between central Veracruz and the northern Campeche coast (Benavides 2005, McVicker 2012). Additionally, based on the ceramic study that Ruz Lhuillier (1945) performed of Campeche sites, he posits that, from identical typology of painted vessel at Jaina, Campeche, Edzna, and Oxkinlok, a homogenous center of power occupied this region during the Classic era facilitating trade between these coastal cities (Ruz Lhuillier 1945). Perhaps the far reaching and differing points of manufacture accounts for the variability in the clay compositions being witnessed within the data. In this case, the outliers could be simply less common examples made from a clay source further away or with a differing environment. On the other hand, the wide variation in the composition of clay body of the Jaina figurines may indicate the need for more and better samples. It is possible that individual figurines were manufactured with several types of clay, or simply that the ceramic paste was badly contaminated by salt and sascab during burial in the Island (Torres et al. 1984).

Two of the most referenced materials in the literature of Maya ceramics are *sak lu'um* and sascab. Arnold (2005) identifies *sak lu'um* (white earth) as pure palygorskite, and that *sah kab* (white powder) or *sascab* as two classes of materials. One is used in construction (plaster, mortar, surfacing) and is a natural mixture primarily composed of montmorillonite, calcite, and dolomite, while the second is used as a temper in Maya pottery and is carefully prepared with various amounts of calcite, dolomite and *sak lu'um* (palygorskite) and rarely montmorillonite. Although it is not expressly mentioned in his article, the use of *sascab* as a temper in ceramics indicates a strong possibility of its use in ceramic figurines as well, and that beyond

understanding the physical benefits of *sascab* as a temper, the Maya also used it for symbolic reasons.

The Maya for whom maize was a predominate source of nourishment, and held great importance in their society, cooked the grain with the addition of lime. By adding lime to boiling maize, the balance of essential amino acids is enhanced and the otherwise unavailable niacin compound is released (Coe 2005). It is likely that the Maya would have found a symmetry in adding a similar white powder to the clay that would infuse the figurine with life just as the addition of white lime to the cooking process was essential for drawing out the life of the maize. In his study to find the source of palygorskite for Maya Blue, Arnold et al. (2012) determined that one of the possible source sites showed samples with similar yttrium levels, but elevated vanadium and chromium. The elevated chromium present in the palygorskite may explain the variance in the chromium of our clay body. If the temper was taken from different source sites, then some may contain elevated Cr levels and while others have lower traces.

Figure 6 Example of a figurine with elevated mercury levels and no red pigment

Out of the 91 figurines analyzed with pXRF, twenty-three contained at least trace amounts of

mercury[5] in the elemental composition of their clay body. These figurines range in style, function type and character-type, and include both modeled and molded figurines. Among them, 13 have no visible traces of red pigment, nor do many of their figure types generally have red pigments used in their traditional decorations. Of the remaining ten that do have red pigment, only six show traces of mercury in the red pigment. It is therefore possible, for the cases where a mercury-based pigment was not used, that the presence of mercury could be explained by the figurines' archaeological context. It has been indeed noted that both hematite and cinnabar were sprinkled over the dead as a part of the funerary ritual (Piña Chan 1998) and, according to a study conducted on pigmented bones from Maya graves, cinnabar was exclusively used for burials of the Maya elite (Batta et al. 2013). Therefore, the presence of mercury in the accompanying grave goods may indicate the object's presence in a burial, and more specifically, an elite burial.

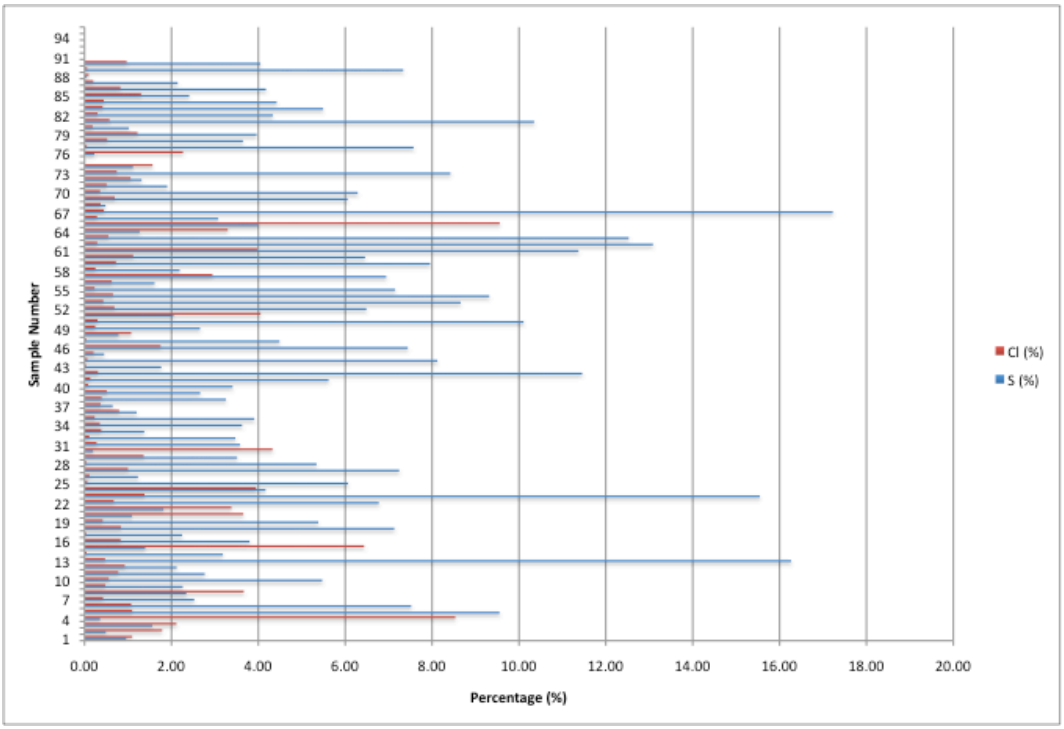

Figure 7 XRF data showing the percentage of chlorine and sulfur present in the clay body of each sample

[5] Only samples with 20 ppm (10 ppm more than the highest error) or above were counted as containing mercury.

As would be expected for ceramic material found in burial in a coastal environment, the Jaina figurines show physical evidence of weathering upon visual examination. The weathering of the ceramic body is also clearly evidenced in both the XRF and the UV/Vis/NIR analysis. In the graph plotting chlorine and sulfur values for each sample (which most likely correspond to chloride and sulfate ions), it would appear that the predominant salt responsible for weathering of the figurines in this collection is sulfate and not chloride, the latter of which would be more likely expected in a marine environment (fig. 3). Confirming the presence of sulfates, UV/Vis/NIR data shows that the spectra of most clay bodies show an absorption at 1940 nm, which corresponds to the combination band of water in gypsum ($CaSO_4$, $2H_2O$). However, the high levels of sulfur (>10 %) found in some figurines raises some questions and it might be possible that gypsum, or another sulfate-rich material, was added alongside with the *sascab* or was used as a slip that is no longer visible, because of a weathering-induced migration into the clay body. Nevertheless, based on the purity of the *sascab* and the careful selection of materials, it seems more likely that gypsum would have been used as a slip. This interpretation could be supported by Corson's (1975) description of the Campeche style figurine type, which he defines as having a uniform level of white paint over the entire front surface (see section 2.2.2).

2.2.2 Pigments

Post-firing, pigments were often applied to Jaina figurines, and in some cases have been identified and documented, though the methods of identification are not specified (Piña Chan 1948, Corson 1976, Coe 2005, O'Neil 2012). It has been suggested that the colors utilized may be able to help identify the represented person or character type, for example, blue paint corresponds to priests and sacrifices, and black and white paint corresponds to warriors (Piña Chan 1948). The use of cinnabar or red hematite also may have given the figures the appearance of life, which would symbolically give the deceased life for the journey to the underworld (Piña

Chan 1998). Additionally, the act of painting or modifying a surface creates a more life-like result, which transfers vital energy conferring identity to the ceramic (Houston et al. 1998).

Of the figures analyzed, 29 had traces of red pigment. Based solely on the XRF data, 20 out of the 29 had high levels of iron suggesting the use of red ochre (iron oxide), which could also be confirmed by the distinct absorptions of the electronic transitions of Fe^{3+} in the visible wavelength range of the UV/Vis/NIR spectra. Three of the samples were identified as a mercury containing pigment, most likely cinnabar, due to the presence of mercury in the XRF data for those objects. Six of the red pigment samples could not be clearly identified, because of similar iron amounts compared to the clay body and the lack of any indicative absorptions in the UV/Vis/NIR spectra.

White is by far the most ubiquitous pigment represented on the figurines. Because so little of the original pigment remains on the majority of the figures, it is unclear if a white ground or pigment was laid down prior to the application of another color, which would explain its prevalence. In the few examples of figurines where a significant amount of pigment still remains, it does appear that there is a white ground layer under the topmost pigment layer, however, due to the small sample size of extant examples and the evidence of cases where no ground exists, the areas in which white is visible must be treated as an intentional decorative application. It is also possible that white pigments were mixed with other colors to alter the hue.

In the XRF spectra, most of the white samples show an elevated presence of calcium (Appendix A). This trend is consistent with the XRD analysis on selected samples (Table 1), which has shown the presence of either gypsum ($CaSO_4$) and/or calcite ($CaCO_3$), both of which are readily available in the Maya lowlands and could have been used as a pigment. Though some white pigments have slightly elevated levels of lead, tin, and barium, trace amounts of these elements can naturally be found in the various materials used to manufacture the figurines (i.e.

clay and temper). Areas in which there were higher levels of barium, lead, and zinc generally correspond to fills, which may indicate the use of barite ($BaSO_4$) or lead and tin white as whiteners or bulking agents in past treatments.

Table 1 Results of x-ray diffraction analysis (See Appendix A for spectra)

Object Number	Sample Type	Minerals identified
X75.1760	White	Quartz, Gypsum, Calcite, Muscovite
X76.722	Gray material on surface	Calcite
X76.738	White	Quartz, Muscovite, Gypsum
X91.2269	Blue	Palygorskite
X2010.16.23A	Blue (2 runs)	1. Palygorskite 2. Palygorskite, Montmorillonite

A yellow pigment was observed on only 3 figurines out of 92. Among those, two showed an elevated level of iron and absorptions in the Vis/NIR at 492, 676, and 929 nm corresponding to Fe^{3+} electronic transitions, which indicates the possible use of yellow ochre, an iron oxyhydroxide. The third sample (X2010.16.11) did have a significant increase in the iron levels as compared to the clay body and had peaks of chromium. As the pXRF will analyze both the surface material and the substrate, it is likely that the Cr readings are found in the clay body. Unfortunately, the presence of iron oxides or lack thereof could not be determined using UV/Vis/NIR due to inaccessibility of the probe to the object's surface.

2.2.3 Maya Blue

As described previously, the pigment Maya blue is composed of two main materials, palygorskite clay and indigo. The presence of palygorskite clay was verified for most of the blues in our data by multiple absorptions including, most notably, the Al-OH combination bands at about 2220 nm. According to the study performed by Gionis et al. (2006), the peak that we are seeing for the Al_2OH combination band is consistent with the ambient form of palygorskite and not the dehydrated form, which has this same band slightly shifted at 2215 nm. As this shift is

reversible upon rehydration, it may indicate that burial and ambient water has been reintroduced to the clay structure following dehydration during in the manufacture heating process of Maya blue.

Unfortunately, the chemical composition of palygorskite limits the usefulness of pXRF for the analysis of the blue pigment, and even if this clay would contain some characteristic trace elements such as chromium, the low amount of blue pigment and the X-ray emission depth that largely includes the clay body underneath the pigment would not allow for accurate measurements.

In their study Leona et al. (2004) found that modern Maya Blue and Maya Blue from archaeological samples produced identical spectra with UV-Visible-Near Infrared spectrophotometer, Fiber optics UV-Visible Reflectance Spectroscopy, Raman Microspectroscopy, and Fourier Transform Infrared Microspectroscopy (FTIR). They also stated that the NIR was the only region where no significant information concerning Maya Blue could be obtained, which is not really correct, as we have shown that the characteristic absorptions of palygorskite can be used as a proxy for Maya blue. Obviously, the most valuable information about the blue is obtained in the visible wavelength range. The spectra show that a majority of the blue areas on the figurines have absorptions bands around 500 and 650-700 nm corresponding to the absorptions of a Maya blue reference samples (fig. 8), in agreement with previous research (Leaona et al. 2004). It should be mentioned that these absorption bands show a blue shift of about 20 to 50 nm compared to the spectrum of indigo.

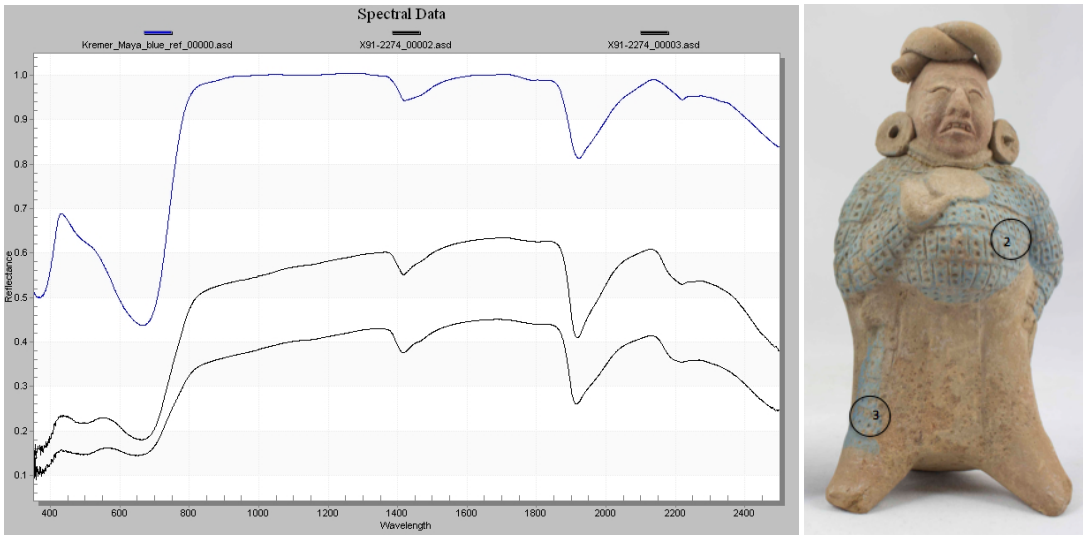

Figure 8: UV/Vis/NIR of a Maya blue reference and a sample of Maya blue from X91.2274, displaying the corresponding absorptions for both the indigo and palygorskite. Also shown is an image of the figure showing the sample locations and approximate spot size.

Many of the blue samples showed also absorptions at approximately 1940 nm indicating the presence of gypsum in the pigment, even when the clay body did not show the same absorptions. This phenomenon could explain the slight color fading observed for Maya blue after exposure to sulfuric acid and may be explained by the formation of calcium sulfate from the calcium carbonate impurities present in the palygorskite clay. Sulfuric acid may have been introduced to the figurines due to acid rain while still in burial. Saliya (2004) showed that exposure to both hydrochloric acid and sulfuric acid induced reactions with calcium carbonate impurities in the clay, resulting in poor color stability.

3. Condition Survey

3.1 Nature of The Fowler Museum and Its Collection

The Fowler Museum, located on the University of California Los Angeles (UCLA) campus, contains a collection of archaeological and ethnographic objects. Objects within the collection have come to the museum through donations from private collections, purchases, and archaeological excavations conducted by the university. In 1963, the UCLA Chancellor Franklin D.

Murphy established the museum, which was known as the Museum and Laboratories of Ethnic Arts and Technology (http://www.fowler.ucla.edu/about/history). At that time, the museum was a means of consolidating the multiple collections of non-western art objects on campus. The original museum was located in the basement of UCLA's Haines Hall until 1992 when a new building was built specifically to house the museum, storage rooms and conservation labs. Although the majority of the collections are at the new Fowler facility, a large portion of the archaeological collection is stored in a separate facility in UCLA's Kinross building. The current Fowler Museum "explores global arts and cultures with an emphasis on works from Africa, Asia, the Pacific and the Americas—past and present" (http://www.fowler.ucla.edu/about).

Among the Fowler Museum's collections is a large group of Jaina and Jaina-style figurines acquired between 1971 and 2012. For a variety of reasons, despite the progressive increase in the number of these objects over the years through various donations, a comprehensive stylistic and technical study of the figurines has never been conducted.

3.2 Aims of the Survey

The survey project was developed with the aim of creating an easily accessible database that gathers the pertinent information of all these Jaina and Jaina-style figurines. By compiling this data in one location, it is hoped that future research and conservation treatments can be more easily implemented. The main focus of the survey was to assess the current condition of each figurine, to document them fully and to evaluate the need for any future treatment to ensure the stability of the objects.

3.3 Methodology

To begin the survey, the records held by the museum were reviewed to determine which of the figurines would be examined. The Fowler museum employs the Argus collection

management system manufactured by Questor Systems Inc. Although the management system is meant to be highly customizable, there are some limits to the functions that it can perform and limitations based on user variability. Therefore, the first search for Jaina figurines resulted in the listing of approximately 80 figurines. However, upon retrieving the figurines from storage for examination, it was noted that some in the storage drawers were not listed in the search results, but had attributes of Jaina or Jaina-style figurines. Following this discovery, a second search was performed to broaden the search parameters, allowing the database to access keywords in the sub-categories as opposed to only the primary ones. This secondary search provided the 168 records that currently make up the survey database. However, based on the difficulty in conducting a thorough search using just the Argus collection management system, and classification systems developed by the registrars, it is possible that the Fowler's collection contains more than just the figurines included in this survey. Once the list was compiled and reviewed, it was decided that 92 of the 168 figurines, which were the most representative would be fully examined as a part of this survey and would be provide an appropriate study set for the parameters of the paper.

Initially, a new survey database was created using FileMaker Pro 12, into which the information existing in the Argus collection management system was looked over and inserted. This information came primarily from the registrar's office, and from the documentation that originally accompanied the figurines to the museum collection[6]. The next step of the survey was to perform a complete visual examination of each figurine, which consisted of a written description of the object and signs of manufacture, assessment of the condition, and surface

[6] The group of figurines that that were donated to the museum in 1976 (object numbers that begin with X76), as part of a larger donation, came with a brief set of notes compiled by Hasso von Winning, an expert in Mesoamerican figurines. Argus records state that these documents should be consulted for further information, however, upon examination of the supplemental paperwork, it seems that all pertinent information was already included in the Argus database.

examination using a binocular microscope. Following the examination, each object was photographed in visible light from six different angles (back, front, proper left, proper right, top, and bottom) in a white softbox light tent diffuser and using a Canon EOS Rebel T3i camera fitted with an 18-55 mm zoom lens.

3.4 Creation of Database and Survey Form

The Jaina figurine database was created to supplement the current Fowler Museum database by including more detailed information on the appearance and condition of the examined objects. It was also meant to create an easier and more accessible search experience to utilize the information that would be useful for future conservators and researchers needing information about this collection of figurines.

The initial versions of the survey form were solely based on a narrative format for all of the information collected, including condition. While this format is helpful for conveying more nuanced information, it was not conducive for quick searches or uniform classifications. Following the pilot run of the form using a small sample of the collection, it was determined that a checklist that would summarize major condition issues and treatment recommendations was needed. These were subsequently added to the form (Appendix D) and clear definitions applied to each of the options in order to create more consistent survey results regardless of who is conducting the survey.

3.5 Results and Discussion

One of the immediate benefits of conducting the survey of the Jaina figurine collection of the Fowler Museum is the overall view of the condition issues present and the severity of those problems. Based on the data collected from the 92 objects, it was established that the

main condition issues were minor losses (71%), visible salt efflorescence (42%), and minor past interventions (38%).

Table 2 Table defining the condition issues as were applied to the survey. It also indicates the number of objects assigned each condition issue and the percentage of objects examined to which these issues were ascribed

Condition Issue	*Definition of issue*	*No. of objects*	*Percentage*
Minor Spalling	Less than 20% of the surface shows evidence of spalling	15	16%
Moderate Spalling	Less than 40% of the surface shows evidence of spalling	6	7%
Severe Spalling	Figure is actively spalling; over 40% of the surface is lost or damaged	2	2%
Minor past interventions	Small reattachments, small areas of fill	35	38%
Major past interventions	Complete reconstruction, large areas of fill, multiple areas of reattachment	16	17%
Powdery or flaking paint	Paint comes off the figure during handling and in contact with housing materials	6	7%
Visible salt efflorescence	Crystals or crusts of salt visible on the surface	39	42%
Minor losses	Small losses along the edges, losses of small elements of costume	65	71%
Moderate losses	Multiple small losses, larger losses of hands, feet, etc.	18	20%
Severe losses	Loss of entire area (entire limb, majority of surface, etc.)	7	8%
Minor cracking	Hairline cracking	16	17%
Major cracking	Large cracks that may effect stability (especially with handling or future treatment)	10	11%

Of the 92 figures examined, 64% required treatment and were assigned priority levels to provide a recommended treatment order. These priority levels were determined based on predefined parameters. The terms were defined as follows: Low – with proper environmental controls, the need for treatment is likely not necessary, though the object may benefit from the recommended treatment; Medium – treatment is recommended though urgency is not required; High – the object should be treated in a timely manner to ensure that further harm

does not come to the object. Based on these definitions, 80% were classified as low priority, 17% as medium priority, and 3% as high priority. This indicated that though the collection was in need of conservation attention, the majority of the figurines are stable in their storage environment.

The survey also indicated that the main treatments, for the objects that need attention, were desalination (71%) and consolidation (32%). Because many of the powdery and flaking surfaces were associated with salt damage, and would therefore first need to be ameliorated by a desalination intervention, many of the required consolidation treatments would be combined with the larger desalination program. Only a small number of the figurines need retreatment of joins (10%) and retreatment of fills (5%).

Based on the survey results it also appears that the current storage conditions are adequate for ensuring the stability of the objects. No special packaging or supports are required at the time of examination.

4. Conservation of Five Selected Figurines

4.1 Selection of Objects

In order to complement the results of the survey, objects were selected for treatment that would provide insight into the future treatment of the remainder of the Fowler Museum's Jaina collection. Although every treatment is ultimately driven by the unique considerations demanded by the objects themselves, a general treatment approach can be developed for objects with similar condition issues. Therefore, the two most representative treatments, desalination and the retreatment of joins, were chosen for treatment.

To provide an extensive and complete desalination protocol for the ceramic figurines in the collection, Fowler object X76.722 (fig. 9) was chosen primarily because it was one of two

objects surveyed that was deemed a high treatment priority. The object is obviously in a very advanced stage of deterioration suggesting the highest chance of encountering diverse examples of the complications that could potentially arise in the desalination and consolidation processes. By addressing the problems inherent to this piece, future desalination treatments for this collection would be more streamlined and safer for the objects.

Figure 9 Before treatment images of object X76.722 (left) and X91.2269 (right)

The figurine chosen for the retreatment of joins, Fowler object X91.2269 (fig. 9), provided the most extensive example of the issue. The figurine was fractured into 11 pieces and reassembled with an excess of adhesive that had yellowed and began to lift, removing the surrounding paint in the process. Additionally, based on visual examination, the adhesive used originally to reassemble the figure appears, to be the same one used on a majority of the

previously treated joins. Due to the number of joins and the complexity presented by the lifting paint layer, this object was chosen as an appropriate example of retreating past joins[7].

4.2 Desalination Treatments

The goal of desalination is to remove soluble salts from within the fabric of an object so that the deliquescence and recrystallization cycles that occur as temperature and humidity fluctuate do not cause harm to the object. The treatment consists of introducing water into a material in order to solubilize and extract salts from the pores of that material. The water can be introduced via many different methods, the most common ones being full immersion of the object fully in water, soaking the water into an applied poultice material, or by creating a vapor chamber (Paterakis 1987, Unruh 2001).

Prior to the desalination process, pre-consolidation of the flaky ceramic surface was required to reduce the losses that can occur during submersion. Pre-consolidation is not always necessary, however, due to the extreme degradation of the surface, it was needed in this case. Consolidation treatment choices need to take a number of factors into consideration such as the strength of the consolidant being used, the effect that the consolidant will have on the appearance of the object, and the compatibility between the consolidant and the object. Additionally, considerations beyond the materiality of the object must also be considered. In the case of treating a large amount of objects from the Fowler Museum, some of the factors that had to be considered included the feasibility of the treatment based on lab conditions, the cost of the materials, and the time needed to fully complete the treatment.

[7] Object X2010.16.7 also required a small retreatment and was chosen to be part of the test treatments due to the fact that the join had failed causing a small loss to the object that needed to be reattached. To lessen the chances of the small section being lost when put back in storage, treatment was performed as part of this intervention. Object X2010.16.6 and X2010.16.23A were also treated (though in this case the treatment was for rejoining breaks) for similar concerns of having the original pieces become disassociated from the piece.

Initially, two pre-consolidation treatments were proposed as possible options. One would be the use of ethyl silicates, and the other of a dilute solution of Paraloid B72 in toluene. Based on a number of factors including insufficient previous testing and studies of ethyl silicates used in consolidation treatments of ceramics, and the time that would have been needed to complete the pre-consolidation treatment, the ethyl silicate option was considered an inappropriate choice for the treatment protocol[8]. Alternately, based on tests conducted for the treatment on two similar figurines in the Fowler collection in the fall of 2011 (X75.1746 & X77.769), a dilute solution of B72 in toluene was known be an effective consolidant that limited color change in the ceramic body. Therefore, due to its proven effectiveness in the testing and subsequent use during treatment of these two ceramics it was decided that this was the most appropriate resin and solvent option. In addition to the main consolidant used, a secondary, bulkier resin was needed for areas on the surface that had actively spalling flakes rising from the surface of the piece. This secondary consolidation had to last only for the duration of the desalination treatment, therefore cyclododecane[9] was heated and applied using a glass dropper on to the extremely vulnerable areas of the surface in order to provide temporary support. The stabilization that was provided by the cyclododecane during immersion would then be reevaluated once the object was removed from the water to avoid over consolidating the ceramic.

Once the figure had been sufficiently consolidated, the desalination treatment was carried out using an immersion method. However, due to the fragility of the object, the length of submersion was a primary concern. The most common submersion methods of desalination

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[8] See Appendix E, treatment report for object X76.722, for a full discussion of the issue of pre-consolidation.

[9] An organic compound ($C_{12}H_{24}$) that is a white waxy solid at room temperature and sublimes at room temperature. Aside from liquefying when heat is applied, the material is soluble in non-polar organic solvents.

rely solely on the ratio of salts present in the bath water. Of these methods, the most widely used is the K_{adj} method (Unruh 2001), which provides the conservator with a mode of desalination that limits water waste and better represents the amount of salts that are being removed from the object. In this method, the object is left in the water bath until the conductivity constant no longer continues to drop towards zero. The equation for Unruh's method is $K_{adj}=K(L)/g$, which accounts for the conductivity reading, the amount of water in the bath, and the mass of the object being immersed. Solving the equation for the conductivity variable, allows comparisons among objects to be made more easily. On the other hand, by introducing time as a factor in the equation, as in the K_{norm} method (White et al. 2010), it provides a more accurate picture of the rate of salt extraction, which permits the object to be in the bath for a shorter amount of time. This method bases the endpoint of desalination on a conductivity reading which takes into account the change in conductivity, the change in time between readings, the volume of water in the bath, and the mass of the object being treated ($K_{norm}=\Delta K(L)/\Delta t(g)$). By incorporating time into the equation and taking measurements more frequently over the soaking period, the White method (White et al. 2010) provides a more accurate measure of the rate of salt extraction as opposed to measurements taken once every 24 hours, which only provides an average of the daily rate of extraction. With the more precise measurements, the point at which the rate of extraction plateaus is seen earlier and can cut down on the immersion time required for an object. For these reasons the White et al. (2010) method was chosen as the most appropriate for this and future cases.

One aspect of both immersion techniques to consider, however, is the end point of desalination. In the White et al. article the authors discuss removing the object when the desalination rate value reaches 2.0, though the reasoning for this endpoint is that it was similar to Unruh's experience with a specific set of ceramics and on "past ASM experience desalinating

Southwestern ceramics" (White et al. 2010, 50). In our case, the final K_{norm} was 5.28 after 17 hours of submersion[10]. Due to concern about longer submersion times, the seeming plateau in the rate of change, and the fact that the object was returning to a controlled environment, this was deemed an adequate endpoint.

4.3 Retreatment of Objects

The retreatment of objects that underwent previous restorations or conservation interventions stems from certain factors that include concerns about future stability and aesthetic issues. The most common factors include degradation of the treatment materials, which can cause further harm to the objects themselves, an incompatibility of materials causing instability in the treated areas, and poor physical alignment that puts stress on the rest of the object.

To effectively retreat previously treated objects, identifying the materials used and how to reverse them, is one of the most important issue to be addressed. The least invasive, though often least indicative test that can be performed to identify past treatment materials, is ultraviolet (UV) induced visible luminescence. Though it does not often lead to a positive identification of the materials, some of the fluorescence colors can be clearly associated with a specific material, or at least narrow down the possible choices. Although the adhesive on figurine X91.2269 did fluoresce, the color of the fluorescence was not clearly indicative of a specific adhesive material.

Following the UV examination, a standard solubility test should be performed in order to determine in which solvents or solvent types the material is soluble, which can help in its identification. The adhesive used in the reconstruction of X91.2269 was insoluble in water,

[10] The 17 hours of submersion time was carried out over two days to allow for adequate supervision during the process. Between days, the object was removed from the water bath and stored in a separate airtight container, then reintroduced to the water bath the next day.

softened in ethanol and mineral spirits, and was soluble in acetone. This information permitted the discard of some of the adhesives that were popularly used in past interventions such as proteinaceous glues (only soluble in water) and shellac (soluble in ethanol).

Due to the yellowing of the adhesive and the results of the solubility tests, there was a strong likelihood that the adhesive was cellulose nitrate. A diphenylamine spot test (Odegaard et al. 2005) was performed on a small sample to confirm this hypothesis, and resulted in a positive result. Object X2010.16.7 had a material with similar visual characteristics on the failed join of the headpiece as well as a comparable fluorescence color from the ultraviolet examination and identical results from the solubility, pointing towards cellulose nitrate though this was not confirmed through more extensive testing.

Identifying the adhesive as cellulose nitrate further validated the retreatment of the object due to its aging qualities. Beyond the dangers that were apparent from the visual examination (i.e. Lifting paint, yellowing), cellulose nitrate is not a stable compound. Cellulose nitrate often contains acid impurities from the manufacturing process that can leach out plasticizers, and/or contribute to alterations induced by common environmental factors such as light exposure and humidity (Koob 1982).

5. Conclusion

One of the greatest mysteries of the Maya that still persists, is the purpose and importance of ceramic figurines in their culture. Complicating the general discussion of Maya figurines, are the Jaina figurines, which have been misattributed and forged over the years, and are often unprovenanced. Through the analysis of the materials that were used to manufacture the figurines in the Fowler's collection, we have been able to confirm the use of native pigments and of those that had previously been documented by art history scholars. The overwhelming

use of iron based pigments for the red painted areas points to the more widespread and common use of ochre. The more limited evidence of mercury use, both in the clay body and in pigment analysis, indicates that mercury-based red pigments were reserved for elites.

Our analysis also indicates that the most frequent blue pigment found on the Fowler figurines is Maya blue. The presence of palygorskite absorption bands in the UV/Vis/NIR is an indicative characteristic of Maya blue pigment, and can assist in verifying the pigment's use. Additionally, the slight shift in the visible from the traditional indigo peak confirms that the indigo has chemically bonded to the clay substrate affecting its charge distribution.

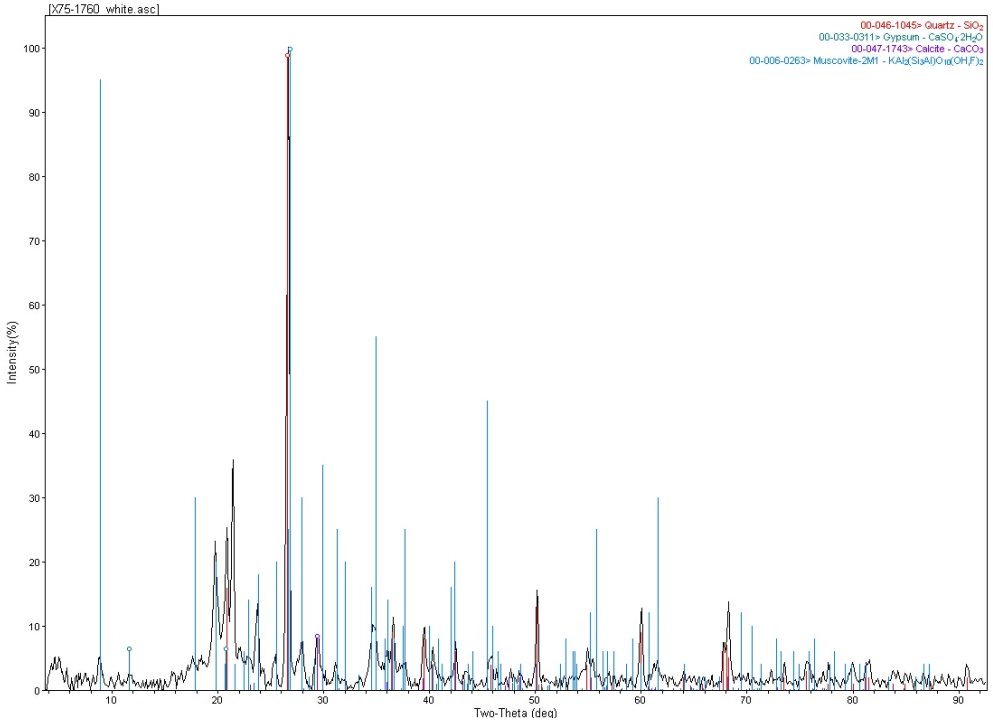
Through the survey of 92 figurines we were able to create a more easily accessible system for the organization of both curatorial and conservation information in regards to the Jaina figurines of the Fowler's collection. The survey provides an efficient method of identifying figurines that share similar condition issues as well as the urgency with which the object requires treatment. This is integral to a museum in which treating backlogged items is not always possible. By making the information more available to the conservator, the rate at which treatments can be performed is significantly higher. Furthermore, the implementation of a treatment protocol for the objects will ensure that in the future, the figurines receive the same level of care regardless of the person carrying out the treatment. The use of the White et al. (2010) desalination monitoring protocol also provides more consistent results while safeguarding the objects from overlong exposure to the detrimental effects of immersion in water.

The survey has also represented an opportunity for a more in-depth study of the figurines allowing a comparison and classification of the variety of figure types that are labeled Jaina figurines. Materials analysis has provided some keys about the nature and variability of the compounds used to manufacture and decorate the figurines as well as to assign a broader

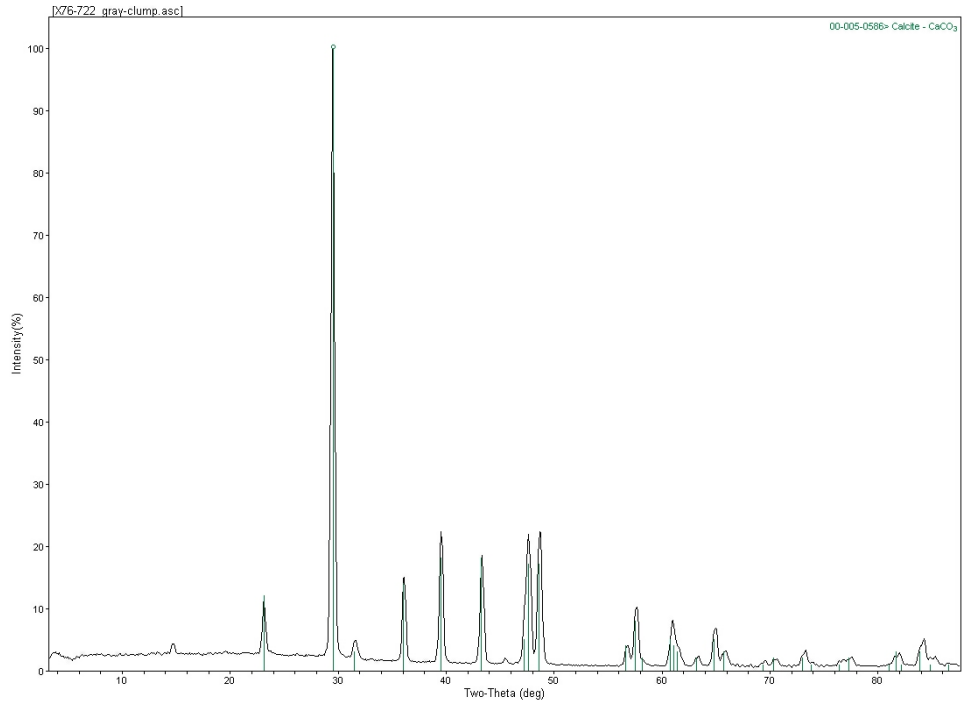
meaning to trade that accounts for stylistic differences as opposed to the common belief that they point to fakes or forgeries. Further research is needed to explore the possible clay types of the Yucatán and farther afield into the Maya territories in order to perform authentication, provenance studies, and sourcing. However, based on the data collected here, it seems that the figures that were discovered in Jaina were most likely traded from other cities along the northern Yucatán coast and perhaps even ones that are farther away.

6. Appendices

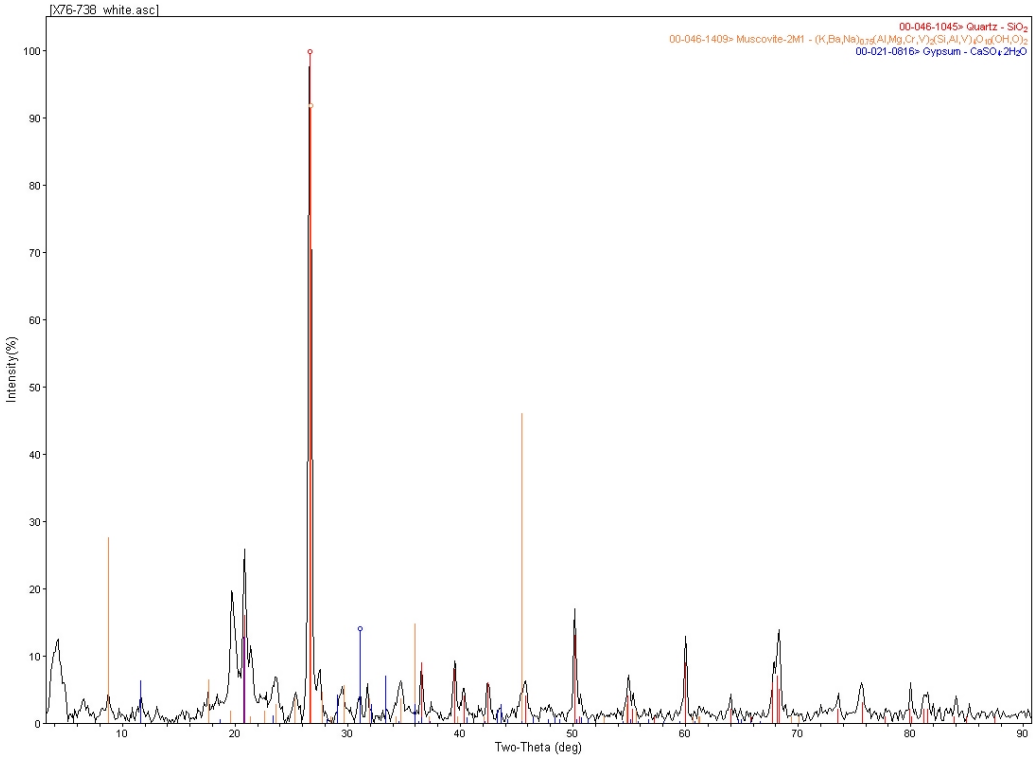
Appendix A – XRD Spectra



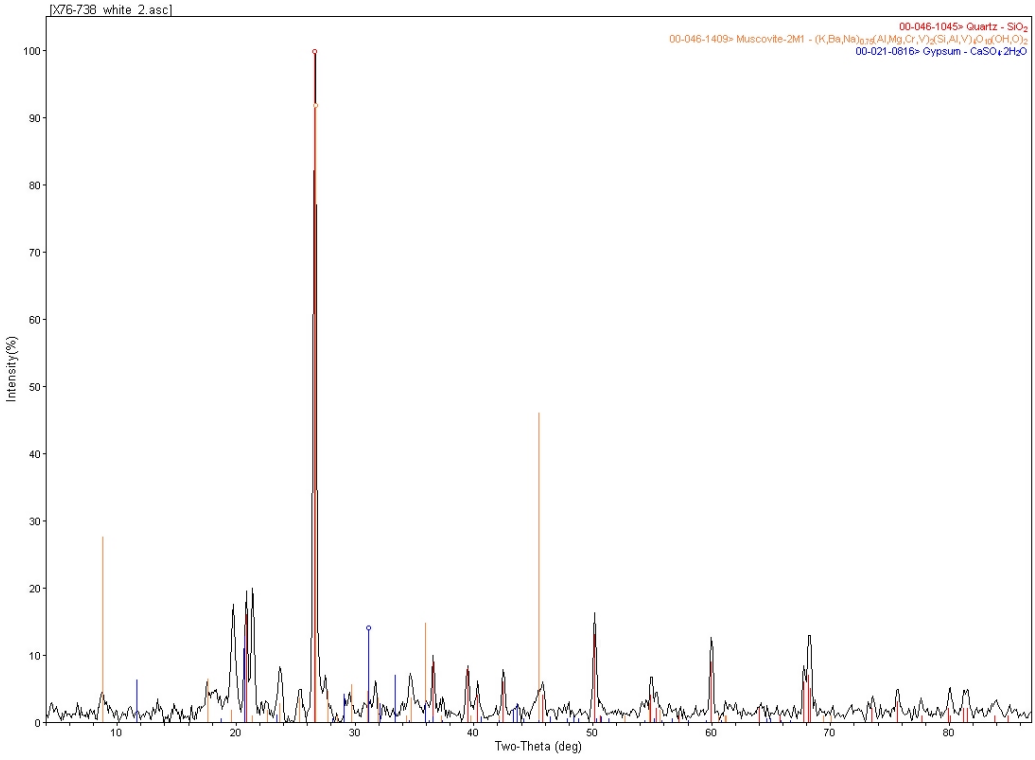
X75.1760 White sample



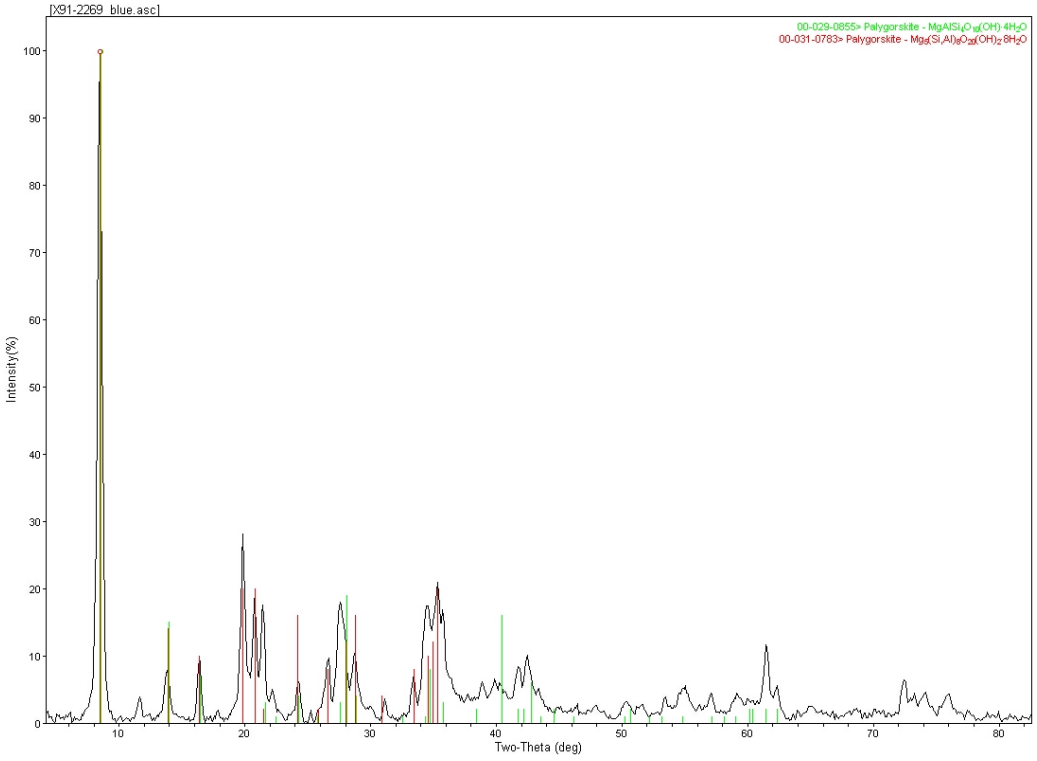
X76.722 Gray material



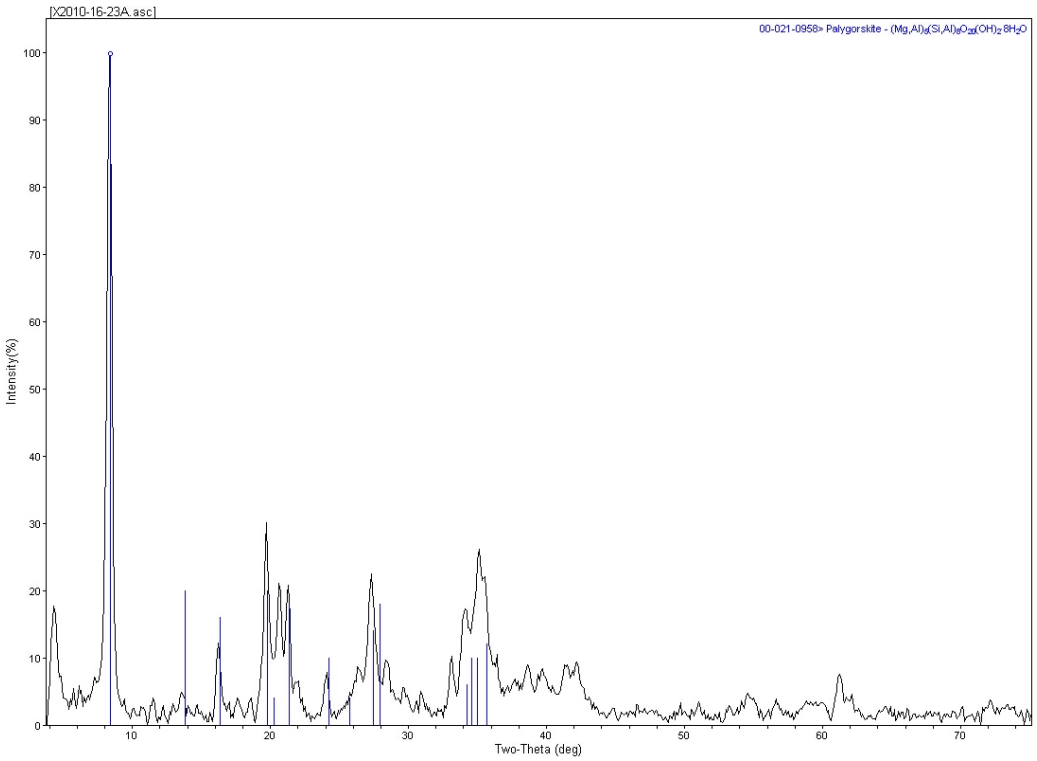
X76.738 White Sample



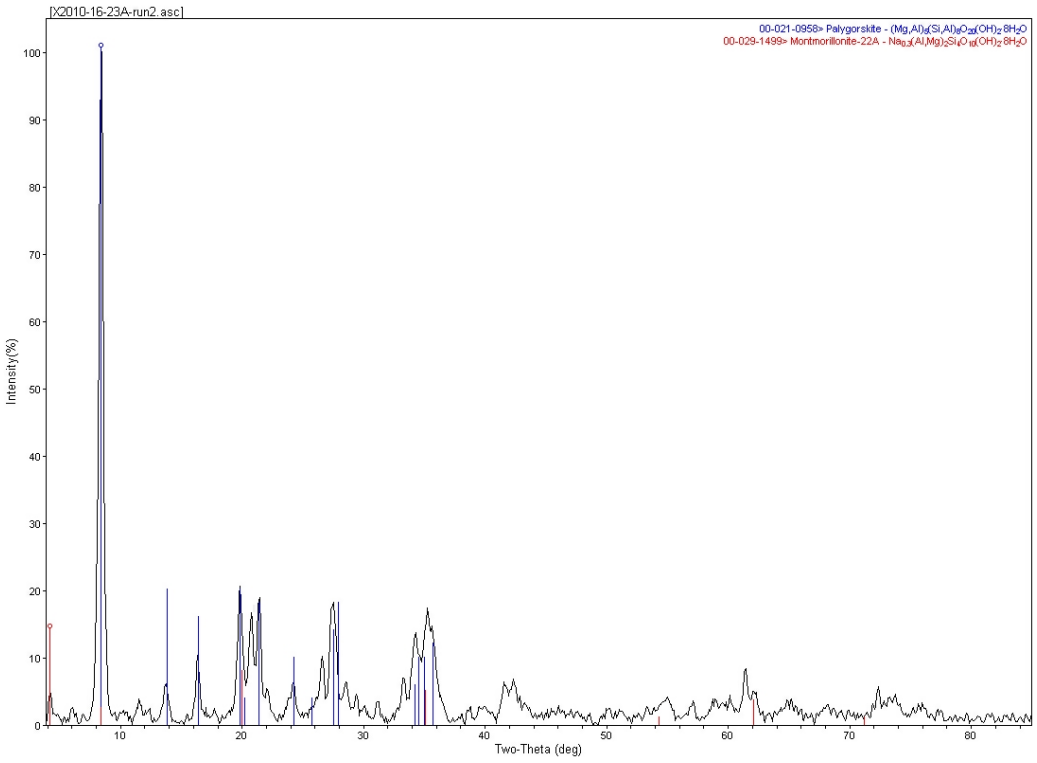
X76.738 White second sample



X91.2269 Blue sample



X2010.16.23A Blue sample



X2010.16.23A Blue sample – second run

SAMPLE	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)	K_2O (%)	P (%)	S (%)	Cl (%)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Ti (ppm)
X71.1738	31.33	4.64	2.20	0.68	0.85	< LOD	0.96	1.10	37	79	759	5824
X72.431	32.09	4.58	2.08	0.69	0.88	< LOD	0.49	1.79	35	77	839	5688
X75.1740	29.16	4.07	2.40	0.80	0.94	0.07	1.56	2.12	43	60	805	5041
X75.1744	21.89	6.13	4.57	1.10	1.90	0.11	0.36	8.54	98	218	259	5142
X75.1752	18.83	6.35	4.15	6.41	2.57	0.10	9.55	1.10	115	376	222	4911
X75.1759	20.32	5.20	4.35	4.56	1.87	0.22	7.52	1.07	99	245	232	5165
X75.1760	25.99	6.76	5.00	2.84	2.79	0.26	2.52	0.43	111	303	231	5799
X75.1762	25.35	4.21	2.99	1.24	0.88	< LOD	2.34	3.67	52	76	796	5783
X75.1763	30.13	4.19	2.09	1.24	0.76	0.19	2.26	0.48	26	102	735	4328
X75.1764	21.95	7.04	4.44	8.19	2.31	0.29	5.47	0.56	111	393	260	4478
X76.722	24.73	8.18	5.00	1.54	2.64	< LOD	2.77	0.78	130	166	215	6228
X76.726	22.22	4.82	4.47	4.55	2.96	0.73	2.12	0.93	108	272	252	6155
X76.727	10.93	2.06	2.81	9.49	1.52	0.60	16.27	0.47	90	399	210	3746
X76.732	21.23	5.27	4.31	3.12	1.63	0.61	3.19	0.05	99	225	319	4843
X76.733	22.26	4.97	4.55	1.27	1.63	0.11	1.40	6.44	89	288	389	4906
X76.735	23.37	6.98	4.60	2.22	2.21	0.11	3.80	0.83	114	263	258	5500
X76.737	24.11	7.36	5.42	1.63	1.74	1.44	2.25	0.04	98	152	319	6055
X76.738	21.12	6.19	4.01	6.96	1.96	< LOD	7.13	0.84	109	385	230	3900
X76.740	28.80	2.54	0.96	3.03	0.95	0.23	5.38	0.42	49	174	321	3573
X76.744	23.86	7.12	5.33	1.54	1.87	< LOD	1.09	3.65	106	203	226	5525
X76.756	23.08	5.43	4.09	5.23	3.56	0.24	1.82	3.38	103	354	241	4165
X76.758	22.62	6.43	3.71	7.50	2.14	< LOD	6.77	0.67	114	456	225	4476
X76.760	14.53	3.26	3.60	5.79	2.24	0.23	15.55	1.38	106	283	241	4457
X76.764	18.96	5.83	3.74	8.37	1.94	< LOD	4.17	3.95	99	397	222	4214
X76.768	22.55	5.52	4.08	3.91	1.78	0.11	6.06	0.06	89	134	319	4881
X76.771	18.86	5.64	5.36	1.96	1.55	0.77	1.23	0.11	102	190	303	6139
X76.772	18.11	5.41	4.81	5.77	1.70	0.12	7.24	1.00	104	189	250	4003
X76.775	25.34	5.61	3.54	2.48	1.50	< LOD	5.34	0.05	93	206	395	5044
X76.778	27.09	4.06	2.14	3.21	0.60	0.73	3.51	1.36	39	114	820	4269
X76.780	28.73	9.84	2.67	0.49	1.10	0.10	0.20	4.33	44	141	572	9855
X76.781	28.25	3.63	1.25	2.05	0.96	0.21	3.58	0.28	58	109	376	3677
X76.782	22.28	4.22	3.07	2.53	1.56	0.42	3.47	0.11	89	194	368	5013
X76.783	29.95	2.94	1.98	0.83	0.62	< LOD	1.37	0.38	28	66	692	4795
X76.786	16.09	3.24	3.85	7.98	1.48	0.26	3.63	0.35	99	252	247	4044
X76.787	29.40	3.62	2.56	1.88	0.53	< LOD	3.91	0.23	26	53	605	4646
X76.788	28.47	3.63	2.18	1.74	1.19	< LOD	1.20	0.80	35	93	893	5226
X76.789	30.30	3.98	1.94	1.74	0.66	< LOD	0.65	0.37	32	67	784	5427
X76.790	31.29	3.71	1.87	1.61	0.76	< LOD	3.25	0.39	31	101	828	4621
X76.791	29.59	2.85	1.73	2.21	0.64	1.08	2.66	0.51	40	105	571	4579
X76.792	20.96	4.61	3.78	4.56	0.51	0.76	3.41	0.08	15	750	155	4837
X76.793	28.25	2.56	1.66	2.75	0.77	0.57	5.62	0.13	34	214	528	5872
X76.794	17.10	4.27	4.32	3.69	2.28	0.35	11.46	0.31	95	224	181	5402
X76.795	25.66	7.70	5.65	3.36	1.45	0.09	1.77	0.04	95	153	314	6124
X76.796	14.60	4.13	4.20	5.19	1.52	0.27	8.12	0.06	39	383	198	4724
X76.798	34.40	3.91	1.84	1.05	0.85	0.33	0.45	0.21	32	289	616	6016

Table 1 XRF data of clay body of analyzed figurines

SAMPLE	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)	K_2O (%)	P (%)	S (%)	Cl (%)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Ti (ppm)
X76.799	18.63	4.84	3.64	6.66	1.58	< LOD	7.44	1.75	108	197	239	3929
X76.801	19.81	5.25	4.22	6.64	1.21	0.92	4.49	0.04	86	253	275	3760
X76.802	32.42	5.89	2.22	0.82	0.74	< LOD	0.78	1.07	49	116	841	6582
X91.625	27.45	3.95	2.33	2.38	1.10	0.58	2.66	0.25	39	95	739	5340
X91.2252	19.51	3.83	3.21	3.63	0.65	0.46	10.11	0.30	27	138	659	6507
X91.2253	31.78	3.11	1.32	1.20	1.08	< LOD	2.05	4.05	34	144	622	5603
X91.2254	20.72	5.15	5.79	2.37	2.29	0.21	6.49	0.69	101	213	238	4811
X91.2255	21.41	2.94	2.88	3.34	1.22	0.15	8.66	0.43	63	174	509	5027
X91.2256	17.11	3.61	4.05	3.96	1.46	< LOD	9.32	0.65	100	215	176	4320
X91.2257	21.58	6.46	5.30	3.67	1.78	< LOD	7.15	0.23	122	222	294	5390
X91.2258	30.05	6.74	4.94	1.07	2.50	0.24	1.61	0.63	107	265	305	6296
X91.2259	21.65	4.48	4.24	2.85	1.27	0.12	6.95	2.95	73	170	368	4910
X91.2260	26.96	8.47	5.54	1.82	2.26	0.39	2.19	0.25	115	254	280	5485
X91.2261	23.67	4.48	4.04	2.85	1.78	< LOD	7.96	0.72	108	186	275	5204
X91.2262	24.99	2.89	1.45	3.80	1.28	0.24	6.46	1.12	72	119	384	3448
X91.2263	9.34	2.09	3.46	10.66	1.22	0.21	11.37	3.97	79	381	182	2358
X91.2264	16.44	4.61	4.68	4.73	1.96	< LOD	13.09	0.29	93	264	376	4705
X91.2265	12.90	3.34	3.96	10.81	2.43	0.17	12.53	0.55	121	381	225	3303
X91.2267	27.90	5.01	4.03	1.01	1.38	0.43	1.27	3.30	64	156	511	5583
X91.2268	14.92	3.98	3.23	6.53	1.31	0.23	3.99	9.56	97	299	259	3199
X91.2269	25.10	4.42	2.98	2.11	1.58	0.34	3.08	0.29	76	285	379	3732
X91.2273	10.29	2.33	4.53	6.16	1.44	0.10	17.23	0.44	118	219	188	4137
X91.2274	34.42	5.08	2.23	0.59	0.71	0.22	0.48	0.37	30	74	800	5469
X91.2275	20.83	5.91	4.76	3.27	1.58	0.14	6.06	0.69	93	247	225	5398
X91.2276	25.29	4.17	3.21	2.34	1.08	< LOD	6.29	0.36	49	132	620	5005
X96.8.37	27.32	3.93	2.05	2.01	1.48	0.07	1.90	0.51	70	274	318	4498
X2010.16.2	31.44	4.27	1.42	0.83	1.40	0.10	1.31	1.06	71	109	342	3366
X2010.16.5	19.20	4.63	4.49	3.21	1.90	< LOD	8.42	0.74	100	284	255	5323
X2010.16.6	32.76	4.12	1.60	0.99	1.16	< LOD	1.11	1.57	52	245	441	4513
X2010.16.9	14.02	10.19	2.62	17.00	2.31	< LOD	0.22	2.27	150	2798	142	1977
X2010.16.11	22.97	2.35	1.92	2.96	0.62	0.08	7.57	0.05	31	97	726	5987
X2010.16.13	24.51	2.79	2.05	2.70	0.80	0.22	3.65	0.52	42	151	651	5667
X2010.16.14	17.20	4.40	6.00	2.20	1.06	0.11	3.96	1.22	76	237	451	6311
X2010.16.15	35.18	2.75	1.64	1.50	0.63	0.09	1.02	0.19	18	120	543	13228
X2010.16.16A	17.47	3.90	4.05	4.38	1.70	< LOD	10.35	0.58	85	274	216	5309
X2010.16.16B	21.20	6.36	4.86	2.63	1.85	< LOD	4.34	0.30	102	345	240	3907
X2010.16.18	10.49	3.95	1.35	26.59	0.35	0.11	5.49	0.42	7	250	130	1824
X2010.16.19	28.44	2.68	1.49	2.39	0.85	0.20	4.42	0.44	27	107	684	4500
X2010.16.20	31.74	4.32	1.35	1.20	1.35	0.14	2.41	1.30	68	136	251	9302
X2010.16.21	27.04	4.75	1.77	2.19	1.17	0.39	4.17	0.83	67	123	400	3604
X2010.16.23A	9.83	2.67	2.97	2.89	0.47	< LOD	2.14	0.20	34	120	332	35227
X2010.16.171	21.97	8.35	5.92	0.96	1.24	0.79	0.05	0.10	26	447	251	7764
X2010.16.174	16.99	3.80	3.59	9.43	1.67	0.34	7.34	0.06	60	468	183	3710
X2010.16.179	30.24	4.07	1.60	1.54	1.14	< LOD	4.04	0.97	61	101	336	3766

Table 2 XRF data of clay body of analyzed figurines

SAMPLE	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)	Pb (ppm)	Hg (ppm)	Ba (ppm)
X71.1738	936	127	< LOD	171	23	11	9	< LOD	< LOD	334
X72.431	1059	68	107	151	18	17	10	< LOD	< LOD	352
X75.1740	877	< LOD	< LOD	139	25	< LOD	< LOD	< LOD	< LOD	401
X75.1744	68	310	264	182	35	57	7	< LOD	< LOD	552
X75.1752	< LOD	331	< LOD	122	34	82	6	11	< LOD	715
X75.1759	< LOD	291	< LOD	86	38	66	11	17	< LOD	546
X75.1760	< LOD	311	< LOD	116	67	113	9	11	44	534
X75.1762	1035	< LOD	136	137	25	34	< LOD	< LOD	< LOD	417
X75.1763	921	< LOD	< LOD	136	18	26	< LOD	< LOD	< LOD	201
X75.1764	< LOD	319	< LOD	134	50	86	< LOD	< LOD	12	705
X76.722	107	308	204	290	50	135	5	8	< LOD	758
X76.726	< LOD	218	156	90	34	96	18	< LOD	20	479
X76.727	< LOD	133	269	81	22	148	< LOD	9	25	386
X76.732	330	630	275	390	59	97	15	22	< LOD	818
X76.733	149	394	< LOD	299	36	72	< LOD	< LOD	123	765
X76.735	122	356	< LOD	266	46	133	< LOD	15	23	684
X76.737	359	586	249	311	39	114	10	17	< LOD	529
X76.738	< LOD	229	207	105	29	46	< LOD	< LOD	< LOD	563
X76.740	330	112	70	68	17	14	< LOD	< LOD	10	411
X76.744	186	359	< LOD	353	55	117	< LOD	11	< LOD	809
X76.756	< LOD	235	< LOD	89	30	99	< LOD	< LOD	113	616
X76.758	< LOD	191	150	118	29	82	10	< LOD	49	562
X76.760	< LOD	201	254	78	35	99	< LOD	12	9	498
X76.764	< LOD	240	186	81	38	62	10	< LOD	16	538
X76.768	314	421	< LOD	327	33	56	< LOD	29	< LOD	526
X76.771	332	1658	184	545	75	135	23	46	< LOD	1071
X76.772	257	542	< LOD	500	44	181	7	9	< LOD	745
X76.775	501	361	< LOD	389	38	83	12	21	< LOD	902
X76.778	1007	207	< LOD	237	22	< LOD	< LOD	< LOD	< LOD	444
X76.780	1079	< LOD	< LOD	168	25	98	< LOD	< LOD	< LOD	< LOD
X76.781	365	195	< LOD	93	36	167	< LOD	< LOD	29	514
X76.782	400	295	< LOD	294	46	100	8	24	< LOD	790
X76.783	839	< LOD	< LOD	111	< LOD	< LOD	< LOD	< LOD	< LOD	269
X76.786	< LOD	311	< LOD	96	33	67	14	27	< LOD	728
X76.787	1398	148	< LOD	88	21	25	15	< LOD	< LOD	273
X76.788	1092	< LOD	< LOD	73	< LOD	< LOD	6	< LOD	< LOD	95
X76.789	875	77	< LOD	161	26	16	< LOD	< LOD	< LOD	390
X76.790	858	94	< LOD	182	26	19	< LOD	13	< LOD	408
X76.791	896	193	< LOD	166	< LOD	24	< LOD	10	< LOD	386
X76.792	< LOD	744	< LOD	124	60	39	< LOD	< LOD	< LOD	1238
X76.793	672	140	93	156	40	39	15	< LOD	29	459
X76.794	194	311	< LOD	358	52	92	< LOD	29	10	884
X76.795	403	852	231	520	46	93	< LOD	17	< LOD	753
X76.796	< LOD	224	< LOD	79	73	63	17	19	< LOD	602
X76.798	804	86	< LOD	149	19	28	< LOD	< LOD	38	383

Table 3 XRF data of clay body of analyzed figurines

SAMPLE	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)	Pb (ppm)	Hg (ppm)	Ba (ppm)
X76.799	134	1361	260	288	42	40	< LOD	10	34	778
X76.801	200	606	< LOD	516	39	69	18	21	< LOD	1044
X76.802	1034	178	< LOD	216	22	26	< LOD	< LOD	< LOD	486
X91.625	876	287	< LOD	84	20	20	< LOD	< LOD	< LOD	114
X91.2252	1120	136	< LOD	185	32	461	11	13	< LOD	232
X91.2253	786	148	97	77	18	< LOD	< LOD	< LOD	21	266
X91.2254	83	641	< LOD	243	41	80	20	10	24	493
X91.2255	138	104	< LOD	146	44	28	8	18	9	589
X91.2256	100	391	169	229	43	122	9	11	< LOD	647
X91.2257	79	386	302	227	44	124	< LOD	9	< LOD	752
X91.2258	114	360	234	213	39	76	16	23	< LOD	738
X91.2259	95	266	260	160	31	64	11	12	< LOD	665
X91.2260	105	654	< LOD	252	45	97	< LOD	15	< LOD	823
X91.2261	218	204	222	265	38	107	< LOD	11	< LOD	377
X91.2262	249	138	< LOD	67	16	26	< LOD	< LOD	145	578
X91.2263	< LOD	241	187	73	31	53	22	20	12	792
X91.2264	112	420	194	243	41	64	< LOD	12	< LOD	808
X91.2265	< LOD	230	241	< LOD	39	82	11	28	13	596
X91.2267	140	94	167	148	34	24	9	< LOD	< LOD	586
X91.2268	< LOD	195	248	102	36	58	8	< LOD	< LOD	708
X91.2269	454	122	149	161	21	62	8	28	116	339
X91.2273	< LOD	379	339	131	63	104	17	33	34	611
X91.2274	1050	99	< LOD	198	23	20	< LOD	< LOD	< LOD	345
X91.2275	179	359	245	352	129	88	14	< LOD	52	842
X91.2276	105	< LOD	130	110	37	23	13	25	< LOD	465
X96.8.37	289	104	< LOD	102	16	28	10	< LOD	< LOD	622
X2010.16.2	225	91	< LOD	< LOD	< LOD	83	< LOD	< LOD	19	409
X2010.16.5	78	350	228	267	60	85	9	10	105	825
X2010.16.6	491	87	< LOD	67	46	< LOD	< LOD	< LOD	94	254
X2010.16.9	< LOD	185	< LOD	123	< LOD	387	12	11	< LOD	611
X2010.16.11	1428	138	< LOD	183	45	71	< LOD	22	7	366
X2010.16.13	835	165	< LOD	205	115	51	8	9	162	489
X2010.16.14	53	2027	< LOD	277	93	256	90	441	< LOD	860
X2010.16.15	805	254	< LOD	164	122	60	6	14	9	300
X2010.16.16A	86	303	251	219	45	60	7	< LOD	54	834
X2010.16.16B	46	427	< LOD	198	43	95	11	< LOD	141	898
X2010.16.18	< LOD	501	< LOD	194	33	< LOD	< LOD	39	< LOD	499
X2010.16.19	962	< LOD	< LOD	158	26	30	9	< LOD	15	487
X2010.16.20	226	167	< LOD	97	45	< LOD	5	< LOD	< LOD	526
X2010.16.21	308	173	< LOD	69	22	14	6	< LOD	< LOD	425
X2010.16.23A	< LOD	341	< LOD	65	28	79	15	9	< LOD	718
X2010.16.171	< LOD	482	200	143	37	44	< LOD	< LOD	< LOD	1356
X2010.16.174	< LOD	2405	< LOD	244	57	80	78	26	828	801
X2010.16.179	356	60	< LOD	< LOD	21	< LOD	< LOD	< LOD	< LOD	136

Table 4 XRF data of ceramic body of analyzed figurines

SAMPLE	TYPE	COLOR	Fe (ppm)	Ca (ppm)	K (ppm)	S (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Ti (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)
X71-1738	Accretion	dark	14804	87383	8476	40705	35	122	758	4053	678	6732	-	136
X72-431	Pigment	White	10315	244720	9387	36392	41	173	668	2580	532	106	148	155
X75-1740	Pigment	Blue	14358	21576	8737	26504	35	126	720	2871	658	120	-	188
X75-1740	Pigment	Blue and White	27130	147197	9238	49489	86	322	234	7281	-	726	286	131
X75-1740	Pigment	White/Yellow	11013	124867	5970	53238	38	213	671	2184	536	87	117	144
X75-1752	Pigment	White	22989	70785	59238	82949	115	373	216	2584	-	301	291	133
X75-1759	Pigment	White	19230	99197	14342	129048	91	257	216	3067	-	131	331	-
X75-1760	Pigment	White	24388	43129	32262	35719	93	328	211	4559	-	250	233	148
X75-1762	Pigment	White	11618	328335	9702	67269	50	225	668	2141	385	91	315	161
X75-1763	Pigment	Blue	14389	39565	14757	48167	25	141	773	3929	1001	103	-	182
X75-1764	Pigment	White (PR)	22157	77326	94912	60476	110	419	246	2962	-	260	382	101
X76-726	Pigment	White (PL)	27625	42142	50433	25477	116	282	257	4711	-	271	334	121
X76-727	Pigment	Red	32102	119319	15126	157009	95	355	220	3892	-	271	-	164
X76-733	Pigment	Red	26158	43060	10022	57962	76	274	231	2181	43	291	247	248
X76-733	Pigment	White	36888	78932	14396	77123	92	395	360	3195	182	416	-	367
X76-737	Pigment	White	38480	27983	26519	21983	91	152	304	6661	324	551	-	474
X76-738	Pigment	White	21521	60423	37172	62048	118	451	211	3079	-	233	358	117
X76-740	Accretion	White	5687	65446	13071	100516	46	155	315	3108	291	85	-	54
X76-740	Pigment	Red	5745	143049	6431	204610	37	295	429	1838	137	95	-	79
X76-744	Accretion		42437	56923	20932	12393	104	225	285	5330	164	356	293	324
X76-744	Pigment	Red	42038	28245	23830	11306	108	238	242	5262	167	438	293	364
X76-756	Pigment	White	21248	45499	44167	41266	121	339	228	2915	-	249	321	-
X76-756	Pigment	Yellow and White	25977	61113	34748	38659	113	341	226	3441	-	279	297	144
X76-758	Pigment	White	25948	52744	22356	20786	108	425	220	3608	-	238	160	113
X76-758	Pigment	Red	37016	63603	20069	44826	116	407	235	3484	-	244	-	171
X76-760	Pigment	White	20861	28716	28969	43932	97	319	229	5050	-	142	227	-
X76-760	Pigment	Blue	17524	51728	22543	72864	95	291	228	3396	-	210	324	101
X76-760	Accretion		16176	174341	17560	101083	95	410	218	2607	-	121	268	120
X76-764	Pigment	White	22259	86957	46973	23920	104	404	206	2939	-	189	333	164
X76-764	Accretion		11835	410847	12916	44857	104	525	199	1073	-	202	355	72
X76-768	Pigment	Red	38169	46385	24476	30778	88	133	329	5029	259	477	-	387
X76-772	Pigment	White	22149	260597	7695	50770	89	358	241	1884	98	285	353	295
X76-778	Accretion		2722	260666	2773	34116	44	1482	344	562	-	96	55	146
X76-780	Pigment	Red	17282	18060	16692	13310	42	127	449	5645	639	104	-	202
X76-781	Pigment	Red	7561	30783	12915	28560	56	168	334	3396	400	177	-	132
X76-781	Fill		3317	83682	3110	84906	-	963	16	32616	-	23284	-	200
X76-786	Pigment	White	26581	49368	20919	5394	101	244	295	6178	-	374	189	123
X76-786	Pigment	Blue	22608	105037	17084	111986	99	289	242	3393	77	308	372	67
X76-786	Pigment	Red	23917	56004	33200	52895	104	260	264	4063	-	230	334	66
X76-788	Pigment	Blue	14346	21974	13965	16550	33	111	788	4594	1057	-	-	119
X76-788	Accretion	Gray	2817	592493	2332	16583	31	530	650	390	-	-	140	82
X76-789	Accretion	White	9612	170823	6494	11536	33	143	706	2805	553	72	-	105
X76-790	Pigment	White	10978	106241	9472	75411	31	323	869	3141	705	127	121	173

Table 5 XRF data of pigments of figures analyzed

SAMPLE	TYPE	COLOR	Cu (ppm)	Zn (ppm)	As (ppm)	Pb (ppm)	Hg (ppm)	Ba (ppm)	Sb (ppm)	Sn (ppm)	Cd (ppm)
X71-1738	Accretion	dark	-	-	7	9	-	272	24	16	12
X72-431	Pigment	White	-	12	18	-	-	499	44	38	15
X75-1740	Pigment	Blue	-	-	29	-	-	688	65	64	28
X75-1740	Pigment	Blue and White	51	445	29	70	-	1237	69	66	25
X75-1740	Pigment	White/Yellow	-	51	29	-	-	561	55	55	23
X75-1752	Pigment	White	58	144	9	16	-	970	55	67	15
X75-1759	Pigment	White	34	47	14	14	-	555	27	22	-
X75-1760	Pigment	White	39	76	9	-	24	738	54	48	-
X75-1762	Pigment	White	25	22	-	-	-	499	45	52	19
X75-1763	Pigment	Blue	20	-	7	11	-	568	54	57	25
X75-1764	Pigment	White (PR)	63	90	-	-	21	774	47	49	-
X76-726	Pigment	White (PL)	42	119	13	24	-	622	34	45	-
X76-727	Pigment	Red	35	59	13	18	-	701	39	41	-
X76-733	Pigment	Red	45	19	-	12	70	1296	95	114	45
X76-733	Pigment	White	34	70	7	12	127	1127	83	74	27
X76-737	Pigment	White	54	97	11	32	-	1011	45	42	-
X76-738	Pigment	White	39	93	-	12	-	634	38	43	-
X76-740	Accretion	White	-	-	-	-	12	425	28	23	11
X76-740	Pigment	Red	-	-	-	-	82	713	70	61	23
X76-744	Accretion		53	908	11	-	-	657	34	34	-
X76-744	Pigment	Red	54	101	8	16	-	947	54	58	-
X76-756	Pigment	White	27	96	9	-	20	356	-	-	-
X76-756	Pigment	Yellow and White	53	89	8	8	21	1007	64	60	16
X76-758	Pigment	White	26	63	7	9	22	753	43	44	-
X76-758	Pigment	Red	34	86	10	-	36	832	46	53	-
X76-760	Pigment	White	21	104	7	13	-	541	25	21	-
X76-760	Pigment	Blue	38	137	-	10	13	745	50	41	20
X76-760	Accretion		27	67	10	-	83	850	39	47	-
X76-764	Pigment	White	24	87	10	9	18	782	43	49	18
X76-764	Accretion		30	90	8	-	1216	770	50	44	16
X76-768	Pigment	Red	52	74	8	29	-	900	58	54	21
X76-772	Pigment	White	45	46	-	17	-	799	61	55	22
X76-778	Accretion		-	102	16	-	69	821	101	88	41
X76-780	Pigment	Red	38	93	-	-	-	451	36	31	15
X76-781	Pigment	Red	38	118	5	-	33	797	76	70	31
X76-781	Fill		78	10979	19	78	-	1445	102	87	58
X76-786	Pigment	White	35	51	7	22	-	747	42	42	14
X76-786	Pigment	Blue	34	95	35	110	-	1085	62	62	24
X76-786	Pigment	Red	38	141	19	56	9	771	56	51	24
X76-788	Pigment	Blue	27	18	16	-	-	281	22	33	-
X76-788	Accretion	Gray	-	-	-	-	-	504	55	50	20
X76-789	Accretion	White	19	13	5	-	-	300	36	35	14
X76-790	Pigment	White	29	28	8	20	42	562	53	51	-

Table 6 XRF data of pigments of figures analyzed

SAMPLE	TYPE	COLOR	Fe (ppm)	Ca (ppm)	K (ppm)	S (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Ti (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)
X76-791	Pigment	Blue	12487	45551	10275	48734	37	127	621	4118	807	88	88	145
X76-791	Pigment	Pink	9820	165335	6579	35059	38	137	550	4058	418	194	116	175
X76-791	Fill		2380	621994	2806	54236	9	659	35	2155	-	572	92	350
X76-792	Fill		17047	104478	20141	25064	44	607	60	2217	-	643	-	129
X76-793	Accretion	Brown	12468	52400	10100	31906	36	198	518	5934	672	773	93	149
X76-794	Pigment	White	12264	534572	8335	35555	18	177	11	1015	-	527	-	233
X76-798	Pigment	Red	16131	27913	20828	16384	42	182	629	5849	914	269	-	136
X76-798	Pigment	Yellow	17675	22061	12462	17574	36	113	685	6199	782	310	-	181
X76-799	Pigment	Black	27317	51120	15230	218459	107	150	227	3248	129	580	226	294
X76-801	Pigment	Black	39872	61311	15148	100301	84	254	246	3887	346	1215	245	512
X91-625	Pigment	Blue	12985	123982	11152	18147	38	87	646	4010	821	290	113	127
X91-625	Pigment	White	11100	314915	7689	172311	13	5215	319	3469	-	86	237	108
X91-2252	Accretion	White	4010	321509	4511	37603	29	1778	212	508	-	186	99	296
X91-2252	Pigment	Blue	18708	66521	9603	62771	31	495	586	3762	585	77	115	118
X91-2252	Pigment	Red	40006	60575	7145	74517	28	102	626	4609	731	113	-	218
X91-2252	Pigment	Red	49938	41785	10703	58368	29	151	571	5392	719	178	-	277
X91-2252	Pigment	White	20483	59547	8703	38242	28	285	632	4153	640	127	-	240
X91-2253	Pigment	Blue	9857	23276	10033	35914	36	234	705	6981	969	140	-	117
X91-2253	Pigment	White	6400	188207	6829	22282	32	226	562	2346	300	176	131	194
X91-2254	Accretion	Dark	72565	49011	8543	68365	64	448	94	-	-	196	-	167
X91-2254	Accretion	Light	45803	55401	11997	91479	126	242	195	844	41	435	-	141
X91-2255	Pigment	Red	23602	67634	15123	111954	62	176	526	4553	135	142	186	155
X91-2255	Pigment	White	20645	92593	12620	77188	66	195	483	2699	68	214	257	88
X91-2256	Pigment	White	28479	169492	17184	75969	100	280	167	3117	-	467	311	183
X91-2256	Pigment	Red	35755	72632	14164	104819	103	228	166	3377	28	334	-	255
X91-2257	Pigment	White	41043	86104	20179	48239	118	290	268	4303	67	508	256	157
X91-2258	Pigment	Red	43842	18522	18270	21447	105	249	246	3947	65	490	-	204
X91-2259	Pigment	White	9369	397129	7308	107593	69	368	179	3467	100	522	265	418
X91-2259	Pigment	White	23369	122180	12285	66847	66	190	349	3784	63	243	213	154
X91-2260	Pigment	Red	41534	29801	56143	24241	133	276	357	6357	331	657	228	276
X91-2261	Pigment	Red	34444	136812	15687	140385	91	252	272	2828	90	475	199	346
X91-2261	Pigment	White	36993	106481	18411	142536	102	305	286	2731	71	638	195	333
X91-2261	Pigment	Blue	37257	114594	21803	61317	106	296	290	3464	193	524	-	243
X91-2262	Pigment	Blue	13936	8264	22485	10886	68	81	343	2872	232	162	-	113
X91-2262	Accretion	White	12452	22130	20341	30611	76	155	373	2350	215	195	-	-

Table 7 XRF data of pigments of figures analyzed

SAMPLE	TYPE	COLOR	Cu (ppm)	Zn (ppm)	As (ppm)	Pb (ppm)	Hg (ppm)	Ba (ppm)	Sb (ppm)	Sn (ppm)	Cd (ppm)
X76-791	Pigment	Blue	20	18	-	10	-	395	28	25	-
X76-791	Pigment	Pink	31	31	-	22	9	602	51	50	13
X76-791	Fill		56	26	-	242	-	5947	111	180	53
X76-792	Fill		59	80	39	283	12	401	43	39	553
X76-793	Accretion	Brown	21	41	16	8	19	397	32	31	13
X76-794	Pigment	White	97	153	-	7368	-	824	86	92	25
X76-798	Pigment	Red	25	19	-	-	-	380	27	30	-
X76-798	Pigment	Yellow	21	37	-	-	-	474	32	41	-
X76-799	Pigment	Black	43	67	9	27	134	557	33	30	-
X76-801	Pigment	Black	105	85	25	30	-	832	40	33	-
X91-625	Pigment	Blue	24	18	-	-	-	351	39	33	14
X91-625	Pigment	White	-	36	262	567	-	1636	38	42	-
X91-2252	Accretion	White	48	114	17	21	155	972	108	97	41
X91-2252	Pigment	Blue	19	78	11	9	41	244	23	-	-
X91-2252	Pigment	Red	-	60	10	10	16	256	35	35	-
X91-2252	Pigment	Red	33	70	15	13	16	494	52	54	25
X91-2252	Pigment	White	28	97	15	16	72	535	66	63	14
X91-2253	Pigment	Blue	28	-	-	-	9	544	34	32	-
X91-2253	Pigment	White	26	-	-	-	27	785	63	58	24
X91-2254	Accretion	Dark	-	103	70	31	6370	703	60	50	22
X91-2254	Accretion	Light	39	165	32	-	4071	648	36	36	17
X91-2255	Pigment	Red	33	33	13	20	-	753	45	48	-
X91-2255	Pigment	White	32	36	7	26	33	747	48	40	-
X91-2256	Pigment	White	53	109	11	10	-	847	52	54	22
X91-2256	Pigment	Red	64	141	10	18	-	903	63	48	15
X91-2257	Pigment	White	44	162	9	21	-	787	43	43	30
X91-2258	Pigment	Red	23	63	11	23	12	700	44	32	19
X91-2259	Pigment	White	63	120	-	7266	-	13431	50	50	-
X91-2259	Pigment	White	44	31	12	25	-	781	56	51	18
X91-2260	Pigment	Red	61	102	9	21	-	984	54	57	-
X91-2261	Pigment	Red	27	61	8	20	-	755	55	50	20
X91-2261	Pigment	White	46	80	10	29	19	833	72	66	27
X91-2261	Pigment	Blue	19	83	11	45	14	328	18	17	-
X91-2262	Pigment	Blue	23	24	-	-	-	517	29	24	12
X91-2262	Accretion	White	-	37	-	-	17	682	51	37	16

Table 8 XRF data of pigments of figures analyzed

SAMPLE	TYPE	COLOR	Fe (ppm)	Ca (ppm)	K (ppm)	S (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Ti (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)
X91-2263	Fill		36581	91005	21079	120608	84	511	199	3288	-	186	404	141
X91-2263	Pigment	Blue	49730	89452	13342	107968	81	344	181	2238	-	282	-	105
X91-2263	Pigment	Red	72981	84106	6685	106863	69	415	166	1121	-	364	-	237
X91-2263	Pigment	White	44118	84192	18835	34811	76	552	181	2963	-	229	-	87
X91-2264	Pigment	Blue	34447	69643	23048	52506	91	281	357	3900	90	458	246	237
X91-2264	Pigment	Red	38446	29193	38387	13837	101	256	364	5026	114	545	246	175
X91-2264	Pigment	White	31006	107797	33803	76729	90	348	379	4668	72	535	269	248
X91-2265	Pigment	White	25133	113077	25038	78622	111	373	207	1910	-	224	310	-
X91-2265	Pigment	Yellow	25724	96997	12524	54847	121	508	225	1000	-	371	231	-
X91-2265	Pigment	Black	21943	134956	23190	111643	110	445	191	1900	-	357	176	116
X91-2267	Pigment	Red (PL)	29843	25693	16025	20394	67	144	438	4619	139	136	225	161
X91-2267	Pigment	Red (PR)	26862	7305	18467	5827	60	248	413	5907	123	141	-	217
X91-2268	Pigment	White	19988	47572	18476	11937	91	309	225	4591	-	238	225	134
X91-2268	Pigment	Blue	4052	310819	2766	24588	51	1297	117	456	-	126	121	-
X91-2268	Accretion	Gray	1023	566201	1525	34479	20	2153	32	122	-	138	-	198
X91-2268	Pigment	Black	17368	294846	9154	114984	85	530	210	1972	-	131	349	121
X91-2269	Pigment	Blue	24064	17740	15822	12710	82	220	390	3739	372	199	-	212
X91-2269	Pigment	Black	21964	40400	27641	56464	97	201	433	3887	426	229	153	239
X91-2269	Accretion	Black	22152	43911	31456	60445	87	208	430	3427	381	1302	-	330
X91-2273	Pigment	Red	35524	101171	19943	163375	121	224	196	3905	-	473	338	183
X91-2274	Pigment	Blue	14108	15313	11700	9416	30	107	738	4794	882	-	107	166
X91-2274	Pigment	Red	18238	20216	23724	11808	36	100	704	5232	1018	228	-	206
X91-2275	Pigment	White	27547	185673	15913	32821	90	340	171	3361	71	327	407	212
X91-2275	Pigment	Black	34795	72809	22931	23430	97	327	169	4932	130	291	199	264
X91-2276	Fill		44845	23583	13191	66413	40	353	249	7723	-	842	-	-
X91-2276	Pigment	Red	18777	41058	22799	61149	48	210	610	5420	155	85	-	160
X91-2276	Pigment	White	21595	44042	17487	51097	53	137	540	3482	71	171	152	155
X91-2276	Pigment	Black	22266	53515	18542	43964	50	150	539	3635	59	143	-	153
X96-8-37	Pigment	Blue	11624	45847	19500	27061	67	147	270	3979	359	173	-	168
X96-8-37	Pigment	White	5634	411292	6731	30270	50	479	240	1505	29	-	78	84
X2010-16-2	Pigment	Blue	9100	21183	12855	20854	66	121	269	2502	210	123	-	77
X2010-16-2	Pigment	Red	19783	27559	14792	19241	68	163	297	3062	163	126	-	86
X2010-16-5	Pigment	Blue	38235	22172	30645	25282	103	289	224	5676	142	299	-	212
X2010-16-5	Fill		19079	281121	15973	52235	-	785	-	28607	2005	469	-	359
X2010-16-7	Pigment	Blue	10240	36559	5614	58396	52	138	419	2480	271	147	-	-
X2010-16-7	Pigment	Red	10513	62391	11439	95220	51	133	402	3722	442	172	-	116
X2010-16-7	Pigment	White	7368	78655	7660	105944	48	183	416	2739	292	161	89	-

Table 9 XRF data of pigments of figures analyzed

SAMPLE	TYPE	COLOR	Cu (ppm)	Zn (ppm)	As (ppm)	Pb (ppm)	Hg (ppm)	Ba (ppm)	Sb (ppm)	Sn (ppm)	Cd (ppm)
X91-2263	Fill		27	35	90	20	-	700	47	51	19
X91-2263	Pigment	Blue	31	51	31	24	-	670	42	51	-
X91-2263	Pigment	Red	-	38	45	31	16	763	58	56	19
X91-2263	Pigment	White	26	51	25	22	-	690	52	45	21
X91-2264	Pigment	Blue	36	59	9	8	11	801	40	39	-
X91-2264	Pigment	Red	50	94	9	16	-	625	38	31	18
X91-2264	Pigment	White	59	79	8	24	-	890	38	57	16
X91-2265	Pigment	White	28	37	11	33	-	525	39	35	-
X91-2265	Pigment	Yellow	52	102	54	51	22	882	73	58	20
X91-2265	Pigment	Black	39	49	52	40	19	771	49	43	17
X91-2267	Pigment	Red	48	27	9	-	-	703	37	40	-
X91-2267	Pigment	Red	37	37	8	-	37	738	45	48	14
X91-2268	Pigment	White	39	73	7	-	-	743	48	46	-
X91-2268	Pigment	Blue	-	-	-	-	13	858	78	70	31
X91-2268	Accretion	Gray	37	-	-	-	20	911	81	70	17
X91-2268	Pigment	Black	41	54	6	9	17	690	33	52	14
X91-2269	Pigment	Blue	20	52	6	-	24	343	-	22	-
X91-2269	Pigment	Black	26	95	-	-	1003	741	47	42	12
X91-2269	Accretion	Black	30	40	7	-	-	892	53	57	23
X91-2273	Pigment	Red	51	69	13	29	-	883	70	67	25
X91-2274	Pigment	Blue	29	36	-	-	10	460	46	37	13
X91-2274	Pigment	Red	25	30	5	-	-	534	43	46	12
X91-2275	Pigment	White	105	69	12	-	366	676	41	41	24
X91-2275	Pigment	Black	404	112	15	8	187	841	55	49	-
X91-2276	Fill		25	69	682	2726	-	1760	-	41	-
X91-2276	Pigment	Red	26	36	13	-	15	580	49	36	-
X91-2276	Pigment	White	40	28	13	20	10	701	45	40	17
X91-2276	Pigment	Black	47	41	6	-	-	647	44	41	14
X96-8-37	Pigment	Blue	43	47	9	31	-	805	49	41	24
X96-8-37	Pigment	White	-	-	-	13	11	443	23	24	-
X2010-16-2	Pigment	Blue	18	-	-	-	17	521	19	22	-
X2010-16-2	Pigment	Red	-	-	7	-	23	619	53	44	21
X2010-16-5	Pigment	Blue	52	61	13	10	88	635	34	37	13
X2010-16-5	Fill		58	418	633	2760	16	1156	154	44	17201
X2010-16-7	Pigment	Blue	-	-	-	10	-	366	50	31	18
X2010-16-7	Pigment	Red	29	-	6	-	-	621	39	36	-
X2010-16-7	Pigment	White	-	-	-	-	-	597	35	27	16

Table 10 XRF data of pigments of figures analyzed

SAMPLE	TYPE	COLOR	Fe (ppm)	Ca (ppm)	K (ppm)	S (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Ti (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)
X2010-16-9	Pigment	White	12920	245638	2374	246493	150	2061	144	359	-	156	299	-
X2010-16-9	Pigment	Red	19495	262255	34124	14459	153	2947	132	2242	-	236	-	131
X2010-16-11	Pigment	Red	13672	94619	7190	83220	23	355	572	32792	754	-	-	124
X2010-16-11	Pigment	Yellow	11164	26419	10324	25633	27	114	696	7149	1606	126	166	168
X2010-16-11	Pigment	Blue	13514	24784	10804	29277	29	160	661	3865	1240	229	-	181
X2010-16-13	Pigment	Blue	16324	57589	9804	13949	49	122	655	3876	653	186	-	210
X2010-16-13	Pigment	Red	13163	66800	8097	92727	100	50	664	3699	690	144	169	220
X2010-16-13	Pigment	Yellow	22687	36042	11224	16825	49	91	734	4818	930	119	-	277
X2010-16-13	Pigment	Red & white	20226	70724	7007	65098	166	28	734	2770	509	237	-	157
X2010-16-14	Fill		26628	20231	17551	23524	77	228	383	6187	537	1076	-	192
X2010-16-14	Pigment	White	26711	79663	14279	45105	73	218	323	4761	561	1321	-	104
X2010-16-15	Pigment	Blue	14764	197817	2386	24839	-	1120	13	96927	-	1399	-	106
X2010-16-16A	Fill		11002	203793	2240	345353	38	946	-	239	-	873	-	-
X2010-16-16A	Pigment	Red	39250	34138	22291	30666	91	307	213	4997	44	375	-	212
X2010-16-16A	Pigment	Blue	33271	44049	19229	50382	98	304	193	4276	53	286	243	221
X2010-16-16A	Pigment	White	29706	61840	19973	65898	95	286	203	3647	82	324	161	226
X2010-16-16B	Pigment	White	26863	49732	25503	56424	89	302	206	4494	45	293	288	237
X2010-16-16B	Pigment	Red	33605	64690	24816	71327	94	304	202	4467	39	353	203	267
X2010-16-18	Accretion	Black	10344	257799	5887	36361	5	340	129	1368	-	417	-	134
X2010-16-19	Pigment	Blue	13807	24792	6589	22357	29	107	739	2381	425	-	-	123
X2010-16-19	Pigment	Red	23466	27086	14016	16329	29	241	663	4547	794	125	-	193
X2010-16-19	Pigment	White	15136	32181	10416	29036	30	143	752	2754	719	91	-	137
X2010-16-20	Pigment	Red	14698	24580	18949	24167	74	136	251	2484	164	144	-	115
X2010-16-20	Pigment	Blue	8412	31657	15493	30439	59	340	214	2744	152	144	-	106
X2010-16-20	Pigment	Orange	14887	22806	12874	25834	60	123	233	2868	248	170	-	148
X2010-16-21	Pigment	Blue	9763	62673	11249	81982	69	137	376	2320	225	500	-	82
X2010-16-21	Pigment	Orange	18614	87856	14909	82267	79	151	523	3244	227	165	-	55
X2010-16-23A	Pigment	Blue	22799	34669	8546	9124	50	170	341	4711	111	209	-	126
X2010-16-23A	Pigment	Black	20371	51112	11801	12196	51	164	349	6491	-	347	123	108
X2010-16-23A	Pigment	White	16503	84684	8537	14404	18	118	311	67188	-	202	-	66
X2010-16-23B	Pigment	Blue	20893	55800	7723	10171	50	175	313	4115	-	800	157	150
X2010-16-23C	Pigment	Blue	10711	78469	4148	16413	21	193	160	19329	-	1026	-	131
X2010-16-23E	Pigment	Blue	23390	49165	11756	13930	71	157	325	4916	170	338	147	253
X2010-16-23F	Pigment	Blue	19963	32460	6002	8612	54	160	249	3260	146	341	-	291
X2010-16-179	Pigment	Orange	13053	47415	8458	67454	50	114	354	2479	260	85	-	99
X2010-16-179	Pigment	White	5328	129314	8274	25505	50	214	423	2300	252	67	-	57

Table 11 XRF data of pigments of figures analyzed

SAMPLE	TYPE	COLOR	Cu (ppm)	Zn (ppm)	As (ppm)	Pb (ppm)	Hg (ppm)	Ba (ppm)	Sb (ppm)	Sn (ppm)	Cd (ppm)
X2010-16-9	Pigment	White	39	257	9	14	-	694	66	70	16
X2010-16-9	Pigment	Red	36	1030	10	25	-	487	53	54	-
X2010-16-11	Pigment	Red	33	428	17	20	9	313	35	39	-
X2010-16-11	Pigment	Yellow	37	66	10	16	-	428	38	30	-
X2010-16-11	Pigment	Blue	41	98	6	16	-	395	25	40	15
X2010-16-13	Pigment	Blue	68	31	6	10	199	510	48	48	18
X2010-16-13	Pigment	Red	91	99	-	-	5370	675	71	71	21
X2010-16-13	Pigment	Yellow	39	21	8	-	97	482	47	49	-
X2010-16-13	Pigment	Red & white	53	232	14	-	10181	666	76	87	43
X2010-16-14	Fill		84	77	135	609	-	788	53	48	13
X2010-16-14	Pigment	White	39	154	141	696	-	636	43	49	16
X2010-16-15	Pigment	Blue	220	90	16	182	-	424	39	49	-
X2010-16-16A	Fill		-	-	661	35219	-	1023	110	127	47
X2010-16-16A	Pigment	Red	60	102	8	16	46	748	57	47	-
X2010-16-16A	Pigment	Blue	50	101	8	13	37	739	40	37	18
X2010-16-16A	Pigment	White	56	98	11	12	47	858	46	51	-
X2010-16-16B	Pigment	White	45	72	7	-	18	896	42	45	-
X2010-16-16B	Pigment	Red	53	109	-	10	95	878	53	60	-
X2010-16-18	Accretion	Black	-	-	-	28	-	630	78	75	26
X2010-16-19	Pigment	Blue	-	-	-	-	-	695	58	41	-
X2010-16-19	Pigment	Red	46	21	5	-	23	595	43	49	17
X2010-16-19	Pigment	White	-	-	7	-	-	685	58	40	17
X2010-16-20	Pigment	Red	-	20	-	-	-	672	43	36	19
X2010-16-20	Pigment	Blue	24	31	5	-	-	741	46	43	14
X2010-16-20	Pigment	Orange	30	13	-	-	-	724	41	48	12
X2010-16-21	Pigment	Blue	22	19	-	-	-	801	53	43	18
X2010-16-21	Pigment	Orange	25	39	6	11	-	574	36	30	14
X2010-16-23A	Pigment	Blue	22	58	9	10	-	762	67	45	21
X2010-16-23A	Pigment	Black	40	62	10	13	-	852	37	40	12
X2010-16-23A	Pigment	White	22	105	20	12	-	396	19	23	221
X2010-16-23B	Pigment	Blue	27	62	7	9	-	880	52	68	14
X2010-16-23C	Pigment	Blue	49	1655	-	15	21	2530	92	79	1374
X2010-16-23E	Pigment	Blue	22	59	8	9	-	737	43	51	-
X2010-16-23F	Pigment	Blue	23	61	8	9	-	1128	64	59	26
X2010-16-179	Pigment	Orange	40	-	5	-	20	511	42	34	16
X2010-16-179	Pigment	White	19	31	5	-	222	512	43	33	13

Table 12 XRF data of pigments of figures analyzed

Object # Date Examined

Object Type ☐ Figure ☐ Rattle ☐ Whistle ☐ Other

Obverse Photo Reverse Photo

Dimensions

Fowler Attribution

Description

Condition

Condition Summary
☐ Minor Spalling ☐ Major Past Interventions ☐ Moderate Losses
☐ Moderate Spalling ☐ Powdery or Flaking Paint ☐ Severe Losses
☐ Severe Spalling ☐ Visible Salt Efflorescence ☐ Minor Cracking
☐ Minor Past Interventions ☐ Minor Losses ☐ Major Cracking

Treatment Needed ○ Yes ○ No Treatment Priority Level ○ Low ○ Medium ○ High

Type of Treatment
☐ Desalination ☐ Retreatment of Joins ☐ None
☐ Consolidation ☐ Retreatment of Fills ☐ Other

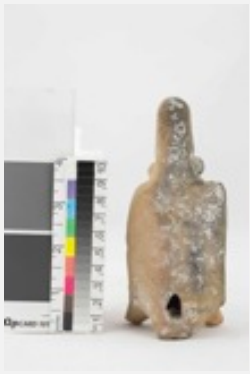
Other Treatment Needs

Object # X72.431 Date Examined 11/16/2012

Object Type ☒ Figure ☐ Rattle ☒ Whistle ☐ Other

Obverse Photo

Reverse Photo



Dimensions H: 14.2 cm, W: 6.3 cm, D: 3.8 cm

Fowler Attribution FIGURE/WHISTLE - MAYA/LATE CLASSIC/JAINA STYLE
Object identified as Pina Chan Type II and Corson Type Jaina Group M(b)?

Description The object is a hollow cast standing male figure wearing a tall headdress, ear spools and a large cloak. The figure faces forward and holds the PR arm close to the body with his palm facing forward and the PL arm down by the side of the body. There are traces of white material on the reverse that may be pigment.

Condition The figure is structurally sound and stable with a visible salt efflorescence along the surface. Along the PL side there is blackened clay possibly due to the firing process. Additionally, there are white accretions along the back. There is also an interesting feature at the center of the obverse chest that is slightly discolored in a circular patch. This area does not appear to be a fill, but could perhaps be an irregularity in the clay that has been exposed.

Condition Summary

☐ Minor Spalling	☐ Major Past Interventions	☐ Moderate Losses
☐ Moderate Spalling	☐ Powdery or Flaking Paint	☐ Severe Losses
☐ Severe Spalling	☒ Visible Salt Efflorescence	☐ Minor Cracking
☐ Minor Past Interventions	☒ Minor Losses	☐ Major Cracking

Treatment Needed ◉ Yes ○ No Treatment Priority Level ◉ Low ○ Medium ○ High

Type of Treatment

☒ Desalination	☐ Retreatment of Joins	☐ None
☒ Consolidation	☐ Retreatment of Fills	☐ Other

Other Treatment Needs

Appendix E

Object (title): Jaina figurine (standing male)

Cultural attribution/provenance: Maya - Jaina

Identification number: X76.722

Medium: Low-fired ceramic

Dimensions: H – 19.4 cm, W – 13.8 cm, D – 7 cm

Current/past owners: Fowler Museum

Purpose of Examination: Stabilization treatment

Date of examination: 26 October 2012
(secondary examination 23 May 2013)

Conservator: Carinne Tzadik

Object Description

The object is a hollow, orange ceramic body figurine. The head and bust emerge from a hollow rectangular base, which features two circular openings on the front and back walls of the base and one circular opening in the center of the underside. The figure is depicted wearing a large feathered headdress and other elaborate elements adorning the head, including ear adornments and necklaces. A small area of the original surface remains intact at the very top edge and along the bottom reverse of the figure.

Materials and Techniques

The object is a mold-made, low-fired ceramic figure with detailing on the obverse and a smooth reverse. The figure has been classified according to the Corson categorization as Jaina Group O, which is identified primarily by the head and bust of the figure emerging from a rectangular base, and as having a medium tempered orange paste. The figure displays many of the features common to this group, including, a man wearing an animal mask headdress, features of advanced aging on the male, the wearing of ear ornaments and beaded necklaces, and traces of white pigment over the obverse features. The holes found on the obverse and reverse, are thought to be related to the function of the piece and are most likely not firing vents or suspension holes that are seen in many of the other types (Corson 1976). One large difference between this figure and the ones examined by Corson during the course of his research is that his examples lacked a bottom surface, which is present in the Fowler figurine (figure 5).

Condition

Structural

Over a majority of the surface of the object there is severe past spalling of the ceramic material (figure 7). The spalling is concentrated on the proper right of the object (both the obverse and reverse) and appears to be the cause of soluble salts that entered the ceramic during burial.

Surface

The figure suffers from active spalling over the entire surface, with more severe areas along the obverse surface and the proper left of the object. There is a variation of surface quality and color, ranging from a bluish-grey at the top of the figure (figure 6) to a beige-orange and orange in other areas. The variance seems to be the result of the spalling and the revelation of under-layers as opposed to uneven firing or past treatments. Areas along the proper left suffer more severely from spalling, which are evident due to the visibility of sub-surface levels. Additionally, attached to the bottom of the figure there is a small masking tape sticker with a small number 1 written in black ink.

Condition Summary

The object is in overall poor condition and is actively spalling. The figure is extremely at risk for further damage without intervention.

Testing and Analysis

Powder samples taken from the object were analyzed using the Rigaku Micro-Diffraction System, which uses a 2-D detector. The x-ray diffraction (XRD) analysis showed the clay sample to have quartz and muscovite (figure 8), and the gray looking substance on the surface to contain calcite (figure 9).

Flakes associated with the figure, but no longer attached to the surface, were soaked in deionized water in order to determine the presence of soluble salts in the ceramic body. The following tests were preformed on the soak water.

To determine the presence of chlorides, a small amount of the soak water was placed on a well slide and two drops of a 7.7M nitric acid (HNO_3) solution were added. As the sample was already in solution, the step requiring distilled water to be added to the sample was skipped, reducing the chances of over dilution. Once the nitric acid solution had been added, one drop of a 0.2M silver nitrate ($AgNO_3$) aqueous solution was added to the slide. The reaction will form a white precipitate of silver chloride (AgCl) if chloride ions are present in the sample (Odegaard et al. 2005). Tests on the soak water yielded positive results for the presence of chlorides.

Nitrate presence was tested using soak water placed on a well slide. The sample was gently heated to remove the water from the sample solution, and a drop of diphenylamine ($(C_6H_5)_2NH$)/sulfuric acid (H_2SO_4)) solution was added to the sample. The reaction occurs in two parts with the sulfuric acid reacting with the nitrate to form nitronium ions (NO_2^+), which subsequently react with the diphenylamine to form diphenylbenzidine violet (Odegaard et al. 2005). The test performed on the soak water produced negative results. An additional test using test strips showed that the soak water contained approximately 10-25 ppm nitrates.

The presence of sulfate ions (SO_4^{2-}) in the soak water was tested by adding a 3M hydrochloric acid solution to the sample and adding two drops of a 2M barium chloride ($BaCl_2$) aqueous solution. The sulfate ions when present will form a white, insoluble precipitate with barium ions (Ba^{2+}) when in an acid solution (Odegaard et al. 2005). The sulfate test was negative. This

information correlates with the UV/Vis/NIR data, which indicated low amounts of gypsum and the XRF data, which showed a relatively low percentage of sulfur.

Proposed Treatment

1. The object will be pre-consolidated to stabilize the object prior to desalination. Testing will be done on fragments of a similar material with similar condition issues using an ethyl silicate (Dynasylan 40 catalyzed with 1% dibutyltin dilaurate). If the testing shows poor results, consolidation will proceed using a dilute solution of Paraloid B72 in toluene, chosen based on previous testing.
2. Once the consolidant has cured, the object will begin desalination in a tap water bath, in order to avoid damage to the object when placed directly into a deionized bath. Following the first bath, the object will then finish the desalination by being placed in a deionized water bath. In both baths, the object will be suspended in order to allow removed salts to settle at the bottom of the container and speed up the desalination process.
3. Once the object is removed from the water bath, and has dried, a secondary consolidation will take place. Depending on the degree of instability, the entire figure may be re-consolidated or selectively on areas that remain at risk.

Treatment

Upon further examination of the proposed pre-consolidation methods, it was determined that the use of ethyl silicates would be inappropriate. The primary reason was that there was inadequate evidence of use and testing of ethyl silicates on ceramic materials in the literature that provided the basis on which consolidant to use. There is however some information available about its use on stone and mud brick (Grissom et al. 1999, Ferreira Pinto et al. 2008, Ferreira Pinto et al. 2012, Ferron et al. 2011). In order to do our own appropriate analysis, we would need to obtain or make a substrate material with similar condition issues and fragility as the object to be treated. Finding archaeological materials that were available for testing was not possible in the allotted treatment time. Additionally, curing time according to experimentation and manufacturer information for ethyl silicates has been described as ranging from 3-11 weeks (Ferron et al. 2011). In order to accomplish adequate testing and analysis of the samples, much more time than what was available would have been needed.

Based on testing done for treatment on two other similar figurines in the Fowler collection in the fall of 2011 (X75.1746 & X77.769), a dilute solution of Paraloid® B72[1] in toluene was known be an effective consolidant that limited color change in the ceramic body. Therefore, due to its proven effectiveness in the testing and subsequent use during treatment, dilute solutions of Paraloid® B72 in toluene were chosen as the pre-consolidant for treatment. A small spot on the figure's base was chosen to test as a confirmation of the previous data and similar results to those previously obtained (slight darkening, but no gloss) were noted.

In order to ensure that the solution penetrated the clay body of the figure, the object was placed in a shallow bath of the 2.5% Paraloid® B72 solution so that the solution could wick up through the ceramic matrix. A small plastic bin was wrapped in aluminum foil, and fit with a thin ethafoam[2] pad cut to fit the base of the bin. The solution was poured into the bin so that it

[1] Paraloid® B72 is a methyl methacrylate copolymer that is available from Talas (www.talasonline.com).

[2] Ethafoam is a closed-cell polyethylene foam that is available from Conservation Resources (www.conservationresources.com).

reached the top of the ethafoam, and would eventually have very minimal contact with the object itself. Additionally, once the object was laid on the ethafoam with the solution present, the entire tray was place in a sealed plastic chamber to prevent evaporation and encourage deeper penetration of the solution. After approximately 24 hours, it was noted that the solution was only rising to a certain point and leaving some areas on the front surface unconsolidated. At this point the chamber was opened and the 2.5% solution was droppered over the obverse surface.

Once the consolidant had sufficiently been drawn into the ceramic body, the object was removed from the chamber. When the surface was examined, the surface was no more stable than it had been before the introduction of the 2.5% Paraloid® B72 solution in toluene. Due to the failure of the strength provided by the 2.5% solution to the severely spalled surface, it was deemed necessary that in those still unstable areas a 10% solution of Paraloid® B72 in toluene (w/v) would be applied selectively by brush[3]. Some areas on the surface had actively spalling flakes with large gaps between them and the object's surface. In these areas, a more substantial consolidant was needed, but only for the desalination treatment. It was feared that in these areas the exterior water pressure and osmotic pressure would cause flakes of ceramic to break off of the surface. Therefore, due to the temporary nature of the consolidant's use, and the strength needed, cyclododecane[4] was heated and droppered on extremely vulnerable areas of the spalling surface to provide the temporary support.

Once the figure had been sufficiently consolidated, it was prepared for desalination. The decision was made to use the Chris White et al. (2010) method, as it allowed the object to be in the bath for a shorter amount of time than other more traditional methods. This method bases the endpoint of desalination on a conductivity reading based on the change of time, versus other methods, which solely rely on the ratio of salts present in the bath water. The most common method for measuring conductivity, K_{adj} method (Unruh 2001) does not provide the conservator with provisions for time during the desalination process, whereas by incorporating the change of time, the K_{norm} method does (White et al. 2010). Using the equation $K_{norm}=\Delta K(L)/\Delta t(g)$ we are able to gain a more detailed picture of rate of salts removed during the process.

In the White et al. article he discusses removing the object when the desalination rate value reaches 2.0, though his reasoning for this endpoint is that it was similar to Unruh's experience with a specific set of ceramics and on "past ASM experience desalinating Southwestern ceramics" (White et al. 2010, 50). These two case studies however, may not be indicative of the appropriate end point for each case of desalination.

In order to reduce the shock to the ceramic fabric, deionized water was brushed onto the surface. However, this effort proved unnecessary as the consolidation layer slowed the rate at which water could enter the ceramic body. The figure was then placed in a water bath for a total

[3] During this point of the treatment it was noted that there was new efflorescence on the select areas of the figure's surface. However, as this was a preliminary step to the desalination, it was decided that this efflorescence should be addressed if still present after that treatment took place.

[4] An organic compound ($C_{12}H_{24}$) that is a white waxy solid at room temperature and sublimes also at room temperature. Aside from liquefying when heat is applied, the material is soluble in non-polar organic solvents.

of 17 hours and was removed when the K_{norm} reached 5.28. Though the rate of desalination did not reach White et al.'s suggested end point, time ended up being a predominant factor for the object's removal. It was decided that exposing the object to a more prolonged period of submersion would ultimately be more harmful than ending at a slightly elevated end point. Additionally, it may be the case that with the Jaina figurines, an elevated end point is actually the most appropriate[5]. Following desalination, the object was allowed to dry slowly by first placing it in a bin with a perforated plastic wrap cover, then removing the plastic wrap entirely.

While the object dried, the cyclododecane was also allowed to naturally sublime. Once the piece was sufficiently dried, an infrared lamp was used to encourage a more rapid sublimation of the cyclododecane. The object was constantly rotated to ensure that the heat would not affect the ceramic or other consolidant negatively. Once the temporary consolidant was removed, the lifting flakes were bulked by wicking a 10% solution of Paraloid® B72 in acetone or a 20% solution of Paraloid® B72 in acetone into the gaps as needed.

Storage and Handling

The object was returned to the Fowler Museum in a box that contains a handling tray. The object should remain on the handling tray to limit handling of the delicate surface, though the box may be discarded if room in storage is limited. Clean hands or gloves should be used when handling the object.

References

Corson, Christopher. 1976. Maya Anthropomorphic Figurines From Jaina Island, Campeche, edited by John A. Graham. Ramona: Ballena Press.

Ferreira, Ana P., and José Delgado Rodrigues. 2008. Stone Consolidation: The Role of Treatment Procedures. In *Journal of Cultural Heritage*, 9: (38-53).

Ferreira, Ana P., and José Delgado Rodrigues. 2012. Consolidation of Carbonate Stones: Influence of Treatment Procedures on the Strengthening Action of Consolidants. In *Journal of Cultural Heritage*, 13: (154-166).

Ferron, Amila, and Frank G. Matero. 2011. A Comparative Study of Ethyl-Silicate-Based Consolidants on Earthen Finishes. *Journal of the American Institute for Conservation*, 50 (1): 49-72.

Grissom, Carol A., A. Elena Charola, Ann Boulton, and Marion F. Mecklenburg. 1999. Evaluation Over Time of an Ethyl Silicate Consolidant Applied to Ancient Lime Plaster. *Studies in Conservation,* 44: 113-120)

Odegaard, Nancy, Scott Carroll and Werner S. Zimmt. 2005. Material characterization tests for objects of art and archaeology. London: Archetype Publications.

Unruh, Julie. 2001. A Revised Endpoint For Desalination at the Archaeological Site of Gordion, Turkey. *Studies in Conservation,* 46: 81-92.

White, Chris, Marilen Pool, and Norine Carroll. 2010. Short Communication: A Revised Method to Calculate Desalination Rates and Improve Data Resolution. *Journal of the America Institute of Conservation*, 49: 45-52.

[5] Past desalinations of hollow Jaina figurines from the Fowler museum collection, also using the White method, found that the higher endpoints (4-7) were where the rate of desalination stopped changing.

Figure 1 Before Treatment, obverse

Figure 2 Before Treatment, reverse

Figure 3 Before Treatment, proper left

Figure 4 Before Treatment, proper right

Figure 5 Before Treatment, bottom

Figure 6 Microphotograph showing the original surface on the right and the deteriorated surface on the right

Figure 7 Microphotograph showing the extent on spalling on the surface

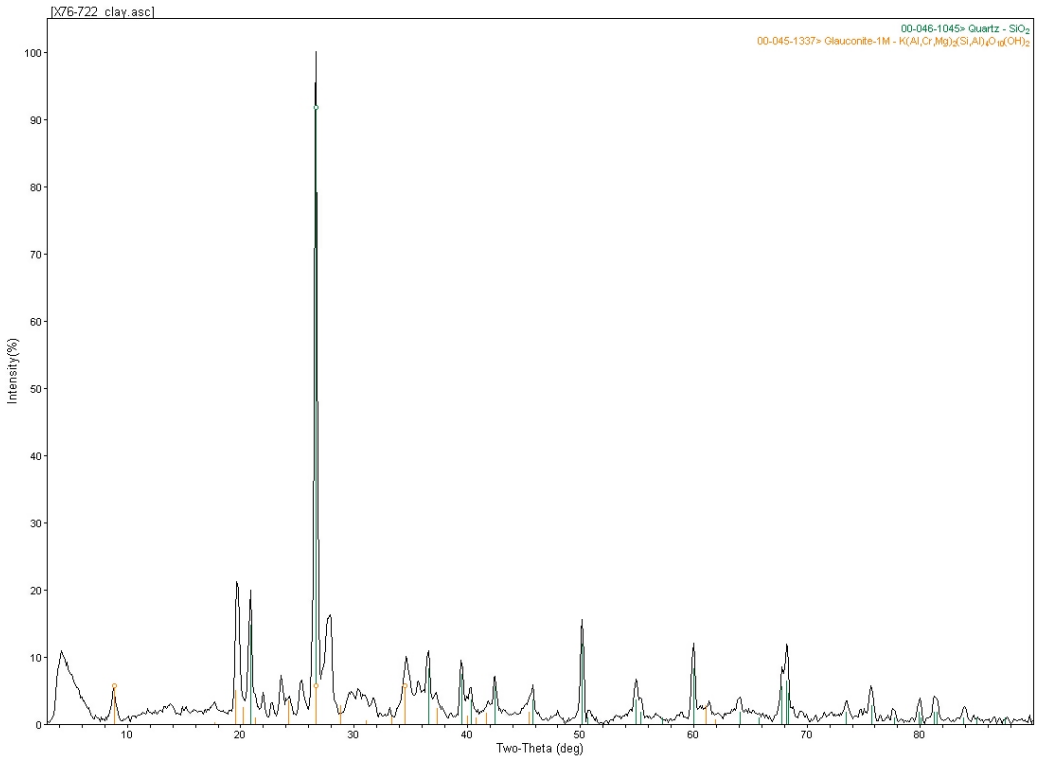


Figure 8 X-ray diffraction spectra of clay sample

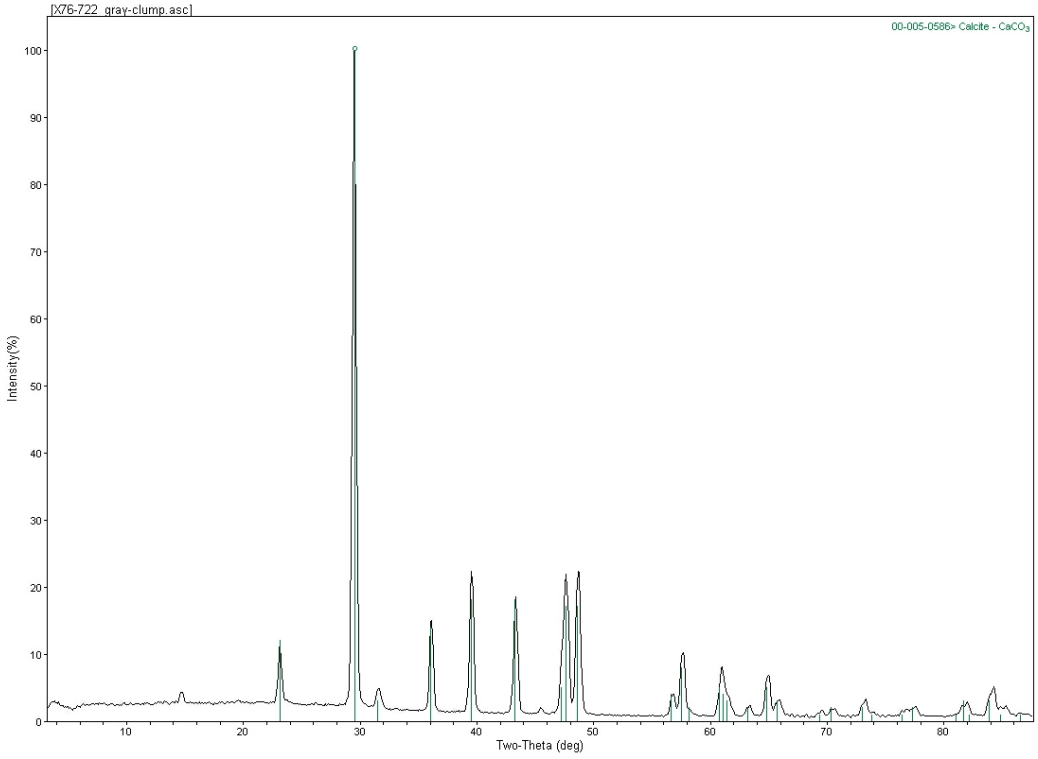


Figure 9 X-ray diffraction spectra from gray colored surface material

Figure 10 After Treatment, obverse

Figure 11 After Treatment, reverse

Figure 12 After Treatment, proper left

Figure 13 After Treatment, proper right

Object (title): Jaina figurine (standing male)

Cultural attribution/provenance: Maya - Jaina

Identification number: X91.2269

Medium: Low-fired ceramic, paint

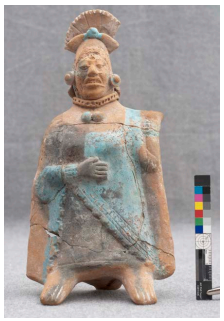
Dimensions: H – 20.4 cm, W – 9.4 cm, D – 7.3 cm

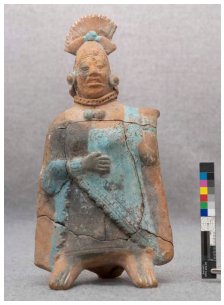
Current/past owners: Fowler Museum

Purpose of Examination: Conservation treatment

Date of examination: 26 October 2012
(Secondary examination 23 May 2013)

Conservator: Carinne Tzadik





Object Description

The object is a hollow, red/orange ceramic body, standing male figurine. The figure is depicted wearing a small, fanned headdress, ear ornaments, and a large cloak. The proper right hand is held at the figure's stomach and the proper left and is held by the shoulder palm facing forward. The cloak and details on the headdress and face have blue and black paint.

Materials and Techniques

The figure is a mold-made, low-fired ceramic figure/whistle. Paint has been applied to the surface of the ceramic body, seemingly post-firing. The pigments represented are black and blue, and it is assumed that the blue pigment is Maya blue, though further testing is needed to confirm. Maya Blue is a pigment created by the Maya and is a clay-organic complex of indigo and palygorskite and/or sepiolite. The figure had not previously been classified within the Corson typology, and does not immediately fit under any of the described groups or categories (Corson 1976).

Condition

Structural

The object has been fragmented into 11 pieces and then previously reassembled using an adhesive that is visible along the seams and on the surfaces surrounding the joins. The adhesive is yellowing and may be removing the topmost surface of the figure. There are losses at the proper left headdress, the proper left hand, and gaps in the body of the figure where fragments were not retained.

Surface

The remaining blue and black pigments are well adhered to the surface of the figure. However, along the join lines, where adhesive is present on the surface of the figure, the adhesive has

begun to lift the paint (figure 8**).** This appears to be the result of the previous intervention and does not reflect on the stability of the paint itself.

The surface also displays black spotty accretions on the top half of the figure at the back and front (figure 7). X-ray fluorescence (XRF) readings of the spotted areas show a significant increase in the manganese levels when compared to the clay body and pigmented areas. This would indicate that these areas have manganese oxide deposits from burial.

Condition Summary

The object has been reassembled from eleven fragments with an unknown adhesive. The object is currently stable, however the adhesive used may cause damage in the future.

Proposed Treatment

1. Spot tests, UV examination and solubility testing will be used to attempt to identify the adhesive type used.
2. A small sample of the blue pigment will be taken to perform XRD analysis.
3. Results of solubility testing of the adhesive and further solubility testing of the surrounding paints will be performed to determine a safe method for reversibility of the joins.
4. Once the pieces have been disassembled, adhesive will be removed from the break lines to ensure that the previous adhesive has been removed completely.
5. Using an appropriate adhesive and consolidant combination, the fragments will be rejoined.

Testing and Analysis

Solubility testing was conducted on the paint and adhesive to determine appropriate solvent and adhesive combinations for any further treatment. Three solvents were tested on each of the materials as a preliminary step with the understanding that if additional testing was needed it would happen subsequently. The initial solvents tested were deionized water, ethanol, acetone, and mineral spirits. Results of the testing indicate that both the blue and black paint layers are insoluble in all of the tested solvents with no visible color changes. The solvents were applied to an inconspicuous section on the reverse of the figure by lightly rubbing the area with a cotton swab soaked in solvent. The same method of testing was then applied to the aged adhesive. The adhesive was found to be insoluble in deionized water, slightly soluble in ethanol and mineral spirits, and soluble in acetone. Ethanol and mineral spirits slightly softened the adhesive, but did not fully solubilize.

UV-induced (365 nm) visible fluorescence images (figures 8,9) were also taken to determine if the previously used adhesive could be identified based on the indicative color of the fluorescence when excited by UV. While there was evidence of strong fluorescence in the images, the color was not indicative enough to make a positive identification of the adhesive type solely with this method.

Finally based on the results of the solubility testing and knowledge of commonly used adhesives, a spot test for cellulose nitrates was performed. The test required taking a small sample of the adhesive, from an area of excess, and placing it on a glass slide. A drop of diphenylamine ($(C_6H_5)_2NH$)/sulfuric acid (H_2SO_4)) solution was added to the sample. The reaction occurs in two

parts with the sulfuric acid reacting with the nitrate to form nitronium ions (NO_2^+), which subsequently react with the diphenylamine to form diphenylbenzidine violet (Odegaard et al. 2005). A positive presence of cellulose nitrate will turn the sample a blue-black, as was the case for this sample, confirming nitrate presence.

Additionally, x-ray diffraction was performed on a sample of the blue removed from the object (figure 10). The spectra identified the material as palygorskite (figure 11).

Treatment

Following solubility testing and other methods to determine the previously used adhesive (see Testing and Analysis), it was determined that the most likely adhesive used was a type of cellulose nitrate. Because this adhesive was deemed inappropriate for use on this and other objects[1], and due to the damage it was causing the surface of the figurine, the adhesive was reduced and removed using acetone. The solvent was brushed onto the joins in an effort to solubilize the adhesive while excess material was removed using a dental tool. Reducing and removing as much excess adhesive as possible was necessary to prevent migration of the adhesive once the object was placed in a solvent chamber. Additionally, during this process, the lifting paint was tacked down in place by applying acetone with a brush and lightly applying pressure.

A chamber was prepared using acetone in open containers within a sealed polyethylene bag. The figure was placed in a tray and supported using shaped pieces of ethafoam[2], and then put into the prepared solvent chamber. The figure was left in the chamber for approximately 48 hours when it was removed. The adhesive in the joins remained tacky and held the figure together even after being in the chamber, however with very slight pressure the object could be easily disassembled.

Once the object was disassembled into its component fragments, edges of the sherds were further cleaned using acetone and bamboo skewers while under the microscope. Once the previous adhesive had been fully removed, the edges of the ceramic fragments were coated with a 3% solution of Paraloid® B72[3] in acetone (w/v). Once sealed, the fragments were pieced together and adhered using a 35% solution of Paraloid® B72 in acetone (w/v).

References

Corson, Christopher. *Maya Anthropomorphic Figurines From Jaina Island, Campeche*, edited by John A. Graham. Ramona: Ballena Press, 1976.

Koob, Stephen P. "The Instability of Cellulose Nitrate Adhesives." *The Conservator*, 6 (1982): 31-34.

Odegaard, Nancy, Scott Carroll and Werner S. Zimmt. 2005. Material Characterization Tests for Objects of Art and Archaeology. London: Archetype Publications.

[1] Cellulose nitrate has been found to have poor aging qualities that cause the adhesive to yellow, become brittle, and weaken over time. Commercially manufactured compounds also often have acid impurities and plasticizers that leach out of the resin and into the substrate (Koob 1982).

[2] Ethafoam is a closed-cell polyethylene foam that is available from Conservation Resources (www.conservationresources.com).

[3] Paraloid® B72 is a methyl methacrylate copolymer which is available from Talas (www.talasonline.com).

Figure 1 Before Treatment, obverse

Figure 2 Before Treatment, reverse

Figure 3 Before Treatment, proper left

Figure 4 Before Treatment, proper right

Figure 5 Black spotty accretions on the obverse surface

Figure 6 Adhesive causing paint to lift along joins

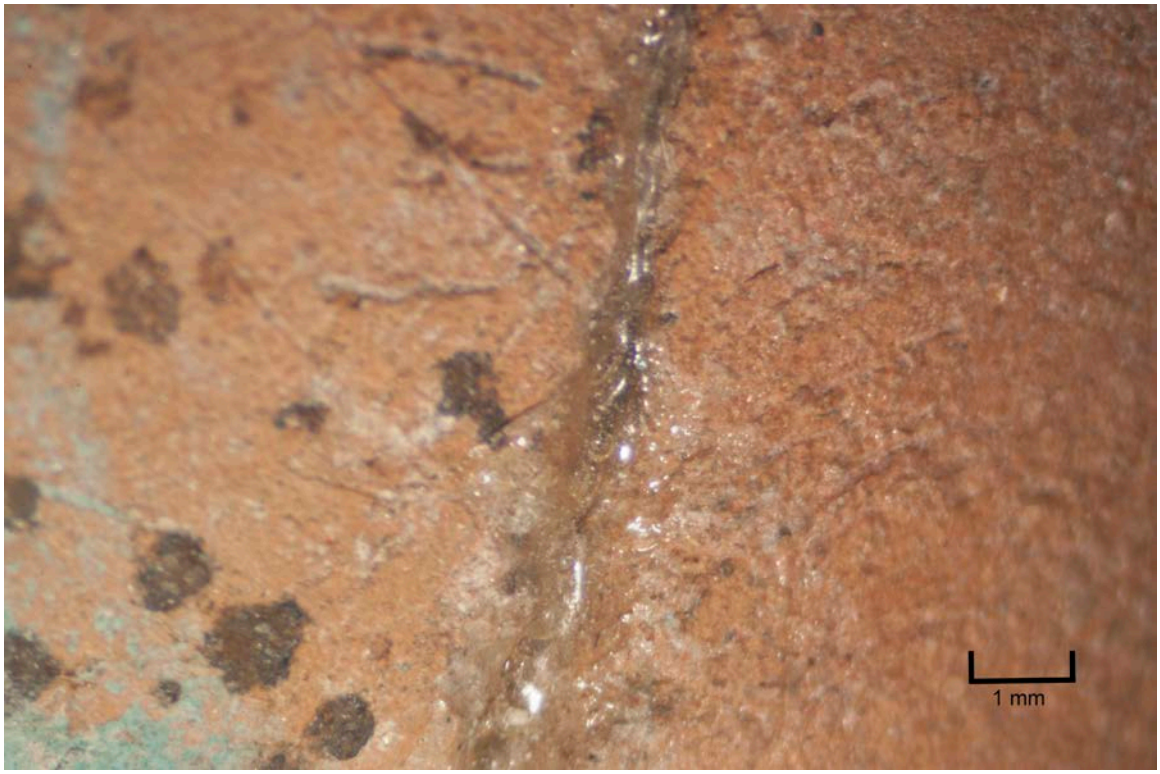


Figure 7 Excess adhesive at joins

Figure 8 UV-induced visible fluorescence, obverse

Figure 9 UV-induced visible fluorescence, reverse

Figure 10 XRD sample location

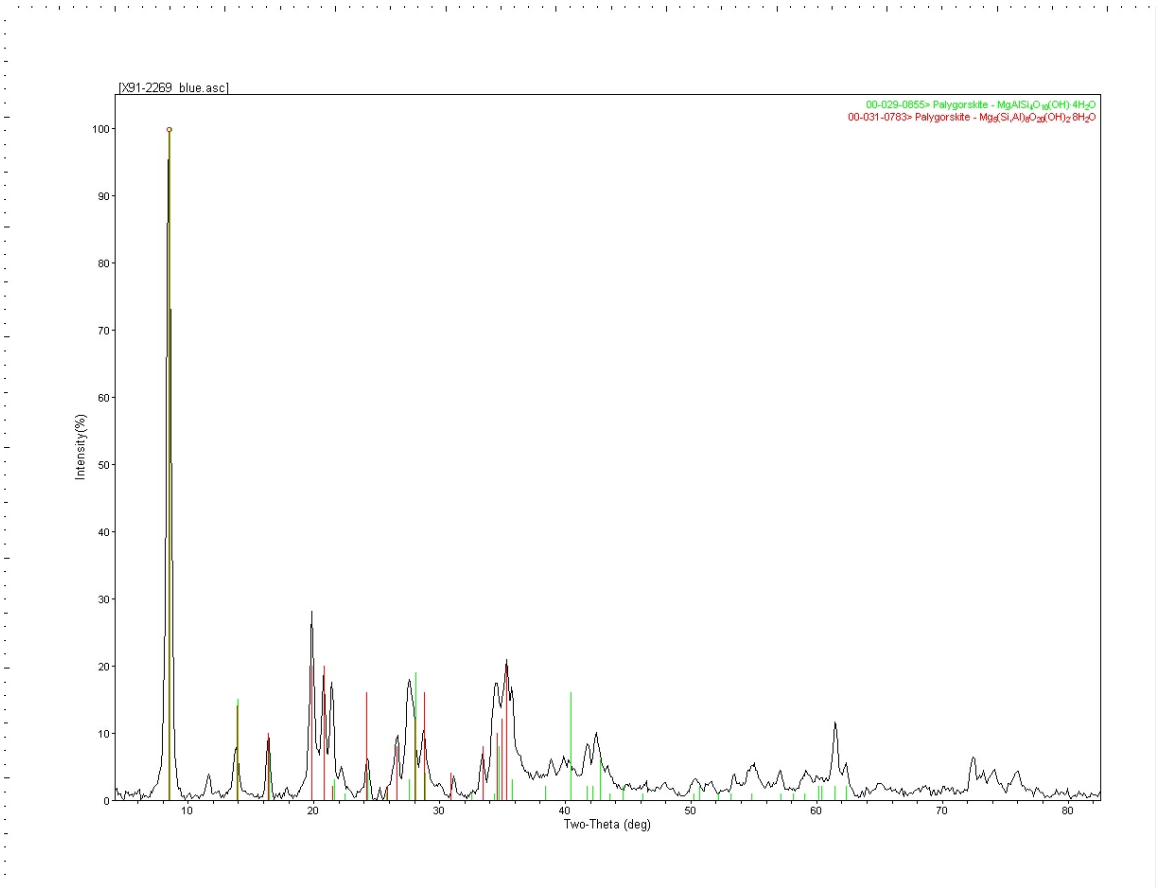


Figure 11 X-ray Diffraction Spectra of the blue pigment on the figure. Peaks identify the material as palygorskite.

Figure 12 After Treatment, obverse

Figure 13 After Treatment, reverse

Figure 14 After Treatment, proper left

Figure 15 After Treatment, proper right

Object (title): Jaina figurine (standing male)

Cultural attribution/provenance: Maya - Jaina

Identification number: X2010.16.6

Medium: Low-fired ceramic

Dimensions: H: 26.3 cm, W: 15.6 cm, D: 6 cm

Current/past owners: Fowler Museum

Purpose of Examination: Conservation treatment

Date of examination: 16 November 2012

Conservator: Carinne Tzadik

Object Description

The object is a hollow bodied standing male figure with solid extremities made from a beige ceramic. The figure is depicted standing with his legs spread wide and facing forward. The proper left arm is held down by the figure's side, while the proper right arm is held upwards and holding a removable round banner in the air.

Materials and Techniques

The figure most likely has a mold-made torso and head and modeled extremities and accents, formed from a low-fired ceramic. Though the figure was not previously classified using the Corson system, based on a review of the classification system, it appears that this figure would fit into the description of the Jaina Modelled Miscellaneous group. The figures that appear in this group are generally males in all varieties of poses. Though the poses are varied, forward facing symmetrical poses with arms at the side or crossed (which is more common). The headdress' represented in this group provide the most diversity while almost all of the males are represented bare chested with a loincloth supported by a large belt. The adornments, namely the ear ornaments are consistent with some of the figures in the group (Corson 1976).

Condition

Structural

The figure has losses at the reverse head, and along the edges of the knot at the belt/loincloth. There is also a loss at the proper right hand that occurred during examination of the object due to the pressure put on the area by the held banner. The banner is a standalone piece that had previously been assumed to part of the figure. By remaining in the proper right hand during travel and analysis, stress caused the delicate area of the hand to break. Additionally, there are past repairs at two places on the raised banner that are made visible by excess adhesive and visible join lines, and a possible repair on the lower half of the proper right arm.

Surface

On the reverse there is a sticker that reads “W/1054” in green ink and 2 bright red spots that appear to be the result of pigment transfer. At the time of examination the note associated with figure read "green deposit in holes at back is from mount - CDB 11/18/10". The mentioned marks can be seen along the interior edges of both holes on the back.

Condition Summary

Overall the object is in stable condition, though it has a small loss at the proper right hand that requires repair.

Proposed Treatment

1. Following testing, an appropriate adhesive and consolidant combination will be used to rejoin the hand fragment.

Treatment

Due to the lack of pigment on the figurine, solubility of surface materials was not a concern. In order to provide adequate strength and beneficial setting time, it was decided that a 35% solution of Paraloid® B72[1] in acetone was used to reattach the hand. The edges were sealed using a 3% solution of Paraloid® B72 in acetone prior to the application of the adhesive and subsequent reattachment. A small break line is still visible at the breakage site.

Storage and Handling

In the future the object should be stored and handled with the banner removed from the hand. For display purposes, the banner may be displayed in the figure’s hand, but a mount should provide appropriate support.

References

Corson, Christopher. Maya Anthropomorphic Figurines From Jaina Island, Campeche, edited by John A. Graham. Ramona: Ballena Press (1976).

[1] Paraloid® B72 is a methyl methacrylate copolymer that is commercially available through Talas (www.talasonline.com).

Figure 1 Before Treatment, obverse

Figure 2 Before Treatment, reverse

Figure 3 Before Treatment, detail of break

Figure 4 After Treatment, obverse

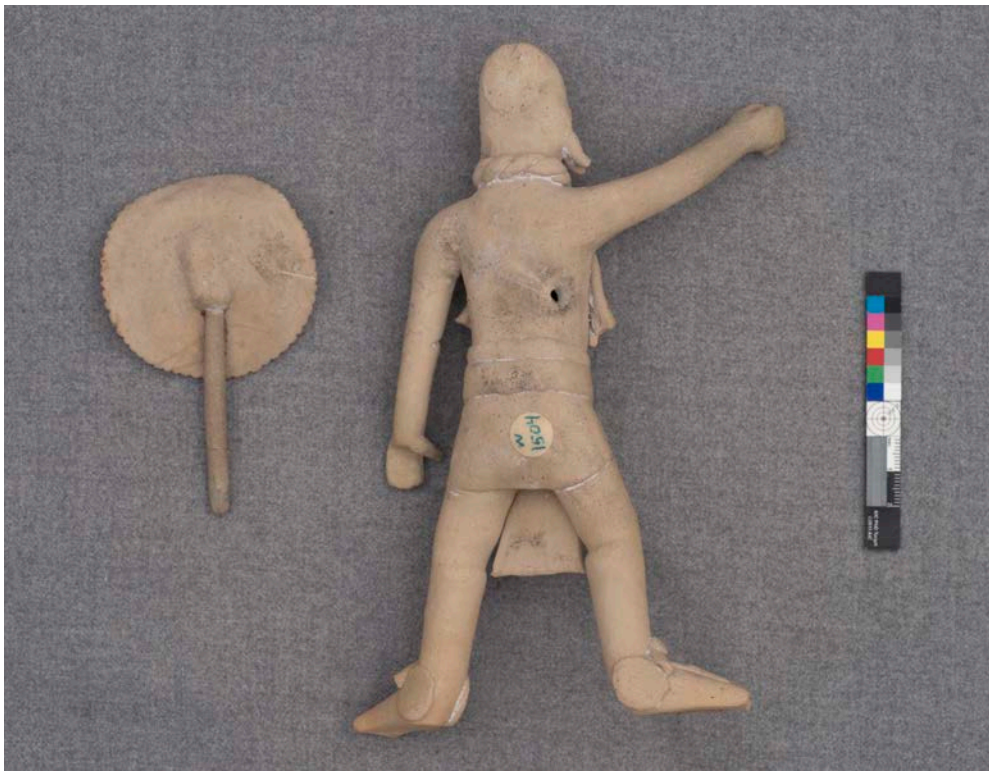


Figure 5 After Treatment, reverse

Object (title): Jaina figurine (standing male)

Cultural attribution/provenance: Maya - Jaina

Identification number: X2010.16.7

Medium: Low-fired ceramic

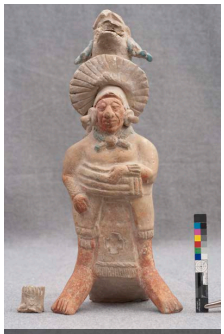
Dimensions: H: 25.4 cm, W: 8.2 cm, D: 8.4 cm

Current/past owners: Fowler Museum

Purpose of Examination: Conservation treatment

Date of examination: 24 May 2013

Conservator: Carinne Tzadik



Object Description

The object is a hollow, beige ceramic body, standing male figure. The figure is depicted wearing an elaborate headdress, ear ornaments, and full body dress. A small hole at the bottom reverse proper right indicates the object's possible function as a whistle.

Materials and Techniques

The object is a mold made, low-fired ceramic figurine/whistle. Paint has been applied to the surface of the ceramic body, seemingly post-firing. The pigments represented are red, white and blue, and it is assumed that the blue pigment is Maya blue, though further testing is needed to confirm. Maya Blue is a pigment created by the Maya and is a clay-organic complex of indigo and palygorskite and/or sepiolite. The figure had not previously been classified within the Corson typology, and does not immediately fit under any of the described groups or categories (Corson 1976).

Condition

Structural

The figure has small losses along some of the decorative elements of the headdress along the proper right side. On the obverse of the headdress the top jaw of the animal represented had previously been reattached along a break, but the join has currently failed. Additionally, along the back rim of the headdress (on the reverse) a section has been reattached using what appears to be a brown grainy grout. While the repair is visually distracting, it is stable.

Surface

The surface shows no visible losses or evidence of salt damage. The remaining paints along the surface are well adhered and have very little losses. Under the proper left foot there is some darkening that appears to be the result of a mounting wax of some type.

Condition Summary

The object is in very stable condition and has minor losses and some evidence of previous repairs.

Proposed Treatment

1. The previous repair will be cleaned to remove the failed consolidant, after solubility testing has been performed.
2. Following testing, an appropriate adhesive and consolidant combination will be used to rejoin the headdress fragment.

Testing and Analysis

The adhesive around the previous break was soluble in acetone, not soluble in deionized water or ethanol, and softens in mineral spirits.

Treatment

Along the break edges there remains of adhesive and an unidentified fill material from the previous intervention. The adhesive was removed using acetone applied by brush, and excess was removed using a dental tool. In order to provide adequate strength and beneficial setting time, a 35% solution of Paraloid® B72[1] in acetone was used to reattach the retained section of the headdress. The edges were sealed using a 3% solution of Paraloid® B72 in acetone prior to the application of the adhesive and subsequent reattachment. A small break line is still visible at the break site.

References

Corson, Christopher. Maya Anthropomorphic Figurines From Jaina Island, Campeche, edited by John A. Graham. Ramona: Ballena Press (1976).

[1] Paraloid® B72 is a methyl methacrylate copolymer that is commercially available through Talas (www.talasonline.com).

Figure 1 Before treatment, obverse

Figure 2 Before treatment, reverse

Figure 3 Before treatment, proper left

Figure 4 Before treatment, proper right

Figure 5 Before treatment, bottom

Figure 6 Before treatment, top

Figure 7 After Treatment, obverse

Figure 8 After Treatment, reverse

Figure 9 After Treatment, proper left

Figure 10 After Treatment, proper right

Object (title): Jaina figurine (standing male)

Cultural attribution/provenance: Maya - Jaina

Identification number: X2010.16.23A

Medium: Low-fired ceramic

Dimensions: H: 23.3 cm, W: 16.2 cm, D: 6.3 cm

Current/past owners: Fowler Museum

Purpose of Examination: Conservation treatment

Date of examination: 16 November 2012

Conservator: Carinne Tzadik

Object Description

The object is a hollow torso figure with solid extremities and accessories with a red/orange ceramic body. The male figure is depicted standing, though the exact nature of the pose is not clear due to the loss of the proper right lower leg. The figure is gazing off to the proper left and holding its arms up and slightly away from the body and bent at the elbows. The figure wears an elaborate headdress, with elements that can be removed. The figure has five elements total that can be removed and that are associated with the figure. The elements act as additional elaboration of the costume and may be provide an indication of the figure's actions.

Materials and Techniques

The figure is a made using a combination of molds and modeling, of a low-fired ceramic body. Though the figure was not previously classified using the Corson system, it appears that this figure would fit in the description of Jaina Modelled Miscellaneous group. The figures that appear in this group are generally males in all varieties of poses. Though the poses are varied, the instances of asymmetrical poses are very rare. The examples that are found are well executed and suggest a longer tradition of employing the contraposto than physical evidence would suggest. The headdresses represented in this group provide the most diversity while almost all of the males are represented bare-chested with a loincloth supported by a large belt. The adornments, namely the ear ornaments, wristlets and paint, are all consistent with some of the figures in the group (Corson 1976). Because the group has such a diverse characterization, classifying it as a member of this style category is not ideal, though it does fit.

Condition

Structural

The object has losses at the proper right lower leg, at the element on the front of the belt, a section from the headdress that has been retained, and tassels on the PR side of the belt. The remaining foot on the figure has possibly had past conservation work.

Surface

The surface is stable and the remaining paint is well adhered. The color and texture of the visible clay body is varied over the piece and may indicate past repairs, though no clear evidence of these repairs can be seen. The clay body also provides the surface with a shimmery quality, possibly due to inclusions in the original materials of the clay or paint used.

Condition Summary

The object is stable with well-adhered paints and displays old losses most notably at the proper right leg.

Proposed Treatment

1. Following testing, an appropriate adhesive and consolidant combination will be used to rejoin the fragment.
2. A small sample of the blue pigment will be taken to use for XRD analysis.

Treatment

Testing of the blue pigment surrounding the break with the retained segment showed that the pigment was not soluble in acetone. In order to provide adequate strength and beneficial setting time, it was decided that a 35% solution of Paraloid® B72[1] in acetone was used to reattach the hand. The edges were sealed using a 3% solution of Paraloid® B72 in acetone prior to the application of the adhesive and subsequent reattachment. A small break line is still visible at the breakage site.

Additionally, powder samples taken from the object were analyzed using the Rigaku Micro-Diffraction System, which uses a 2-D detector. The x-ray diffraction (XRD) analysis showed the first run of the blue sample to contain palygorskite (figure 5), and the second run of the sample to contain palygorskite and montmorillonite (figure 6).

References

Corson, Christopher. Maya Anthropomorphic Figurines From Jaina Island, Campeche, edited by John A. Graham. Ramona: Ballena Press (1976)

[1] Paraloid® B72 is a methyl methacrylate copolymer that is commercially available through Talas (www.talasonline.com).

Figure 1 Before Treatment, obverse

Figure 2 Before Treatment, reverse

Figure 3 Before Treatment, detail of break

Figure 4 XRD sample location site

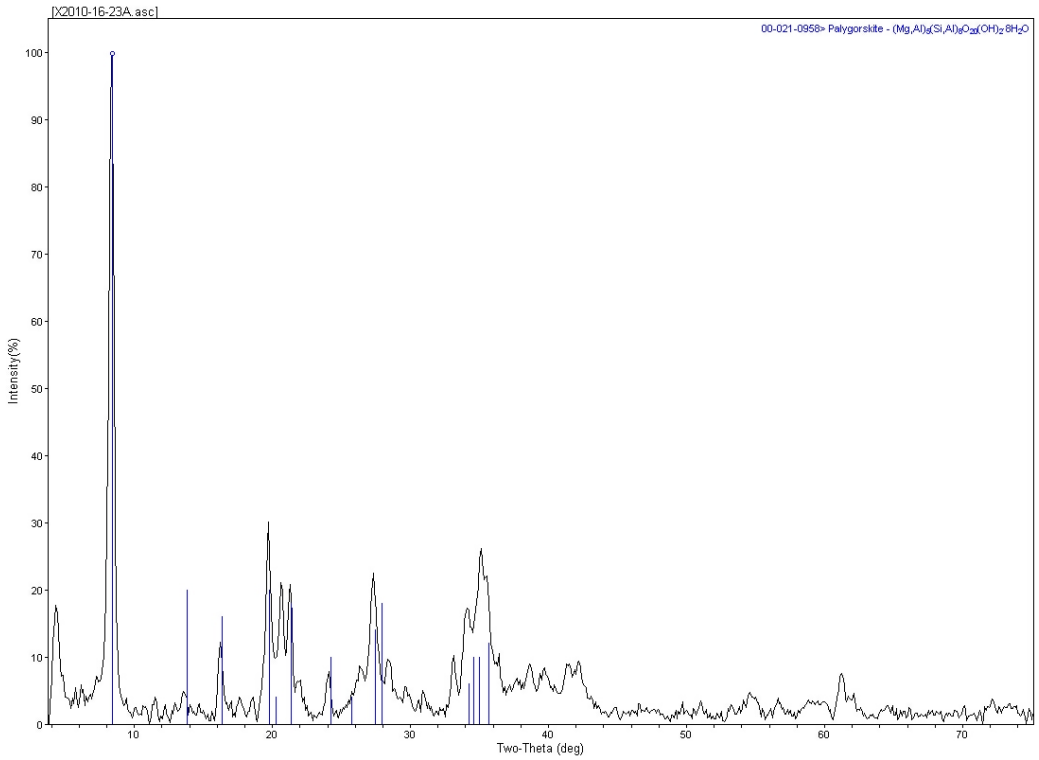


Figure 5 X-ray diffraction spectra of the first run of the blue pigment sample

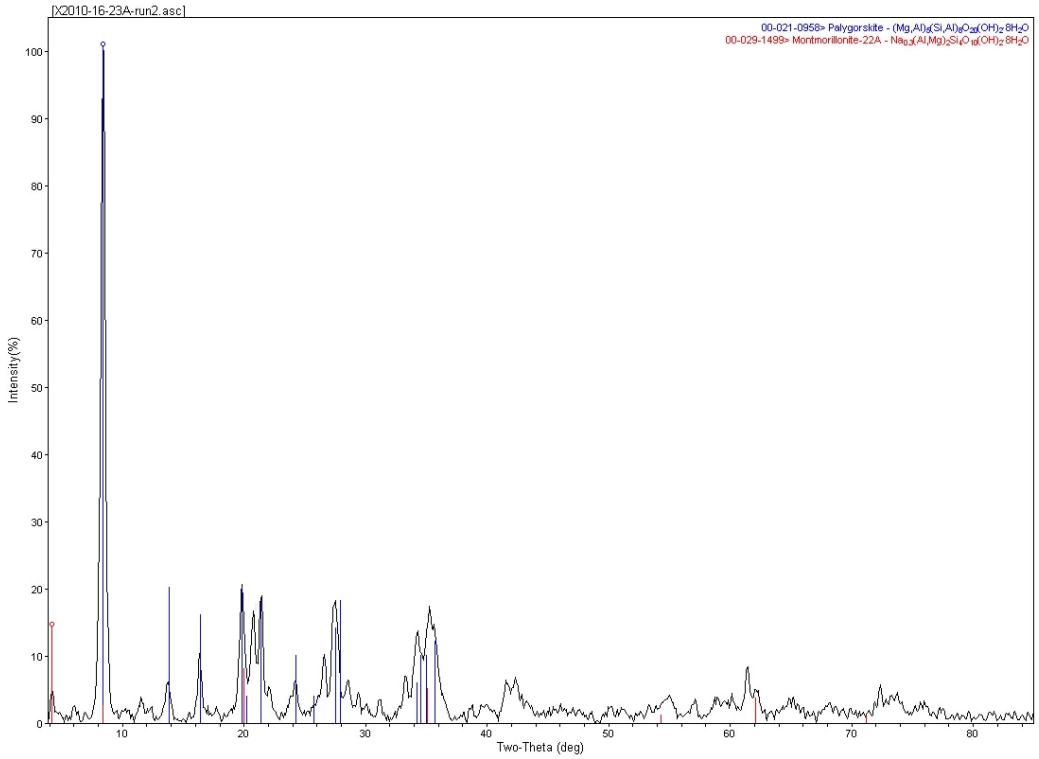


Figure 6 X-ray diffraction spectra of the second run of the blue pigment sample

Figure 7 After Treatment, obverse

Figure 8 After Treatment, reverse

Figure 9 After Treatment, detail of break repair

7. References

Arnold, Dean E. “Maya Blue and Palygorskite: A Second Possible Pre-Columbian Source.” *Ancient Mesoamerica*, 16 (2005): 51-62.

Arnold, Dean E., Bruce F. Bohor, Hector Neff, Gary M. Feinman, Patrick Ryan Williams, Laure Dussubieux, and Ronald Bishop. “The First Direct Evidence of Pre-Columbian Sources of Palygorskite for Maya Blue.” *Journal of Archaeological Science*, 39 (2012): 2252-2260.

Becker, Marshall Joseph. "Earth offerings among the Classic period Lowland Maya: burial and caches as ritual deposits." In *Perspectivas antropológicas en el mundo maya*, pp. 45-74. Sociedad Española de Estudios Mayas, 1993.

Benavides C., Antonio. “Campeche Archaeology At The Turn of the Century.” *Anthropological Notebooks*, 11 (2005): 13-30.

Bishop, Ronald L., Veletta Canouts, Patricia L. Crown, Suzanne P. de Atley. “Sensitivity, Precision, and Accuracy: Their Roles In Ceramic Compositional Data Bases.” *Society for American Archaeology*, 55 (1990): 537-546.

Butler, Mary. “A Study of Maya Mouldmade Figurines.” *American Anthropologist,* 37 (1935): 636-672.

Cecil, Leslie G. “Central Petén Blue Pigment: A Maya Blue Source Outside of Yucatán, México.” *Journal of Archaeological Science*, 37 (2010): 1006-1019.

Cariati, Franco, Paola Fermo, Stefania Gilardoni, Anna Galli, Mario Milazzo. A New Approach for Archaeological Ceramics Analysis Using Total Reflection X-ray Flourescence Spectrometery. *Spectochimica Acta Part B*, 58 (2003): 177-184.

Chiari, Giacomo, Roberto Giustetto, and Gabriele Ricchiardi. “Crystal structure refinements of Palygorskite and Maya Blue from Molecular Modelling and Powder Synchrotron Diffraction.” *European Journal of Mineralogy*, 15 (2003): 21-33.

Coe, Michael D. *The Maya*. London: Thames & Hudson, 2005.

Coe, Michael D. “Three Maya Figurines from Jaina Island.” *Yale University Art Gallery Bulletin*, 35 (1975): 24-25.

Corson, Christopher. *Maya Anthropomorphic Figurines from Jaina Island, Campeche*, edited by John A. Graham. Ramona: Ballena Press, 1976.

de la Garza, Mercedes. “The Rediscovery of a Civilization.” In *Maya*, edited by Peter Schmidt, Mercedes de la Garza, and Enrique Nalda, 19-27. New York: Rizzoli, 1998.

Delamare, François. *Blue Pigments: 5000 Years of Art and Industry*. Trans. Yves Rouchaleau. London: Archetype Publications, 2013.

Doménech, Antonio, María Teresa Doménech-Carbó, Manuel Sánchez del Río, Sara Goberna, and Enrique Lima. “Evidence of Toplogical Indigo/Dehydroindigo Isomers in Maya Blue-Like Complexes Prepared from Palygorskite and Sepiolite.” *The Journal of Physical Chemistry C*, 113 (2009): 12118-12131.

Doménech, Antonio, María Teresa Doménech-Carbó, Manuel Sánchez del Río, María Luisa Vázquez de Agredos Pascual, and Enrique Lima. "Maya Blue as a nanostructured polyfunctional hybrid organic-inorganic material: the need to change paradigms." *New Journal of Chemistry*, 33 (2009): 2371-2379.

Eastaugh, Nicholas, Valentine Walsh, Tracey Chaplin, and Ruth Siddall. *Pigment Compendium: A Dictionary and Optical Microscopy of Historical Pigments.* San Diego: Elsevier, 2008.

Folan, William J., Joyce Marcus, Sophia Pincemin, María del Rosario Domínguez Carrasco, Laraine Fletcher, and Abel Morales Lopez. "Calakmul: New Data From An Ancient Maya Capital in Campeche, Mexico." *Latin American Antiquity*, 6 (1995): 310-334.

Forster, Nicola, Peter Grave, Nancy Vickery and Lisa Kealhofer. "Non-Destructive Analysis Using PXRF: Methodology and Application to Archaeological Ceramics." *X-Ray Spectrometry* (2011).

Fowler Museum. "About the Museum." Accessed May 24, 2013. http://www.fowler.ucla.edu/about

Fowler Museum. "History of the Museum." Accessed May 24, 2013. http://www.fowler.ucla.edu/about/history

García-Heras, M., J. Reyes Trujeque, R. Ruiz Guzmán, M.A. Avilés Escaño, A. Ruiz Conde, and P.J. Sánchez Soto. "Estudio Arqueométrico de Figurillas Cerámicas Mayas de Calakmul (Campeche, Mexico)." *Boletin de la Sociedad Española de Cerámica y Vidrio*, 45 (2006): 245-254.

Gettens, Rutherford J. "Maya Blue: An Unsolved Problem in Ancient Pigments." *American Antiquity*, 27 (1962): 557-564.

Gillespie, Susan D. "Body and Soul Among the Maya: Keeping the Spirits in Place." *Archaeological Papers of the American Anthoropological Association,* 11 (2002): 67-78.

Halperin, Christina T., Ronald L. Bishop, Ellen Spensley, and M. James Blackman. "Late Classic (A.D. 600-900) Maya Market Exchange: Analysis of Figurines from the Motul de San José Region, Guatemala." *Journal of Field Archaeology*, 34 (2009): 457-480.

Hein, A., A. Tsolakidou, I. Iliopoulos, H. Mommsen, J. Buxeda I Garrigós, G. Montana, and V. Kilikoglou. "Standardization of Elemental Analytical Techniques Applied to Provenance Studies of Archaeological Ceramics: An Inter Laboratory Calibration Study." *The Analyst*, 127 (2002): 542-553.

José-Yacamán, M., Luis Rendón, J. Arenas, and Mari Carmen Serra Puche. "Maya Blue Paint: An Ancient Nanostructured Material." *Science*, 273 (1996): 223-225.

Kelker, Nancy L. and Karen O. Bruhns. *Faking Ancient Mesoamerica*. Walnut Creek: Left Coast Press, 2010.

Koob, Stephen P. "The Instability of Cellulose Nitrate Adhesives." *The Conservator*, 6 (1982): 31-34.

Leona, Marco, Francesca Casadio, Maurio Baccland, and Marcello Picollo. "Identification of the Precolumbian Pigment Maya Blue on Works of Art by Noninvasive UV-Vis and Raman Spectroscopic Techniques." *Journal of the American Institute for Conservation*, 43 (2004): 39-54.

Littmann, Edwin R. "Ancient Mesoamerican Mortars, Plasters, and Stuccos: The Composition and Origin of Sascab." *Society for American Archaeology,* 24 (1958): 172-176.

McVicker, Donald. “Figurines Are Us? The Social Organization of Jaina Island, Campeche, Mexico.” *Ancient Mesoamerica*, 23 (2012): 211-234.

Merwin, H. E., E. H. Morris, and A. A. Charlot. *The Temple of the Warriors at Chichen Itza*. Washington D.C.: Carnegie Institution of Washington (1931).

Miller, Mary Ellen. *Jaina Figurines: A Study of Maya Iconography*. Princeton: The Art Museum, Princeton University (1975).

Moser, Mary Beck. “Seri Blue.” *Kiva*, 30 (1964):27-32.

Nalda, Enrique. “The Maya City.” In *Maya*, edited by Peter Schmidt, Mercedes de la Garza, and Enrique Nalda, 102-129. New York: Rizzoli, 1998.

Odegaard, Nancy, Scott Carroll, and Werner S. Zimmt. *Material Characterization Tests for Objects of Art and Archaeology*. London: Archetype Publications, 2005.

O’Neil, Megan E. “Jaina-Style Figurines.” In *Ancient Maya Art At Dumbarton Oaks*, edited by Joanne Pillsbury, Miriam Doutriaux, Reiko Ishihara-Brito, and Alexandre Tokovinine, 400-430. Washington D.C.: Dumbarton Oaks Research Library and Collection, 2012.

Padilla, R., P. Van Espen, P.P. Godo Torres. “The Suitability of XRF Analysis for Compositional Classification of Archaeological Ceramic Fabric: A Comparison With a Previous NAA Study.” *Analytica Chimica Acta,* 558 (2006): 283-289.

Paterakis, Alice Boccia. “The Deterioration of Ceramics by Soluble Salts and Methods for Monitoring their Removal.” In *Recent Advances in the Conservation and Analysis of Artifacts: Jubilee Conservation Conference, London 6-10 July 1987*, 62-72. Summer School Press, 1987.

Peirce, H. Wesley. “Seri Blue—An Explanation.” *Kiva,* 30 (1964): 33-39.

Piña Chan, Román. “Jaina: Its Funerary Art.” In *Maya*, edited by Peter Schmidt, Mercedes de la Garza, and Enrique Nalda, 387-399. New York: Rizzoli, 1998.

Piña Chan, Román. *Breve Estudio Sobre la Funeraria de Jaina, Campeche*. 1948. Reprint, Campeche: Gobierno del Estado de Campeche, 2001.

Rathje, William L. “Socio-political Implications of Lowland Maya Burials: Methodology and Tentative Hypotheses.” *World Archaeology*, 1 (1970): 359-374.

Reinen, D., P. Köhl, and C. Miller. “The Nature of the Colour Centres in ‘Maya Blue’ – The Incorporation of Organic Pigment Molecules into the Palygorskite Lattice.” *Journal of Inorganic and General Chemistry*, 630 (2004): 97-103.

Reyes-Valerio, Constantino. *De Bonampak Al Templo Mayor: El Azul Maya En MesoAmérica.* Mexico D.F.: Siglo Veintiuno Editores, 1993.

Ruz Lhuillier, Alberto. *Campeche en la Arqueologia Maya*. Mexico D.F.: Acta Anthropologica, 1945.

Sabloff, Jeremy A. “Ancient Maya Civilization in Space and Time.” In *Maya*, edited by Peter Schmidt, Mercedes de la Garza, and Enrique Nalda, 52-71. New York: Rizzoli, 1998.

Saliya, Rajesh Gopalan. “Industrial Applications of Maya Type Pigments.” PhD diss., University of Texas at El Paso, 2004.

Speakman, Robert J., Nicole C. Little, Darrell Creel, Myles R. Miller, Javier G. Iñañez. “Sourcing Ceramics with Portable XRF Spectrometers? A Comparison with INAA Using Mimbres pottery from the American Southwest.” *Journal of Archaeological Science,* 38 (2011): 1-14.

Torres, Luis M. “Maya Blue: How the Mayas Could Have Made the Pigment.” *Material Research Society Symposium Proceedings*, 123 (1988): 123-128.

Torres, Luis M., Ana W. Arie, and Beatriz Sandoval. “Provenance Determination of Fine Orange Maya Ceramic Figurines by Flame Atomic Absorption Spectrometry: A Preliminary Study of Objects from Jaina (Campeche) and Jonuta (Tabasco), Mexico,” In *Archaeological Chemistry – III.* Ed. Joseph B. Lambert, 193-213. Washington D.C.: American Chemical Society, 1984.

Van Olphen, H. “Maya Blue: A Clay-Organic Pigment?” *Science*, 154 (1966): 645-646.

Von Winning, Hasso. *The John-Platt Collection of Pre-Columbian Art*. Charlottesville: The University of Virginia Art Museum, 1986.