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Analysis and Conservation of Archaeological Ceramics from the Site of Amapa, Mexico.

A thesis submitted in partial satisfaction of the requirements

for the degree Master of Arts in Conservation of

Archaeological and Ethnographic Materials.

by

Lindsay Michelle Ocal

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ABSTRACT OF THE THESIS

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University of California, Los Angeles, 2018

Professor Ioanna Kakoulli, Co-Chair

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The site of Amapa is located near the western coast of Mexico, in the state of Nayarit. In 1959, a team from the University of California, Los Angeles completed archaeological excavations of the site, unearthing thousands of artifacts that dated from c. 350 BCE to 1450 CE, proving that Amapa was occupied for almost two millennia.

Ceramics from Amapa have a great variety of types, functions, and decoration. Among the finds from UCLA's 1959 excavations were 788 ceramic vessels and over 68,000 decorated pottery sherds. However, despite their abundance and variety, little is known about their

constituent materials and methods of production. These factors, along with the burial conditions on-site at Amapa and in storage at the Fowler Museum at UCLA, have implications for the state of preservation of the ceramics. This research undertakes a study of the materials and techniques used both in the original creation and in the more recent conservation of these ceramics in order to aid in future conservation and exhibition of these materials.

The thesis of Lindsay Michelle Ocal is approved.

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Chapter One

Introduction

The Fowler Museum at UCLA is home to hundreds of thousands of pieces of art, archaeological artifacts, and ethnographic objects from all over the world that represent many different cultures and time periods. One of the Fowler Museum's most extensive collections is from the archaeological site of Amapa in Mexico. This collection includes artifacts made from clay, stone, obsidian, metal, bone, antler, and shell (Meighan, 1976). In 1959, a team from the University of California, Los Angeles completed archaeological excavations of the site, unearthing thousands of artifacts that dated from c. 350 BCE to 1450 CE, indicative of Amapa's significance for almost two millennia (Meighan, 1976). These objects are now housed in the Fowler Museum's archaeological storage facilities at UCLA.

The ceramics from Amapa in particular, form a large and important collection. These have a great variety of types, functions, and decoration. Among the finds from UCLA's 1959 excavations were 788 whole or reconstructible ceramic vessels and over 68,000 decorated pottery sherds (Meighan, 1976). However, despite their abundance and variety, little is known about their constituent materials and their methods of production, or their conservation history and the adhesives used to reconstruct them after excavation. These factors, along with the burial conditions on-site at Amapa and in storage at the Fowler Museum at UCLA, have major implications in the state of preservation of these ceramics.

Figure 1.1: Map of the States of Mexico.

This research project was launched following discussions between Dr. Michael Mathiowetz, Assistant Anthropology Professor at Riverside City College, and Fowler Museum staff about the possibility of creating an exhibition and associated publication about the ceramic artifacts from Amapa. As most of these ceramics were unstable and would require conservation treatment before an exhibition could be planned, it was considered appropriate to investigate their technology and materials and provide an assessment for their condition and conservation history. This research was therefore proposed, focusing on the following:

1. Application of non-invasive and minimally invasive techniques for the study of selected Amapa ceramics.

2. Development of a documentation methodology to record characteristic production features and degradation patterns of the ceramics.

3. Characterization of the materials and production technology of the Amapa ceramics.

4. Visualization and identification of degradation patterns of the ceramics.

5. Characterization of previous conservation/restoration materials.

6. Development of conservation treatment methodology.

The information gained from this research will further inform decisions on conservation treatments for these objects and lead to the development of treatment protocols that may be applied to a larger group of Amapa ceramics in preparation of future exhibition and publication of these artifacts.

Chapter Two

Historical Background

2.1 The Beginnings of UCLA's West Mexican Program

In the 1950s, the University of California, Los Angeles' Department of Anthropology began a series of archaeological and ethnohistorical research projects in the region of West Mexico, including the states of Nayarit, Jalisco, Colima, and coastal Michoacán. The first archaeological project was at Peñitas, a mound site along the Río San Pedro in Nayarit. Fieldwork at Peñitas was performed from January to April 1956, under the supervision of George Brainerd. Two graduate students, Ernst Goldschmidt of UCLA and Jacques Bordaz of Columbia University, assisted with the project (Proskouriakoff, 1956; Nicholson and Meighan, 1974).

Unfortunately Brainerd died suddenly and unexpectedly during the field season, and Clement W. Meighan supervised the final phases of excavation (Nicholson and Meighan, 1974). The full results of the Peñitas excavations were never published, but Meighan did prepare a brief summary of the project for *American Antiquity* (Proskouriakoff, 1956) and presented a paper at the December 1956 annual meeting of the American Anthropological Association (AAA, 1956). The most significant publication from the Peñitas project was Bordaz's 1964 Ph.D. dissertation, which focused on the three Pre-Columbian ceramic kilns and their associated finds.

While excavating at Peñitas, the UCLA team also surveyed the nearby site of Coamiles and the surrounding area in search of their next site to excavate. Ten kilometers south of Peñitas, they found a much larger mound complex, near the Río Grande de Santiago and the modern village of Amapa.

2.2 Excavations at Amapa: Archaeological Context

In 1959, UCLA's Anthropology Program returned to Nayarit and carried out a major campaign of surveys and archaeological excavations at the site of Amapa (Fig. 2.1) from January to April. Directed by Meighan, the excavation team also included six UCLA graduate students: Betty Bell, Mildred Wissler, Jack Smith, Gordon Grosscup, Frank Clune, and David Pendergast (Nicholson, 1959).

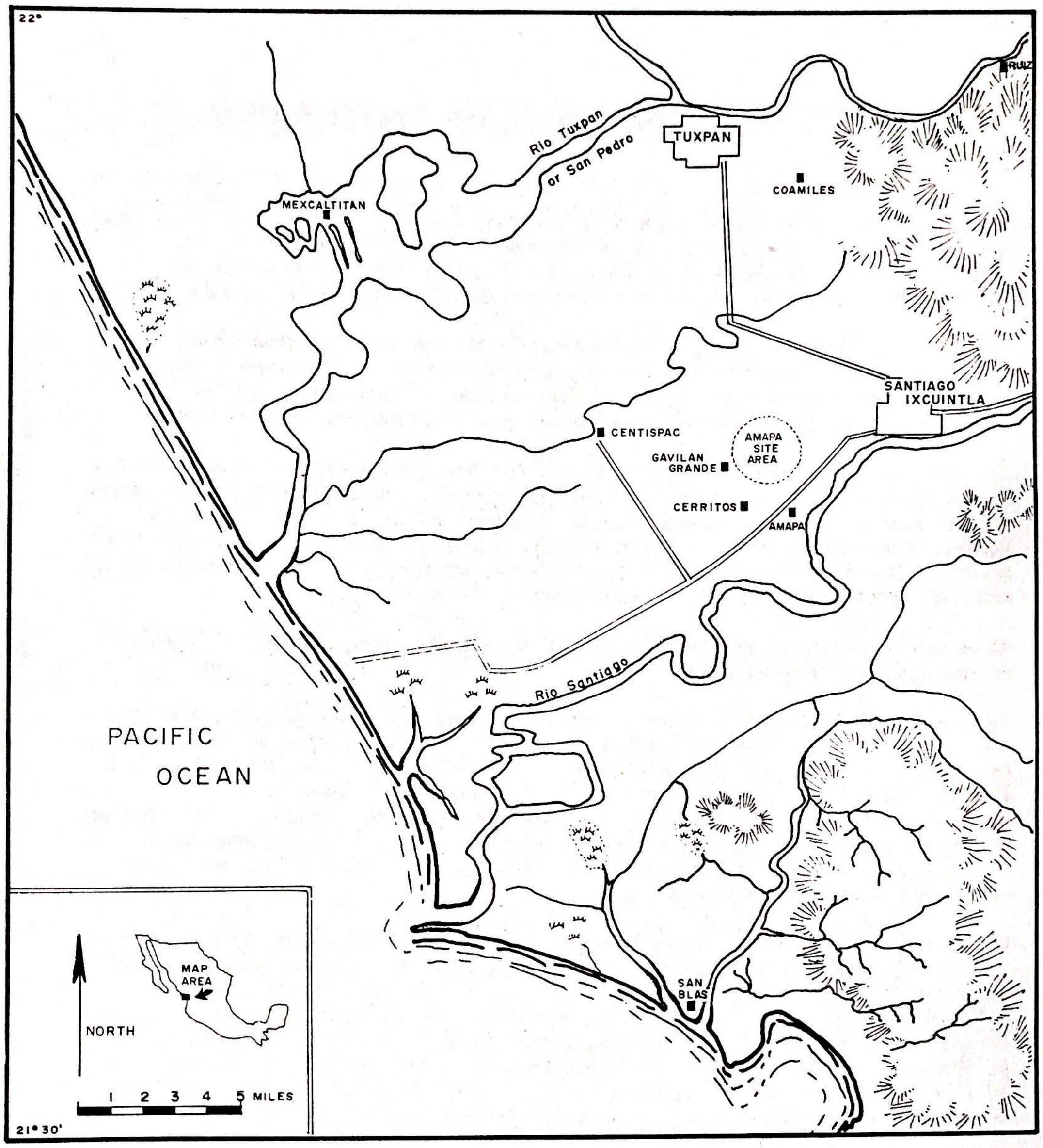

Figure 2.1: Map of the area surrounding Amapa, Nayarit, Mexico.
From Meighan, *The Archaeology of Amapa, Nayarit*, Map 1.

The archaeological site of Amapa lies along a coastal floodplain, created by the Río Grande de Santiago as it empties into the Pacific Ocean. As such, the area is flat with fine sandy or silty soil, and the water table is high. Today, dams and levees now control the river's flow, but in ancient times, the area would have flooded regularly (Meighan, 1976).

The occupational area of the site was approximately one square kilometer, surrounded by agricultural fields and mounds on all sides. The area contained more than one hundred man-made earthen mounds of various lengths and heights, ranging from two to seven meters high (Nicholson and Meighan, 1974). The only evidence for architecture in the early occupation of the site (Gavilán and Amapa phases, c. 200-750 CE) are impressions of sticks in fragments of clay, remnants showing wattle-and-daub construction. This suggests that Amapa began as a small riverside village that expanded significantly in the Late Period (Cerritos and Ixcuintla phases, c. 900-1400 CE) with the construction of many earthen mounds (Meighan, 1976).

The bases of the mounds were built up with adobe mud bricks, arranged in a checkerboard configuration, with refuse and dirt used to fill voids between the bricks. Then, earth was piled and packed over the bases until the mound had reached the desired height (Meighan, 1976). Mud bricks were also used as facing materials on the mounds and for building walls. However, the bricks were made with the local silty clay, tempered with grass, and unfired, making them vulnerable in Amapa's wet climate (Meighan, 1976). Both domestic and public buildings were constructed atop the mounds, which protected the structures from floods and allowed Amapa to grow and thrive.

Many of the mounds were built as groups around central plazas, as illustrated in Mound Groups A-D of Figure 2.2. On this map, Group B comprised the site's ceremonial center, which included the primary temple. Group A's mounds included workshops and residences, and Group

C seemed to be entirely residential. The site also featured a ballcourt, built as a group of four mounds around a rectangular plaza (Fig. 2.2, Group D).

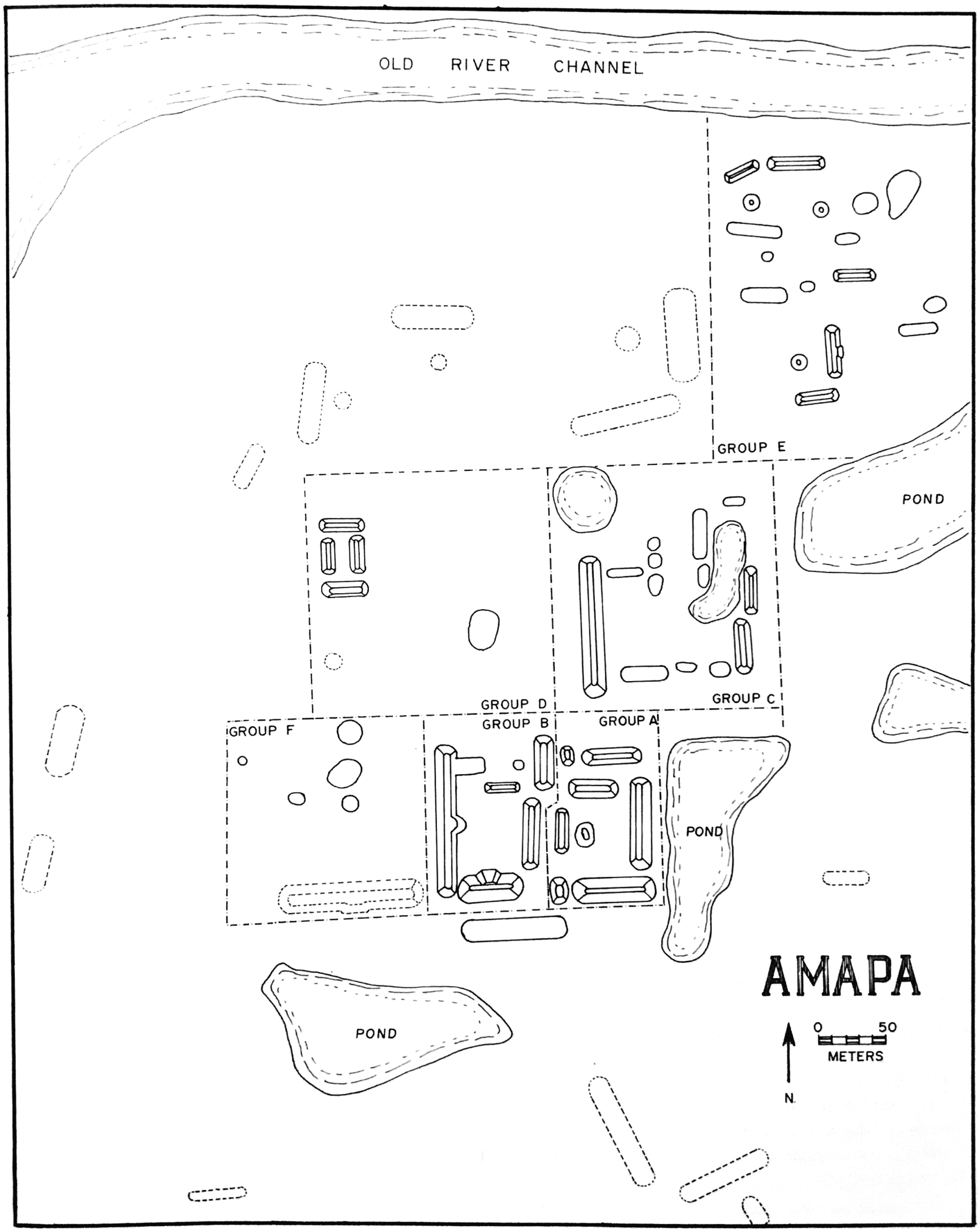

Figure 2.2: Map of the archaeological site of Amapa.
From Meighan, *The Archaeology of Amapa, Nayarit*, Map 2.

The entire area was mapped, and 29 of the mounds were excavated. In total, 164 2x2 meter pits were dug across the site (Nicholson and Meighan, 1974). Many of the most significant finds, including hundreds of whole ceramic vessels, were recovered from two cemeteries in Mound Group E. The cemeteries were located in flat areas adjacent to two round burial mounds.

2.3 Ceramics

The ceramic finds from Amapa include not only vessels, but also figures, tools, jewelry, and other small objects. Among these finds were 246 human figures, 40 animal figures, and over 700 other manufactured pottery objects, including ear spools, discs, whistles, spindle whorls, pipes, stamps, beads, models, and fragments of other objects (Meighan, 1976).

Over 700 whole or reconstructible ceramic vessels were found during UCLA's excavations at Amapa, primarily from the two cemeteries. There were also approximately 154,000 sherds found during excavation. Due to limited storage, all sherds were documented, but only those with decoration or diagnostic features (i.e. rim, base, handle, leg, spout, etc.) were retained for further examination and analysis. This collection consists of approximately 200 plainware sherds with diagnostic features and over 68,000 decorated sherds (Grosscup, 1976).

2.3.1 Previous Scholarship

While the archaeological fieldwork at Amapa both commenced and concluded in 1959, the full results of the project were not published until 1976 (Meighan, 1976). This 506-page publication included detailed descriptions, diagrams, and photographs of the site as a whole, the areas excavated, the architecture and artifacts discovered during excavations, and the results of scientific testing, which included soil sample analysis, radiocarbon dating, and obsidian hydration readings. The latter two methods aided in establishing the chronology and ceramic sequence at Amapa (Meighan, 1976).

During the time between the conclusion of the 1959 fieldwork and the 1976 publication of *The Archaeology of Amapa, Nayarit*, short summaries and preliminary reports were published in *Kiva* (Meighan, 1959) and *American Antiquity* (Nicholson, 1959a, 1959b). Some findings from Amapa were also included in Meighan's 1974 article, "Prehistory of West Mexico" in *Science.* During this intermediary period, UCLA's West Mexican program continued working, both in the field and in the laboratory.[1]

In addition to Meighan and Nicholson, the UCLA graduate students that participated in the Amapa excavations were also examining and interpreting the data collected during their fieldwork. Four of the six students focused their doctoral dissertations directly on the Amapa project. David Pendergast focused his research on the metal artifacts uncovered at Amapa and wrote his 1960 dissertation and a 1962 article in *American Antiquity* on his findings. Francis Clune wrote his 1963 dissertation about the I-shaped ballcourt, which was partially excavated by the UCLA team. Much of Clune's dissertation was also included in the 1976 Amapa publication. Betty Bell and Gordon Grosscup both concentrated on the ceramic finds from Amapa.

Bell's 1960 dissertation, "Analysis of Ceramic Style: A West Mexican Collection," focused on the decorative styles and iconography represented on the ceramic vessels. Bell defined styles in terms of form, color, design layouts, design elements, types of symmetry, vessel treatment, and area of design. Her examination and classification of 660 whole vessels from Amapa showed the wide breadth of decorative features present in the collection.

Grosscup examined all sorts of ceramic finds. He published a 1961 *American Antiquity* article on Late Period Mazapan-style ceramic figures. These were flat, mould-made

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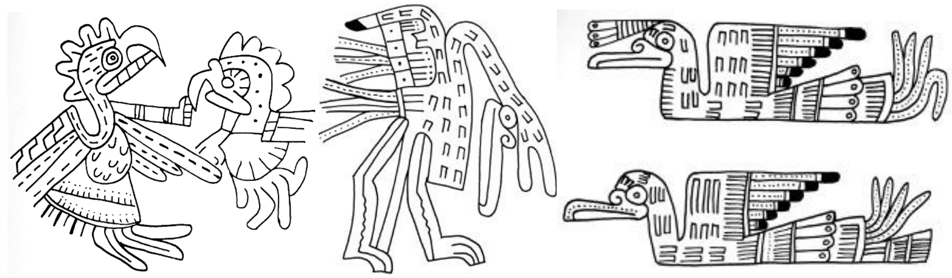
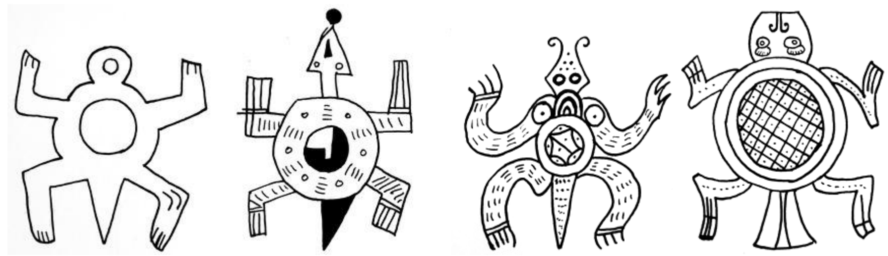
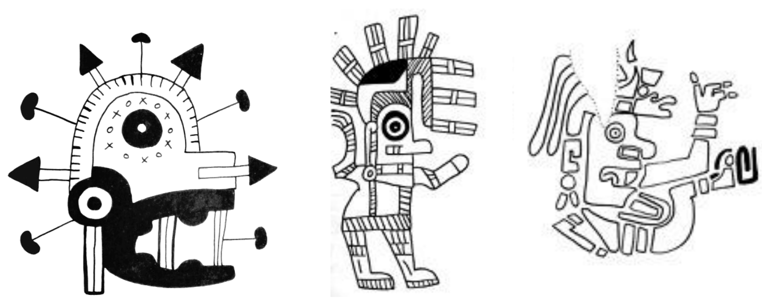
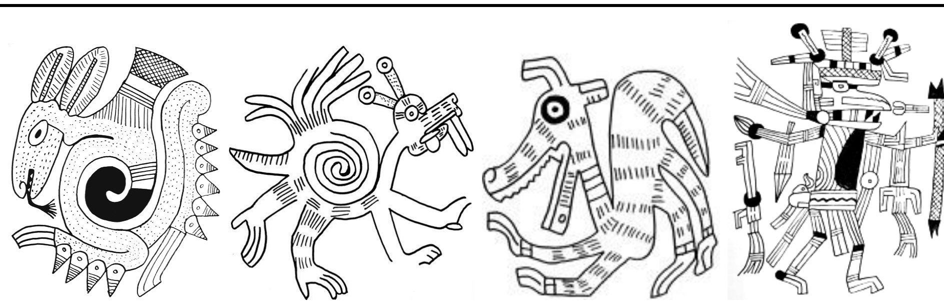
[1] Other field projects undertaken by UCLA's Anthropology Program in West Mexican Archaeology-Ethnohistory during this intermediary period include Project A (1960-1962), the Magdalena Lake Basin (Etzatlan) Project (1962-1964), Tizapan El Alto (1965-1966), and the Ameca Valley Project (1970). Descriptions of these projects may be found in Nicholson and Meighan, 1974.

anthropomorphic figures, fragments of which were abundant finds at Amapa. From the hundreds of fragmented figures found, Grosscup identified 27 distinct types of figures and placed them in a chronological sequence.

Grosscup's 1964 dissertation, "Ceramics of West Mexico," focused on the ceramic vessels from Amapa, including both the whole or reconstructed vessels and the thousands of pottery sherds that had been brought back from Mexico and housed at UCLA. In this work, he described the types of Amapa ceramics, compared them with ceramics discovered at other archaeological sites in West Mexico, and proposed a chronological sequence for the Amapa ceramics. Much of his dissertation was also included in the official Amapa publication (Grosscup, 1976).

2.3.2 Style and Iconography

Of the 660 whole ceramic vessels that Bell examined and classified, only 65 ceramics were true plainwares, having no embellishment. The remaining 595 pieces showed one or more decorative features, including slips, painted decoration, and engraving. Of these, there were 84 slipped monochrome ceramic vessels, 60 bichrome vessels, 170 engraved pieces, and 281 polychrome vessels (Bell, 1960; Meighan, 1976). The primary decorative motifs used on both the engraved and painted pottery included geometric and curvilinear designs. Depictions of animals, both real and mythical, were also included on many painted vessels (Table 2.1). Birds were the most common real animal depicted, appearing as the main decoration on at least 15 vessels, but serpents, turtles, and anthropomorphic figures also appear on several pieces (Bell, 1960). Composite, mythical, and unidentified animals account for the main decoration of at least 20 different vessels (Bell, 1960).

Table 2.1: Examples of Iconography Depicted on Whole Vessels from Amapa	
Birds	
Turtles	
Anthropomorphic Figures	
Curvilinear Animal	
Composite Animals	
Line drawings by Betty Bell, 1960.	

Chapter Three
Materials and Methods

3.1 Ceramic Artifacts

In this research, four decorated vessels from the Fowler Museum's collection of Amapa ceramics were documented, analyzed, and conserved (Fig. 3.1, Appendices 2-5). Three of the vessels (246-2107, 246-1782, and 246-1937) are slipware with painted decoration. A slip, which is a solution of finely levigated clay particles suspended in water, was applied over the entire ceramic body to create the desired background color. Afterward, different colored slips were used to create the painted designs. The fourth vessel (246-3270) has no slip, but its surface is burnished to create a polished finish. A band of spirals is also incised along the rim of the bowl.

The first vessel, number 246-2107 (Figure 3.1a), is a round polychrome ceramic bowl, depicting two birds. It is a Late Period type of ceramic, known as "Mangos Polychrome," that is characterized by low, open bowls that have decoration on the interior surface (Meighan, 1976). The surface is burnished and slipped an orange-buff color. The interior of the bowl is covered with white, red, and black painted decoration. The central scene shows two birds depicted in profile and facing each other. A series of concentric black and white circles radiate outward from the central scene on the bowl. The rim is painted a dark red color.

Ceramic vessel number 246-1782 (Figure 3.1b) is a round bowl with a round pedestal base and dates to the Ixcuintla phase (1,000 – 1,3500 CE). It has an orange slip, which is burnished to a fine glossy finish. A red paint was used for the decoration of the rim, base and central decoration of the vessel. Most of the painted decoration was applied with white paint and portrays the head of a skeletal being with pointed darts and circular elements protruding from its head and face. Red and white concentric circles and white geometric designs surround the skeletal figure. The round pedestal base also features white geometric designs.

(a) Accession Number 246-2107

(b) Accession Number 246-1782

(c) Accession Number 246-1937

(d) Accession Number 246-3270

Figure 3.1: The four ceramic vessels chosen for this study (Before Treatment).[2]

[2] These four ceramics were studied by the author. However, five other Amapa ceramics (see Chapter 5) were documented and treated by Morgan Burgess, Mari Hagemeyer, Marci Jefcoat Burton, Hayley Monroe, and Michaela Paulson during the Winter 2016 course, CAEM 230: Conservation Lab - Ceramics, Glass, and Glazes.

Vessel 246-1937 (Figure 3.1c) is a shallow bowl with an all-over matte buff-colored slip. The interior features dark brown painted decoration, with the representation of a feathered serpent in a coiled position. The central figure has three thin circles around it and a thicker, dark brown band around the entire rim of the vessel.

Conversely, ceramic 246-3270 (Figure 3.1d) is a simple bowl that was probably utilitarian in nature. The interior is undecorated. The exterior has only a simple band of incised spiral designs along the outer rim. The surface coloration is varied and smoke blackening covers much of the bottom exterior.

3.2 Characterization Techniques

For the analysis of these ceramic vessels, non-invasive techniques, such as analytical photography and X-ray fluorescence (XRF) spectroscopy, were carried out first. Several methods of analytical photography were used, including reflectance transformation imaging (RTI), ultraviolet (UV)-induced visible fluorescence, UV reflectance, photomicrography, and X-radiography. These techniques provided preliminary qualitative results on the materials and techniques used to create the ceramics. They also helped identify areas that were altered by previous conservation treatments or natural degradation.

Minimally invasive techniques, requiring microsampling (Table 3.1), included polarized light microscopy (PLM), variable pressure scanning electron microscopy (VP-SEM) coupled with energy dispersive X-ray spectroscopy (EDS), and attenuated total reflectance Fourier transform infrared (ATR-FTIR) spectroscopy. Microchemical testing, a technique that is destructive because it consumes the sample to yield results, was also employed. In order to minimize sampling and maximize the amount of information gained from each sample, the microchemical tests were performed at the end, after all other analyses were completed on the same sample.

Characterization techniques were used in tandem and/or sequentially, helping to identify the baseline composition of the ceramic fabric, slips and paints, as well as foreign materials, such as previous conservation materials, salts, and degradation products.

Table 3.1: List of Samples

Sample Type	**Special Features**	**Vessel Number(s)**	**Sample Location**	**Sample Preparation**	**Analysis**
Surface Soiling and Accretions	Efflorescence or burial accretions?	246-2107, 246-1782, 246-1937, 246-3270	Interior and exterior surfaces	Collected in sample vials	Microchemical tests
Powdery Efflorescence	Unknown substance, fluoresces under UV light	246-1782	Underside of vessel	Collected in sample vial; Adhered to SEM stub	Microchemical tests, VP-SEM
Ceramic Fabric (Sample1)	Orange slip on surface, Plant Fiber (Temper)	246-2107	Along break edges on underside of vessel	Embedded in resin	VP-SEM-EDS
Ceramic Fabric (Sample2)	Orange slip				
Ceramic Fabric (Sample3)	Aged adhesive along one side				
Ceramic Fabric	Very small amount of red slip on surface, Volcanic ash identified in fabric	246-1782			
Red Slip		246-1782	Underside of vessel	Dispersion, Mounted to Glass Slide	PLM
Orange Slip					
White Slip					
Adhesive (Type 1)	Adhesive Type 1 is thin, transparent, and brittle when dry.	246-2107, 246-1782, 246-1937, 246-3270	Excess adhesive along joins	Collected in sample vials	Microchemical Tests, ATR-FTIR
Adhesive (Type 2)	Adhesive Type 2 is thick, opaque (white), and hard when dry.	246-2107			

3.2.1 Analytical Imaging

The ceramics were photographed in diffuse light, using a Nikon D90 DSLR camera with an AF-S Micro Nikkor 60mm f/2.8G ED lens and two halogen lights. In order to better assess the ceramics' conditions, they were also photographed under raking light, using reflectance Transformation Imaging (RTI). For this technique, each ceramic was placed on a black cloth with two black reflective spheres next to it, and the Nikon D90 DSLR camera was placed on a tripod. The camera and ceramics remained in a stationary position, taking photographs while the light source was positioned at various angles. Cultural Heritage Imaging's RTIBuilder and RTIViewer software were used to compile, process, and view the photographic data.

To see previous restorations, the ceramics were examined under ultraviolet light (λ_{exc} max = 365 nm) in both reflectance and luminescence, using a Mini-CrimeScope MCS-400 from Horiba Scientific as the light source. Ultraviolet-induced visible fluorescence images were taken, using a modified Nikon D90 DSLR camera, in which the hot mirror had been removed in order to allow for imaging from the ultraviolet (UV) to the near infrared (NIR) region (~350-1000 nm) of the electromagnetic spectrum. A Nikon AF-S Micro Nikkor 60mm f/2.8G ED lens fitted with a Peca 916 filter, allowed the capture of images in the visible light region (λ = 400-700 nm).

The analysis of the decorated surfaces of 246-2107 ("the bird bowl") and 246-1782 ("the skull bowl") using ultraviolet reflectance photography enhanced the appearance of the white painted decoration, rendering the designs more discernible. UV reflectance images were obtained with the same modified Nikon D90 DSLR camera and lens described above, but fitted with a Peca 900 filter to capture in the ultraviolet light region (λ = 300-400 nm).

Examination of the ceramics under a stereomicroscope also provided invaluable information about their original manufacture and current condition. Photomicrographs of the ceramic surfaces were taken using a Nikon D90 DSLR camera attached to a Meiji EMZ-5 stereomicroscope in order to document significant features and condition issues.

Subsequently, the ceramics were imaged using an X-radiography instrument equipped with a 20-450 kV Comet tube. X-radiographs were developed on Kodak Industrex M film. The settings used varied slightly among ceramics with energy between 45 and 50 kV, 7.70-8.15 mA, and 90-120 seconds. For all X-radiographs, the focal spot was 2.5 mm and the distance was 1 m.

3.2.2 X-Ray Fluorescence (XRF) Spectroscopy

A Bruker Tracer SD-III handheld X-ray fluorescence (XRF) spectrometer equipped with a rhodium (Rh) x-ray source and palladium (Pd) slits, was used for qualitative elemental analysis of the ceramic body and the slips. For each vessel, several areas were analyzed, including cleaned break edges, slipped and unslipped ceramic surfaces, and painted decoration. The spectra were acquired at 40 kV, 11 mA (no filter) for 120 seconds. Bruker's S1PXRF (Version 3.8.0.30) and Artax (Version 7.4.0.0) software were used to identify the elements present.

3.2.3 Polarized Light Microscopy (PLM)

To assist in the characterization of original materials, samples were taken from the slip and paint surface of vessel 246-1782. Dispersion samples were made of the orange, red, and white slips. The samples were taken using a speedle and permanently mounted on a glass side with Cargille Meltmount™ (Refractive Index 1.662) thermoplastic media. All samples were taken from discrete areas on the underside of the vessel to avoid damaging the object or disrupting its visual integrity. The dispersion samples were examined under plane polarized and cross polarized light, using an Olympus BH2 Microscope with a rotating stage in order to observe the shape and color of the particles, and compared to standards in *The Pigment Compendium* (Eastaugh et al., 2004). By examining dispersion samples under plane polarized and cross-polarized light and rotating the microscope stage, phases could be identified based on their physical and optical properties.

3.2.4 Microchemical Tests

Microchemical tests were undertaken to identify the adhesives used in previous conservation treatments. Samples were taken from an area along the joins, where excess adhesive was present on the surface, using a scalpel. Because cellulose nitrate and PVA-based adhesives have been extensively used for ceramic repairs in the past, tests to identify cellulose nitrate using diphenylamine and polyvinyl alcohol and its derivatives using iodine/potassium iodide were performed using protocols published by Odegaard, et al. (2005).

There were also unidentified accretions, efflorescence, and soiling on the surfaces of the ceramics. Samples of these were collected from each vessel. These were dissolved in small amounts of deionized water and tested for the presence of soluble salts commonly found in archaeological ceramics. These included the tests for chlorides using silver nitrate, for nitrates using iron (II) sulfate, and for sulfates using barium chloride (Odegaard et al., 2005). These salts could lead to serious condition issues, so desalination would be a possible treatment step if these tests showed positive results.

3.2.5 Variable Pressure-Scanning Electron Microscopy-Energy Dispersive Spectroscopy (VP-SEM-EDS)

The samples analyzed using VP-SEM-EDS included both powdery and solid materials. The powdery sample was a fluffy material that appeared on the surface of several ceramics and showed characteristic fluorescence in the visible range under ultraviolet light. This was collected and adhered to double-sided carbon tape on a SEM pin stub mount. The solid samples included a cross-section taken from a break edge on the decorated surface of 246-1782 and three small ceramic fragments that detached from break edges on the underside of 246-2107.

One of the fragments from 246-2107 contained a small inclusion of plant material. This fragment was split in half, so that both longitudinal and cross-sectional views of the plant material could be analyzed. One half was directly adhered to a double-sided carbon tape on a SEM stub along its longitudinal section. The transverse cross-sectional cut of the plant fiber from 246-2107 and the the stratigraphic sample containing the slipped surface of 246-1782, were both prepared as polished cross sections before analysis. For the preparation of the polished cross-sections, the samples were first embedded in Struers EpoFix epoxy resin. After curing, the samples were ground using Buehler silicon carbide grinding papers at 400, 600, 800 and 1200 mesh, and then polished, using Buehler's MetaDi water-based diamond suspensions of 6 μm and 1 μm.

Microstructural and elemental analysis of polished cross-sections were performed using a FEI Nova NanoSEM™ variable pressure scanning electron microscope (SEM), coupled with a Thermo Scientific™ NORAN™ System7 X-ray energy dispersive spectrometer (EDS). The GAD (Gaseous Analytical Detector) detector was used for compositional contrast imaging and phase characterization in low vacuum imaging and analysis. ZAF corrections were applied to the EDS measurements to convert apparent concentrations from the raw peak intensities into semi-quantitative concentrations, correcting for the inter-element matrix effects. Imaging and spot analysis were performed at 640 – 5600x magnification, 6.0 mm working distance, 5.0 spot size, and a voltage of 15.0 kV.

For the samples mounted directly on carbon double-sided tape on the SEM stubs, the same FEI Nova NanoSEM™ instrument was used, but with the following parameters: 540 – 1250x magnification, 5.1 – 5.5 mm working distance, 4.0 – 4.5 spot size, LVD (Low Vacuum Detector), and a voltage of 10.0 kV.

3.2.6 Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) Spectroscopy

ATR-FTIR spectroscopy was performed on samples from the adhesives used in previous restorations using a Perkin-Elmer FT-IR Spectrum Two Spectrometer combined with the Universal ATR Two Accessory. The resulting spectra were processed and analyzed using Perkin-Elmer's Spectrum™ v.3.3 software and then compared to reference materials from the Infrared and Raman Users Group (IRUG) spectral database.

3.2.7 X-Ray Diffraction (XRD)

XRD was carried out on powdery samples obtained from surface debris and efflorescence on 246-1829, 246-2547, 246-2799, and 246-3047. Each sample was mounted on a glass spindle with Apiezon N grease, and then run at 50 kV and 40 mA for 120 seconds in a Rigaku R-Axis Spider Diffractometer with a Cu-α target. Data were processed with Jade software (version 8.3) and run against reference spectra from the International Center for Diffraction Data (ICDD).

Chapter Four
Results and Discussion

4.1 Materials and Technology of the Ceramics

Physical examination and analytical investigation of the ceramics and samples allowed for the characterization of both the original materials and techniques used to create these ceramics and the foreign surface materials/accretions resulting from weathering, previous restorations/conservation attempts, and storage conditions after excavation.

4.1.1 Ceramic Fabric

The ceramic fabric consists of two major types of materials: plastics and aplastics. The plastics are the actual clay components, which are very fine sediments, having a particle size of less than 2 μm. Clay sediments are formed by the weathering and breakdown of silicate material on or near the earth's surface (Rice, 1987). When combined with water, the clay becomes cohesive and pliable. The aplastics, often called temper, are non-clay materials present in the clay. Aplastic inclusions may be organic, such as chopped straw, or inorganic, as in sand, and they may be intentionally added to the clay or be naturally occurring impurities within the clay matrix. Tempering clay with aplastic materials alters the plasticity, workability, and porosity of the clay and helps prevent the ceramics from shrinking and cracking as the clay dries. This creates a stronger, more stable ceramic after firing (Rice, 1987).

Visual examination of the pottery sherds excavated at Amapa showed that at least two different types of clay were used for the ceramic production. The most prevalent type of clay produced ceramics that had a paste with color that ranged from reddish brown to gray (Meighan, 1976). All of the Amapa ceramics examined in this study were made using this type of clay.

XRF data of the ceramic fabric, obtained by analyzing the cleaned break edges during conservation treatment, detected the presence of major and minor elements in the ceramics. These include aluminum (Al), silicon (Si), phosphorus (P), sulfur (S), potassium (K), calcium (Ca), titanium (Ti), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), gallium (Ga), arsenic (As), rubidium (Rb), strontium (Sr), zirconium (Zr), and niobium (Nb). Though the relative intensities of the peaks do not constitute quantitative data, the iron peak was most prominent in all spectra (Fig. 4.1).

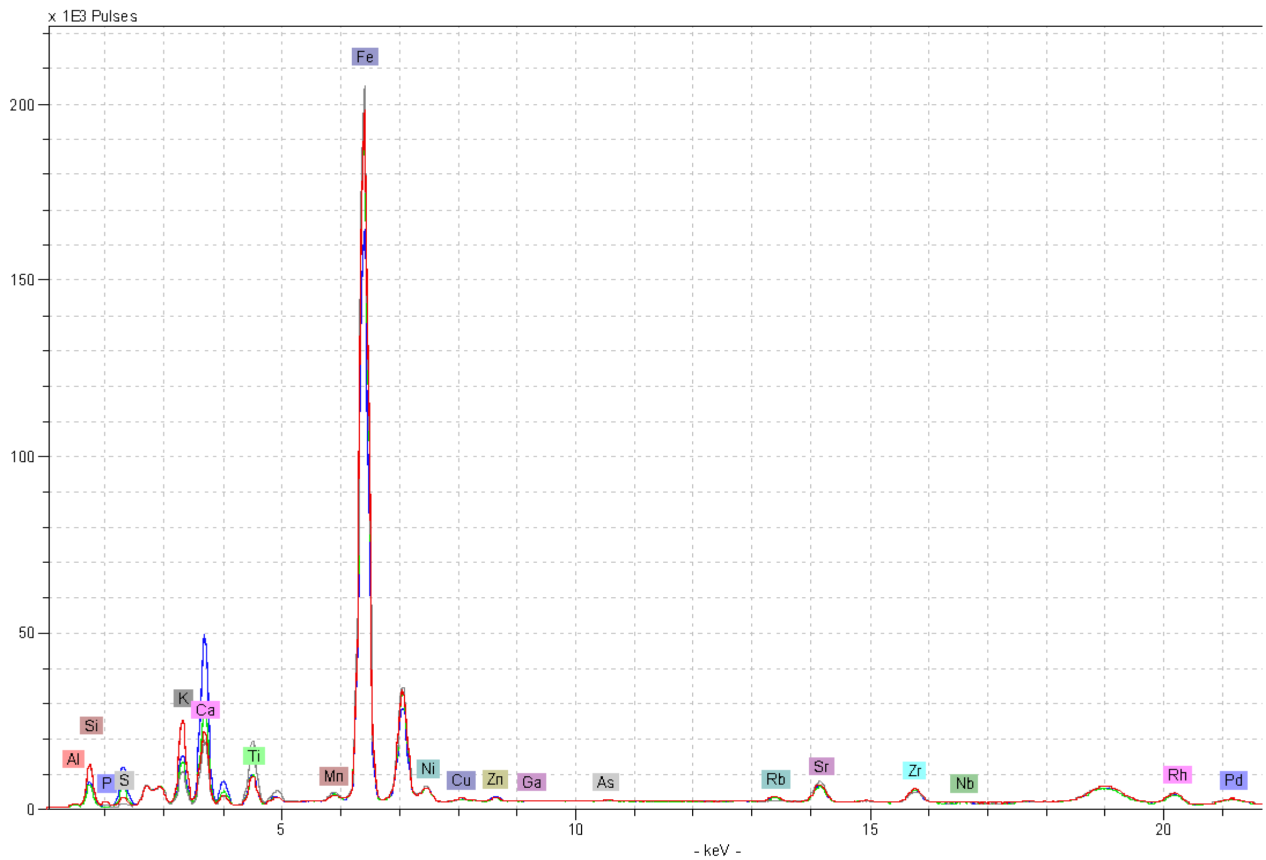


Figure 4.1: XRF spectrum overlay depicting the ceramic fabric of each ceramic studied.

Among the Amapa ceramics analyzed in this study, there is little variation in the aplastic materials identified within the ceramic matrix. The predominant aplastic found in the ceramic fabric contains silicon (Si) and is most likely quartz sand (SiO_2), though it is unclear how much of this material may have been naturally present in the clay and how much was intentionally added as a tempering material. In Early Period ceramics (Gavilan and Amapa Phases, c. 250-800 CE), the temper is coarser and gradually become finer in the Late Period (Tuxpan, Cerritos, Ixcuintla, and Santiago Phases, c. 800 – 1500 CE). The aplastics in Amapa ceramics range from Temper I (coarse) to Temper III (very fine). All of the ceramics in this study date to the Late Period and have Temper II (intermediate) aplastics (Meighan, 1976). This gradual evolution in the size of the aplastics in the clay fabric does suggest that the ancient Amapa potters were intentionally adding temper to the clay to alter its working properties.

Analysis of four different ceramic cross-sections from 246-2107 and 246-1782 using SEM revealed both the fineness of the plastic clay particles and also the variety, sizes, and shapes of the aplastics present within that clay matrix. An example from 246-2107 is shown in Figure 4.2. In these images, the finely levigated orange slip is apparent on the surface of the vessel by its lack of larger inclusions, which differentiate the slip from the ceramic fabric below.

Within the ceramic matrix, SEM-EDS helped in the identification of certain minerals, based on their morphology (Fig. 4.2) and their elemental abundances (Table 4.1). Several spots within the ceramic paste itself were analysed and found to be aluminosilicate materials, containing approximately 57-72% silicon dioxide (SiO_2) and 15-25% aluminum oxide (Al_2O_3) by weight. Among the larger inclusions, silicate materials, including quartz, mica, and feldspar, were the most prevalent materials identified in the samples. Additionally, iron oxides, such as hematite (Fe_2O_3), magnetite (Fe_3O_4), and ilmenite ($FeTiO_3$) were quite abundant. Gypsum ($CaSO_4 \cdot 2H_2O$) was also identified in one of the samples, though that may be a weathering product, as it was found close to the surface.

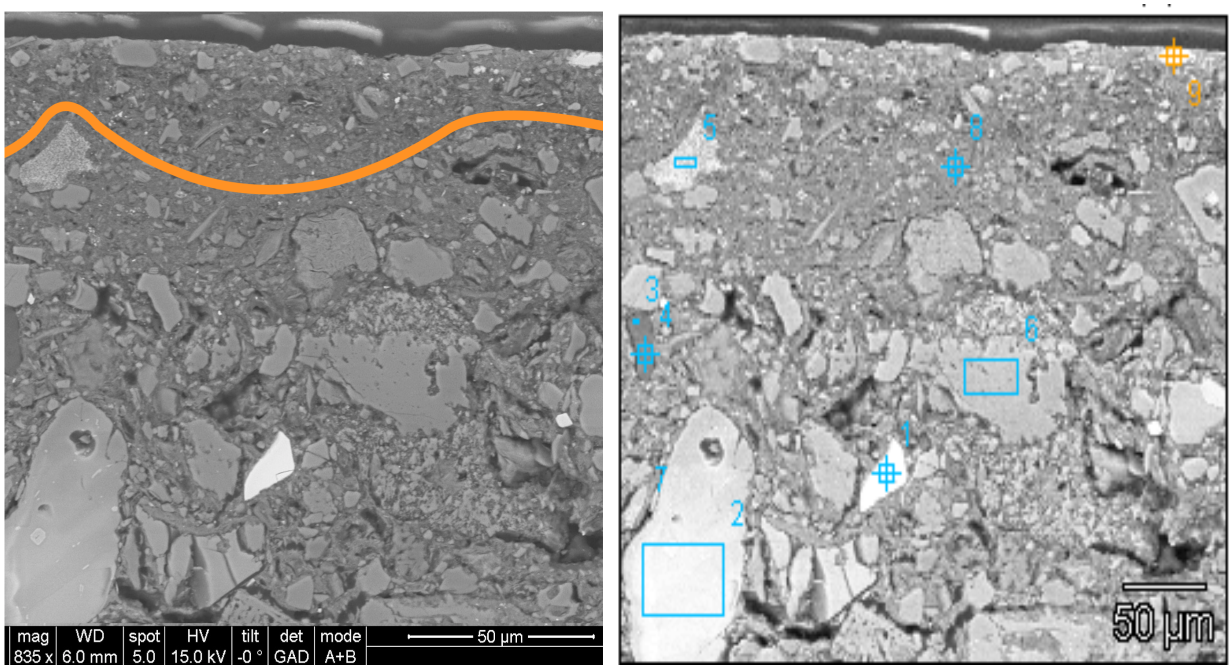


Figure 4.2: Backscattered electron micrograph of a cross section (Sample 2) from 246-2107.
Left: The orange line shows the interface between the ceramic body and the slip.
The upper portion represents the orange-slipped surface.
Right: The numbered points illustrate spot and area analyses using EDS. These results are shown in Table 4.1.

Table 4.1: Oxide Weight Percentage for Spots Analyzed by EDS for 246-2107 (Sample2)

Point No.	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl	K_2O	CaO	TiO_2	Fe_2O_3	Comments
1	0.36	0.00	1.02	41.28	56.11	0.00	0.00	0.73	0.00	0.00	0.50	Unclear
2	6.65	0.39	17.64	66.64	0.27	0.00	0.00	2.92	2.89	0.72	1.88	Feldspar
3	No Data											
4	1.38	2.08	18.49	66.69	0.50	0.00	0.25	2.68	1.10	0.71	6.33	Clay Matrix
5	0.09	0.44	9.95	87.44	0.16	0.00	0.09	0.63	0.32	0.00	0.88	
6	0.00	0.00	1.39	97.71	0.00	0.00	0.06	0.56	0.00	0.00	0.27	Quartz
7	No Data											
8	1.18	1.71	20.20	57.26	5.63	0.32	0.34	2.69	5.93	0.44	4.30	Clay Matrix
9	0.67	0.94	21.57	64.04	1.49	2.21	0.28	1.82	1.41	0.77	4.81	Clay Matrix

Volcanic ash, or pumice, was also identified in the samples. These particles are easily recognizable because of their porous structure, created by the rapid cooling and depressurization of the frothy lava as it is ejected from an erupting volcano. Ash was present as an aplastic inclusion in several areas of the ceramic paste in both 246-2107 and 246-1782 and also in burial soiling recovered from the underside of 246-1782 (Fig. 4.3). This may indicate that while pumice is an aplastic inclusion within the ceramic fabric, its presence may not be an intentional addition. It may just be a part of the soil and clay in that area.

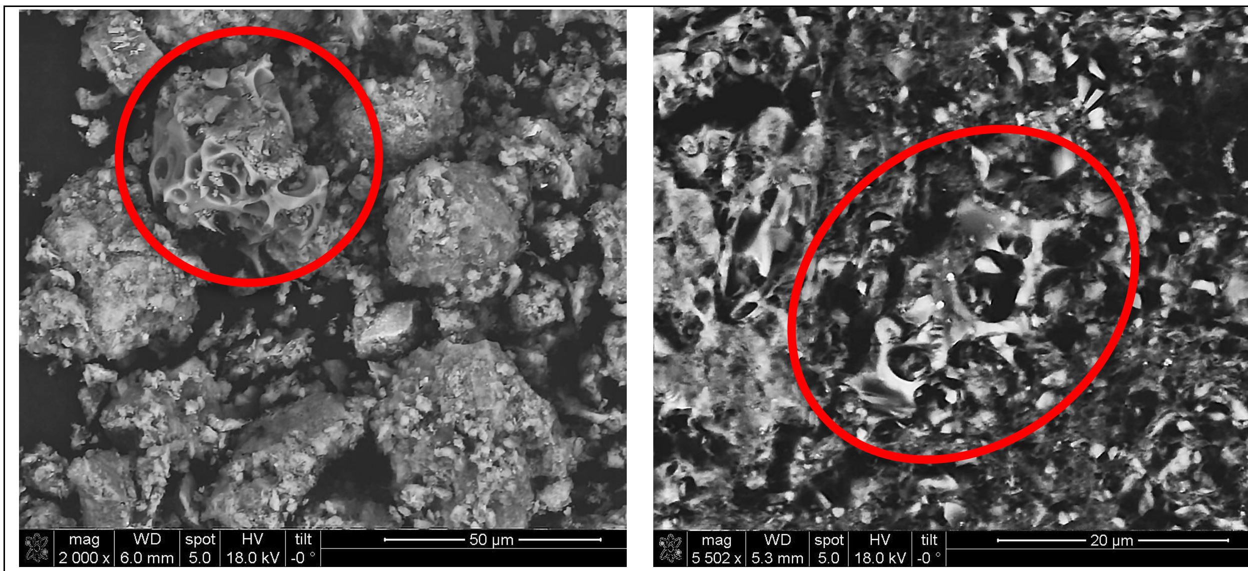


Figure 4.3: Secondary electron (SE) micrographs of volcanic ash in burial deposits (*left*) and in the ceramic paste (*right*) of 246-1782.

Besides inorganic materials, organic temper was also included in the ceramic paste. A few plant fibers were evident in the cross-sections examined under a stereomicroscope and with SEM. SEM images of the plant materials (Fig. 4.4) show that they are very degraded due to the ceramic firing processes and burial. However, it is clear that the materials are very small fragments of a monocot, such as straw or dried grasses.

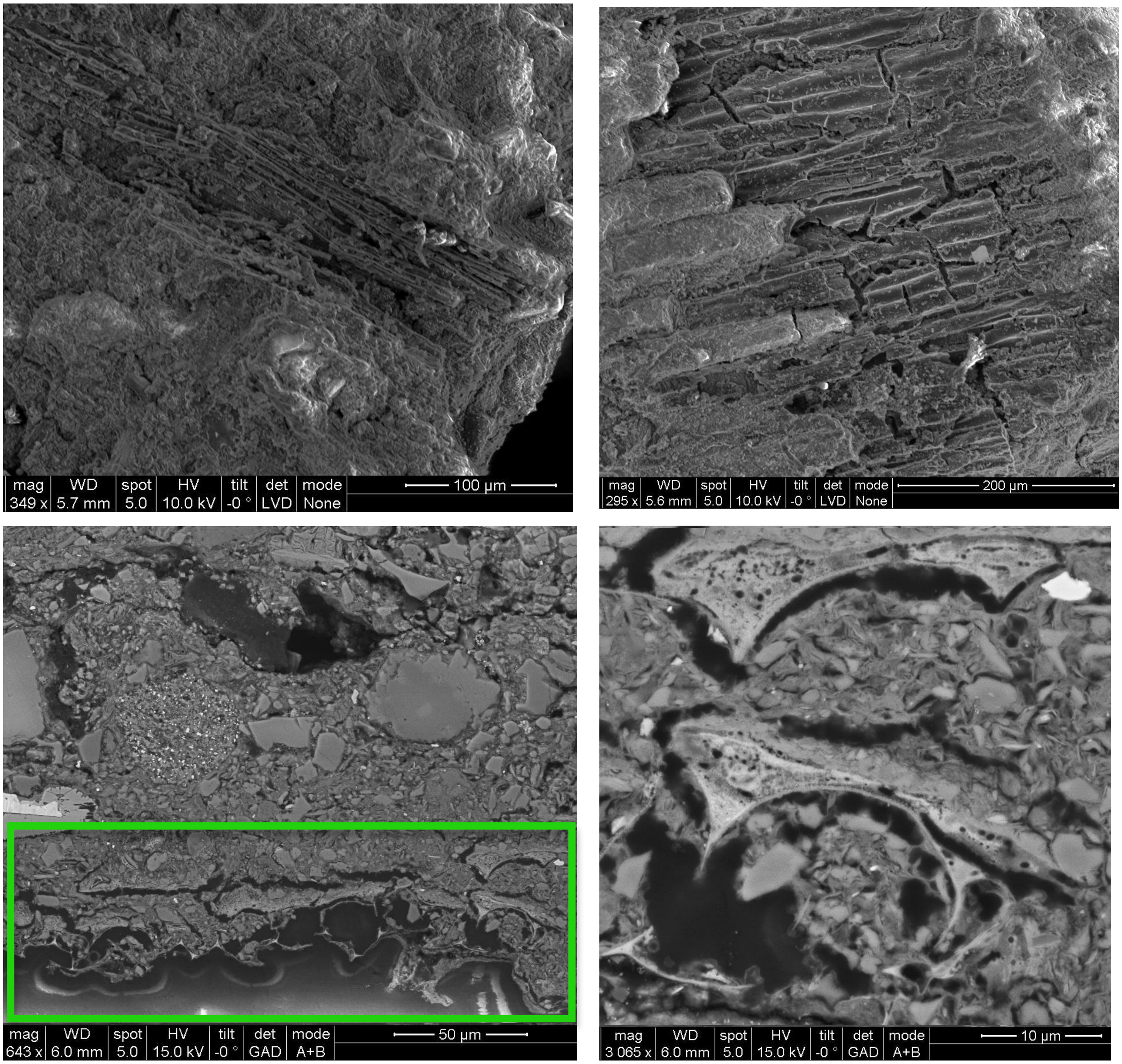


Figure 4.4: Secondary electron (SE) micrographs (top) and backscattered electron (BSE) micrographs (bottom) of plant fibers preserved in the ceramic paste of 246-2107. The top two micrographs show longitudinal sections the fibers. The bottom micrographs show a cross-sectional view of the fiber *(bottom left, inside green box)* and a magnified view of the two degraded xylem at the upper right corner of the green box.

4.1.2 Fabrication

Physical examination and analytical imaging confirm that the ceramics were built by hand rather than thrown on a potter's wheel. X-radiography can often reveal diagnostic features of certain materials and/or techniques used to make ceramics. By examining the orientation of elongated voids and inclusions in the ceramic fabric, it may be possible to determine which primary forming techniques the potter employed (Rye, 1977; Berg, 2007, 2011). While most of the voids and inclusions visible in the X-radiographs of Amapa ceramics are small and rounded, some arcs of voids and inclusions can be distinguished where several are lined up or grouped closely together (Fig. 4.5). This suggests that the vessels were hand-built, using the coiling method.

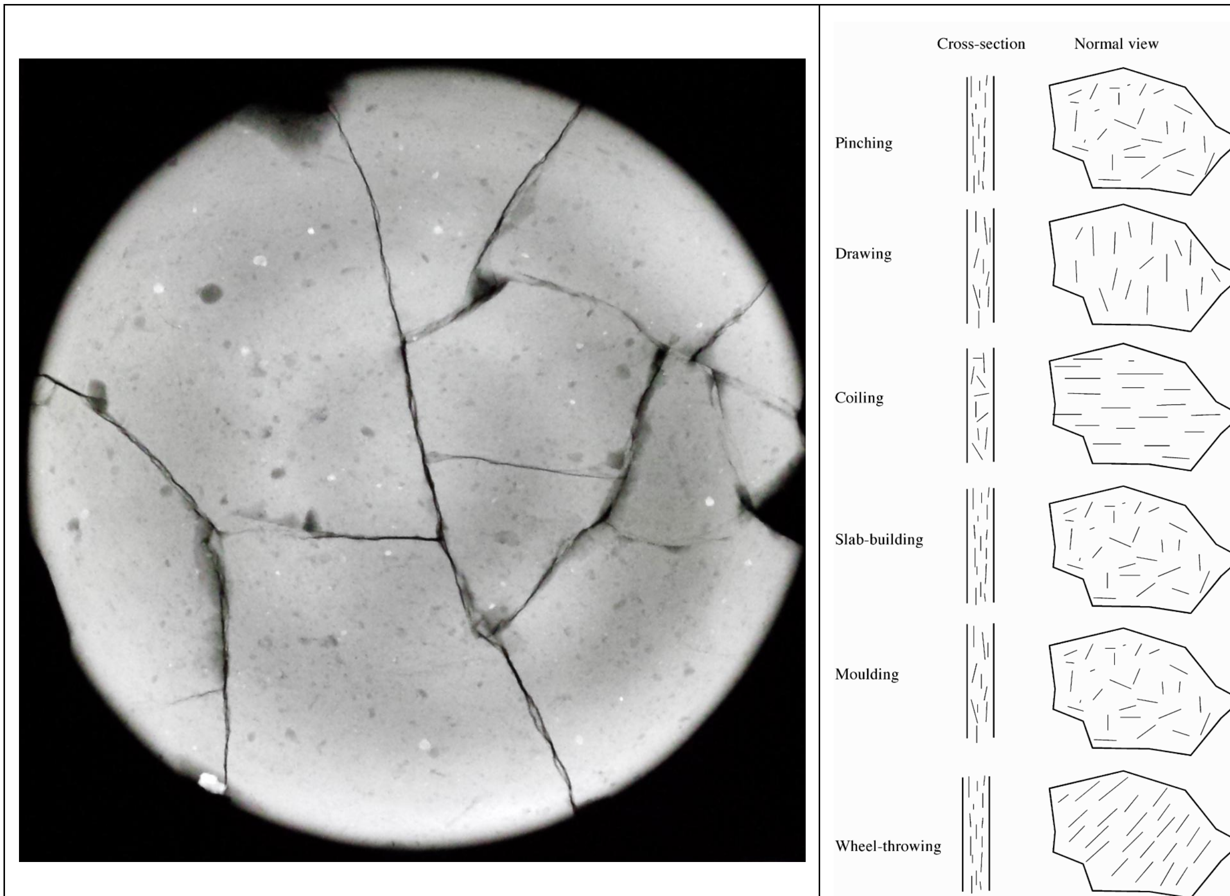


Figure 4.5: *Left*: X-ray of 246-2107 (settings: 50.2 kV, 8.15 mA, 120 seconds).
Right: Temper and inclusion orientations characteristic of the main pottery forming techniques. Diagram courtesy of Berg, 2007.

Raking light photography and RTI of the ceramics surfaces show even more obvious signs that these ceramics were hand built. The images in Figure 4.6 show striations and finger markings on the walls and bases of two different vessels. These marks were made by the ancient potters who created the ceramics and further emphasize that the pieces were likely coil built and then smoothed by hand while the clay was still fairly plastic.

Figure 4.6: RTI images showing details of ceramics 246-1937 (*left*) and 246-3270 (*right*), with characteristic striations and finger marks from the vessels forming.

The remarkably smooth and sometimes glossy surfaces of the ceramics suggest that after the vessels were shaped, they were left to dry until the clay was leather hard, and then the surfaces were burnished, using a smooth, hard object, such as a river pebble (Rice, 1987). The burnishing process created a smooth, shiny surface over the entire ceramic. Burnishing could also be done on slipped surfaces. In that case, the leather hard ceramic would be dipped in or painted with slip beforehand, and the potter would burnish the surface after the slip had dried, and before firing.

4.1.3 Surface Decoration

The majority of ceramic vessels found at Amapa were decorated. Even utilitarian vessels show evidence of decoration, whether as a simple engraved design along the rim, such as that of 246-3270, or an all-over slipped and burnished surface. Surface decoration could have been carried out in various stages of the manufacture process. Application of slips, certain painted decoration, incising, and burnishing would have been performed before firing (Rice, 1987). After firing, more painted decoration, using organic materials or inorganic pigments that could oxidize and change color during firing, could be applied. For example, the white painted decoration on the two polychrome vessels was applied after firing. This is evident because the white areas are clearly thicker, unburnished, and sit on top of the orange and red slips (Fig 4.7). The white is also more powdery and prone to damage and loss because it is not chemically bonded to the ceramic, but probably adhered to the surface with an organic binder (Rice, 1987).

Figure 4.7: Detail of White Slip Painted Decoration.

Engraving, unlike incising, was done after firing, using a very sharp, pointed tool to score a design into the fired ceramic. This created a contrasting design, as the engraving would have the rough texture and lighter color of the ceramic paste rather than the smoother, darker ceramic surface (Meighan, 1976). Of the 660 whole vessels excavated by UCLA at Amapa, 170 were engraved, 149 were monochrome, 60 were bichrome, and 281 had polychrome decoration (Meighan, 1976).

While most of the utilitarian types of vessels are represented only by sherds rather than entire pots, the more ceremonial and highly decorated ceramics are most often found in a burial or tomb context and therefore are more likely to be complete or near-complete (Meighan, 1976). Three of these vessels were examined in this study: 246-2107 (Mangos Polychrome), 246-1782 (Ixcuintla Polychrome), and 246-1937 (Botadero Black on Buff). These three ceramics feature an all-over base color with painted decoration over it.

The slips and pigments are in shades of white, buff, red-buff, orange, dark red, and dark brown. XRF analysis showed that all of the slips contained the same elements detected in the ceramic fabric, but with varying relative peak intensities for calcium, titanium, manganese, and iron (Appendix 1). Of all of the spectra obtained for the slips, the white and buff slips featured the smallest peak for iron and the highest peaks for calcium and titanium. The red-buff, dark red, and orange colors showed very prominent iron peaks. Of those three colored slips, orange had the smallest iron peak and the most intense calcium peak, indicating that it may be a mixture of the red and white slips. The dark brown slip, which accounted for all of the painted decoration on 246-1937 and small accents on 246-2107, showed a large peak for manganese suggesting probably the use of an umber. Umbers are mineral pigments, ranging in color from dark brown to black. They are composed of manganese oxides and hydroxides, primarily pyrolusite (MnO_2) and manganite [MnO(OH)], and the iron hydroxide goethite [FeO(OH)] (Eastaugh et al., 2004).

Analysis of dispersion samples of the slips from 246-1782 also aided in their characterization. The white slip (Fig. 4.8) showed microscopic translucent and white particles with physical and optical properties characteristic of quartz (SiO_2) and calcium sulfate ($CaSO_4$). Under plane-polarized light, both quartz and calcium sulfate particles appear colorless and have moderate to low relief (refractive index <1.662). Quartz does not have cleavage, so many of these particles exhibit conchoidal fractures along their edges. Calcium sulfate features three sets of cleavage, which creates rhombic particles when the crystals are ground (Eastaugh et al., 2004).

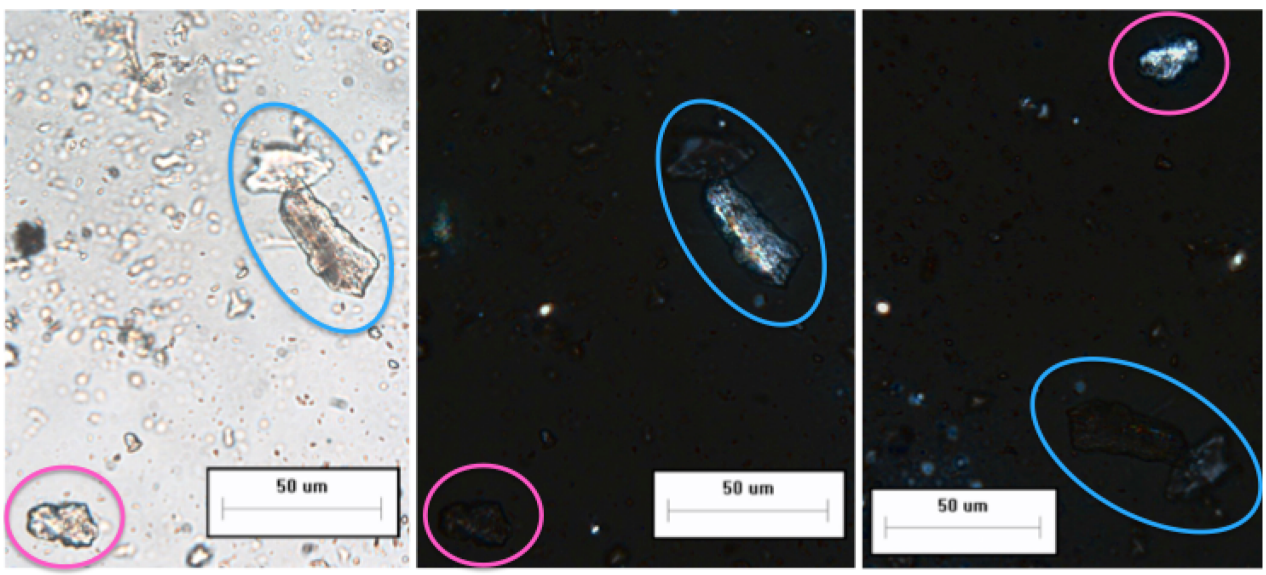


Figure 4.8: Polarized light photomicrographs of the white slip under plane-polarized light (*left*) and cross-polarized light (*center, right*). The circled particles are characteristic of quartz, which undergoes extinction when the microscope stage is rotated 180 degrees (*right*).

Under cross-polarized light, both quartz and calcium sulfate are anisotropic and exhibit extinction and low birefringence. The main differences that may be observed are that calcium sulfate has a lower birefringence than quartz, and their extinction patterns are slightly different.

Quartz exhibits straight, or parallel, extinction, meaning that the particles will appear dark when the microscope stage is rotated in increments of 90 degrees (Eastaugh et al., 2004; Patraco and Kubic, 2004). Calcium sulfate exhibits inclined extinction and an extinction angle of 38 degrees (McCrone, 2018).

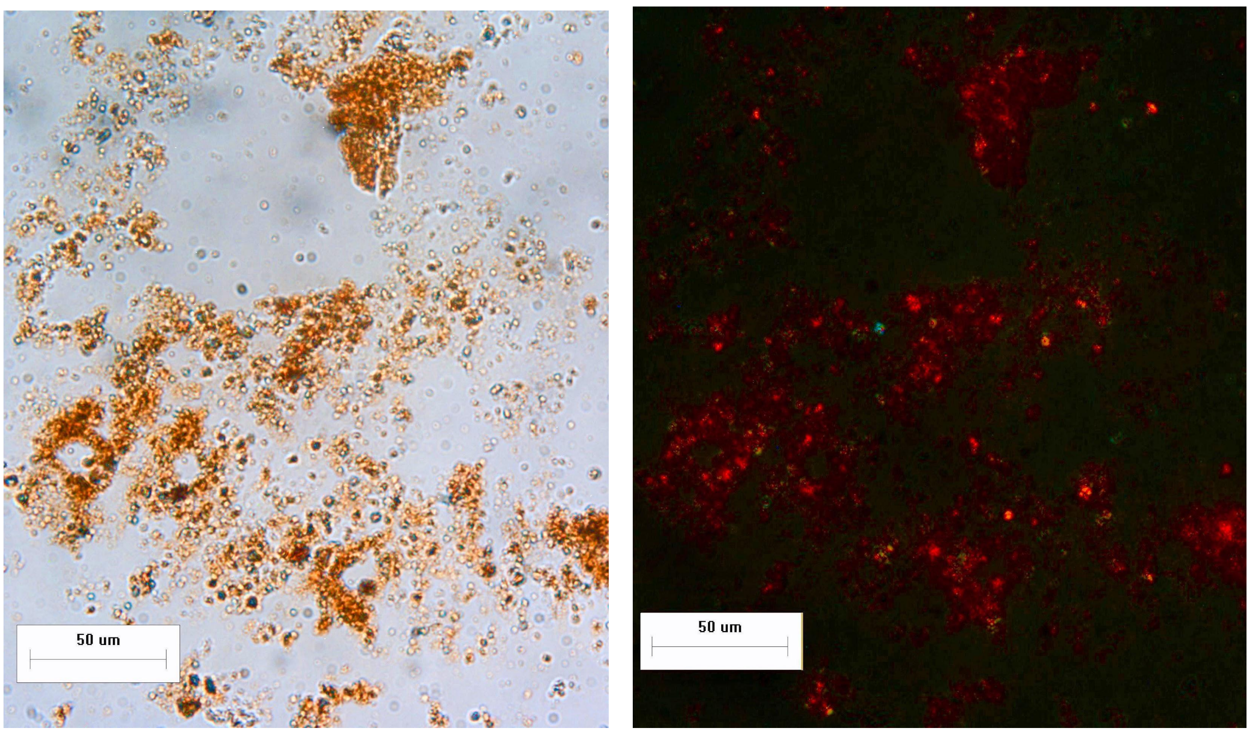


Figure 4.9: Polarized light photomicrographs of red slip under plane-polarized light (*left*) and cross-polarized light (*right*).

The red slip (Fig. 4.9) is composed of extremely fine red and orange particles. The bright red crystals visible under polarized light microscopy are characteristic of hematite (Fe_2O_3), an anhydrous iron oxide. In this sample, the particles showed a dark red/brown color under plane polarized light, refractive index greater than 1.662 and strong birefringence under crossed-polars. These physical and optical properties are consistent with those of finely ground hematite (Eastaugh et al., 2004; McCrone, 2018). Hematite is the most common red iron oxide mineral on earth and has been used as a pigment by many cultures throughout history because of its natural abundance, stability, and durability (Eastaugh et al., 2004; Nicola et al., 2016).

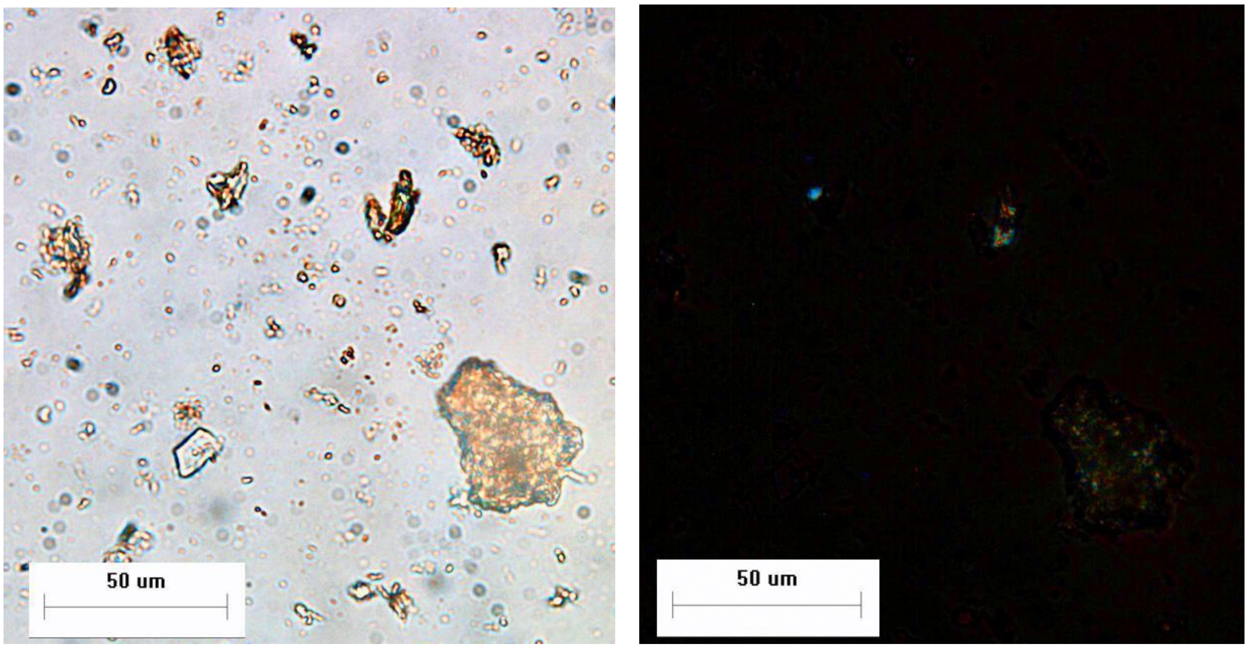


Figure 4.10: Polarized light photomicrographs of orange slip under plane-polarized light (*left*) and cross-polarized light (*right*).

The orange slip (Fig. 4.10) was so thin and finely burnished that it was extremely difficult to obtain a sample, so insufficient sample size made it difficult to identify the components of this slip. However, the dispersion does contain red, orange, white, and colorless particles, matching properties of some of the particles identified in the red and white slips. Quartz and calcium sulfate were identified in the sample, as well as fine grain hematite. Some orange particles are isotropic, and have a refractive index less than 1.662. Some of the larger orange particles also exhibit pleochroism and undulose extinction. These traits may indicate the presence of jarosite (sodium or potassium, iron sulfate), goethite (iron hydroxide), and various clay minerals, as these are often present in red earth pigments (Eastaugh et al., 2004).

4.2 Condition Assessment

4.2.1 Salts and Other Surface Particulates

Samples of surface particulates and accretions from the four ceramics analyzed and treated in this study tested negative for the presence of soluble salts, including chlorides, nitrates, nitrites, and sulfates. However, five other ceramic vessels (Fowler Cat. Nos. 246-1829, 246-2547, 246-2799, 246-3047, and 246-3126) from Amapa were also treated by students in the UCLA/Getty Master's Program in the Conservation of Archaeological and Ethnographic Materials. Of those five ceramics, 246-1829 tested positive for the presence of chlorides (Paulson, 2016) and 246-2799 had both chlorides and nitrates (Jefcoat Burton, 2016).

Some surface samples were also analyzed by X-ray diffraction (XRD), which showed the presence of gypsum in ceramics 246-1829, 246-2547, and 246-2799. Calclacite [$Ca(CH_3COO)Cl \cdot 5H_2O$] was also identified on the surface of ceramic 246-2799 (Fig. 4.11). The presence of calclacite is particularly interesting because its presence may relate to inappropriate storage conditions. Calclacite, a calcium salt, may form due to interactions between chlorides and acetic acid (Grzywacz, 2006). Acetic acid is an organic carbonyl pollutant, and it is one of the primary air pollutants found in museum environments.

Acetic acid may be off-gassed from a specific source, such as wooden shelving or cardboard boxes, or it may be a secondary pollutant formed from the oxidation of acetaldehyde (Grzywacz, 2006). Volatile acetic acid, off-gassed from wooden display cases, has been known to cause the formation of calclacite crystals on archaeological ceramics and has been identified in some of the world's foremost museum collections, including the British Museum (FitzHugh and Gettens, 1971), the Metropolitan Museum of Art (Wheeler and Wypyski, 1993), the Ashmolean Museum (Halsberghe et al., 2005), and the Athenian Agora (Paterakis and Steiger, 2015). In the case of the Amapa ceramic 246-2799, the chlorides were likely present in the ceramic due to its burial conditions before being excavated. The acetic acid likely off-gassed from the cardboard boxes in which the ceramics are housed in the Fowler Museum's archaeological storage facility.

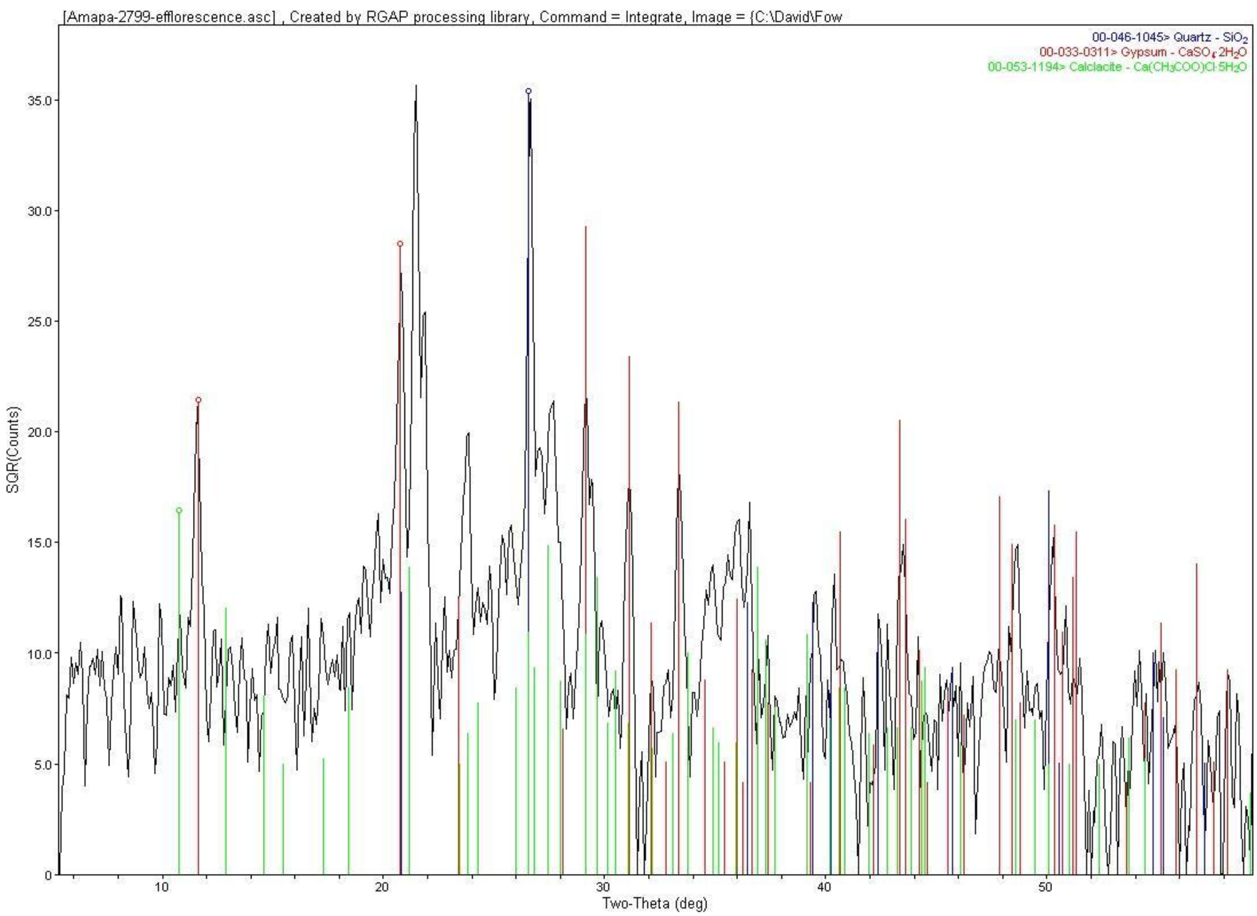


Figure 4.11: XRD analysis of efflorescence on the surface of 246-2799.

Other surface debris observed included small clumps of lightweight fluffy material, which was evident on most of the ceramics examined. The nature of the material made it difficult to examine and sample, as its three-dimensional shape made it difficult to obtain focused photomicrographs, and the clumps collapsed when disturbed. The extent of the material's presence was determined when examining the ceramics under ultraviolet light because of its strong fluorescence in the visible range of the electromagnetic spectrum (Fig. 4.12). On most of the ceramics, the material was closely associated with the adhesive used during the previous restoration work. However, two of the vessels, 246-1829 and 246-3047, showed the material all over the vessels' interior surfaces (Burgess, 2016; Paulson, 2016). Both of these vessels were *molcajetes*, specialized vessels with a ring base and a grooved interior, used for grinding food products, so residues on the interior surface and especially within the grooves may relate to the ceramics' original use.

A sample of these residues was taken from ceramic 246-1782, and analyzed with SEM-EDS. EDS analysis detected elements related to soiling, but did not provide useful information on the fluffy material as it is most likely organic. SEM micrographs (Fig. 4.12) showed what may be withered and degraded mold or fungi. The spherical and ovoid shapes may be fungal spores in various stages of maturity. The linear features could be sporangiophores, stolons, rhizoids, or fungal hyphae. Discussion with the Fowler Museum's Head Conservator, Christian de Brer, concluded that the fluffy material is likely a mold because the museum's former storage facilities, which were located off-campus on Kinross Avenue in Westwood, had flooded in the recent past.

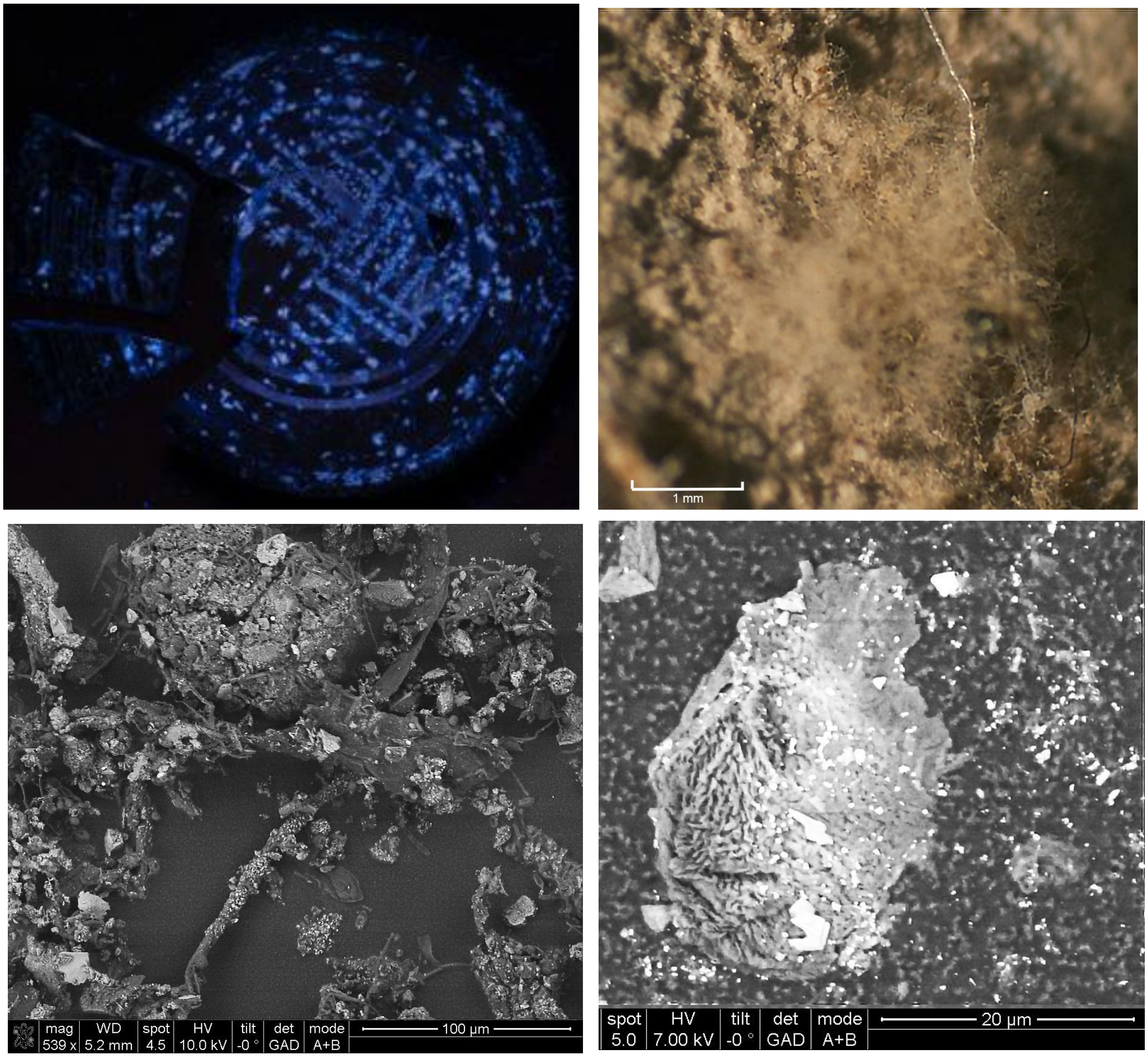


Figure 4.12: UV-induced visible fluorescence photograph of 246-3047 (*top left*), diffuse light photomicrograph of fluffy material on 246-2547 (*top right*), and secondary electron (SE) micrographs of fluffy material from 246-1782 (*bottom*).

4.2.2 Materials from Previous Conservation Treatments

Although the 1959 on-site reconstruction work done by the UCLA Anthropology graduate students provided invaluable information about the ceramic vessels' shapes, functions, and decorations, the adhesive used has aged poorly and become a conservation concern. Excess adhesive of the joins smeared on the surface caused discolorations and attracted dust and dirt.

Along many joins, the adhesive had become brittle and was shrinking. In some places, the shrinking adhesive was pulling apart the ceramic fabric where, previously, there had been firm adhesion. Furthermore, the adhesive must have a fairly low glass transition temperature, allowing it to become tacky in temperatures reached in the field or in storage conditions. This caused some joins to become misaligned while more dust and dirt was adhered to the ceramics.

Microchemical tests (Odegaard et al., 2005) on samples of the adhesive from each ceramic studied showed that the material was poly(vinyl alcohol) [PV(OH)] or one of its derivatives, such as poly(vinyl acetate) [PVA or PVAc] or a poly(vinyl ketal). There is a long history of these types of adhesives being used for ceramic repairs. In Mexico, Resistol 850 is a PVA emulsion that is easy to find, affordable, and has been used extensively for ceramic repair even though it is not archival or acid-free, and it does not have good aging properties (Silva and Muñoz, 2006).

FTIR analysis of the adhesive samples from the archaeological ceramics showed very similar spectra among the ceramics, indicating that the ceramics were likely all treated with the same adhesive. These spectra showed the greatest similarity to poly(vinyl alcohol), although the spectra were also a very close to poly(vinyl acetate) (Fig. 4.13). Unfortunately, there was not an exact match to any of the adhesive samples in the IRUG database. This could be due to a variety of factors, such as the degraded nature of the samples and possible additives or impurities in the different adhesive formulations.

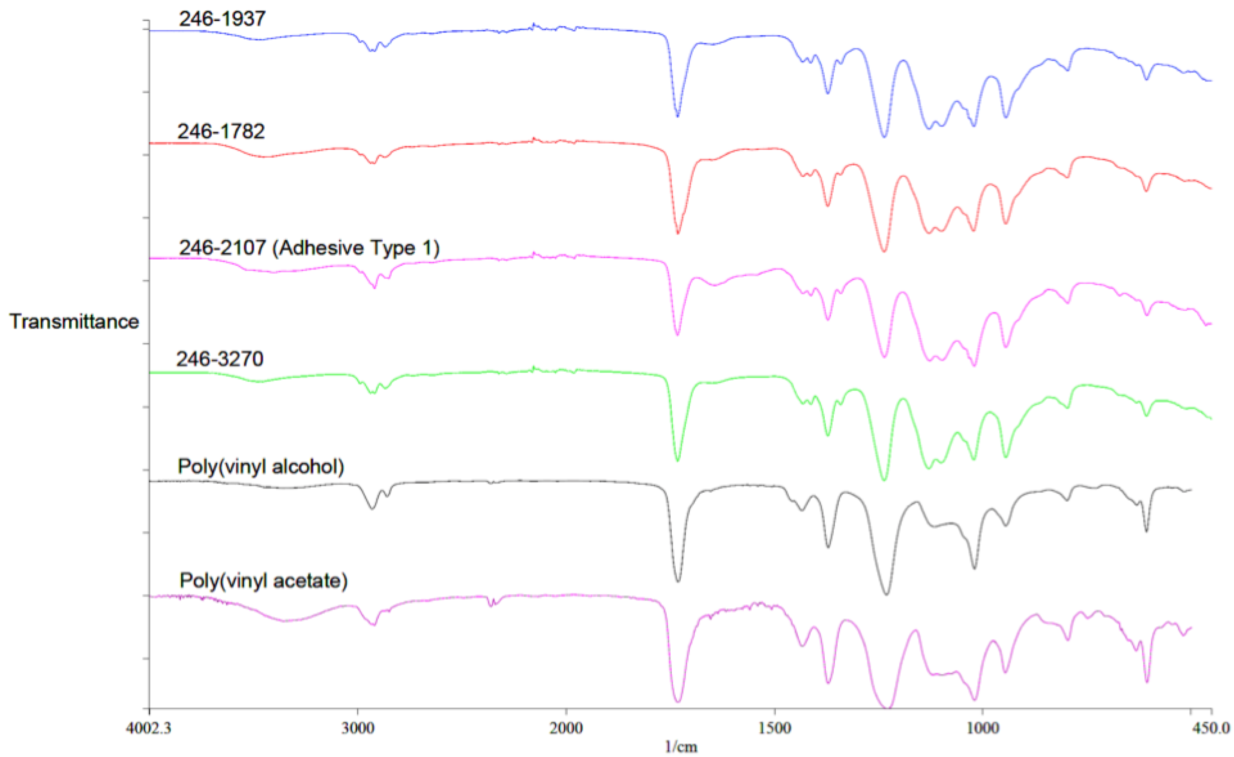


Figure 4.13: FTIR transmittance spectra for the unknown adhesive samples and poly(vinyl alcohol) and poly(vinyl acetate) reference samples.

Although the samples show a slightly closer match to PV(OH) than PVA adhesives, it is possible that a PVA-based adhesive was used during the original reconstruction on-site at Amapa after excavation. Poly(vinyl acetate) is a synthetic thermoplastic polymer with a formula of $(C_6H_{10}O_2)_n$ (Polymer Properties Database, 2018). Its ester groups are sensitive to base hydrolysis, and cause PVA to degrade into poly(vinyl) alcohol and acetic acid (Amann and Midge, 2011).

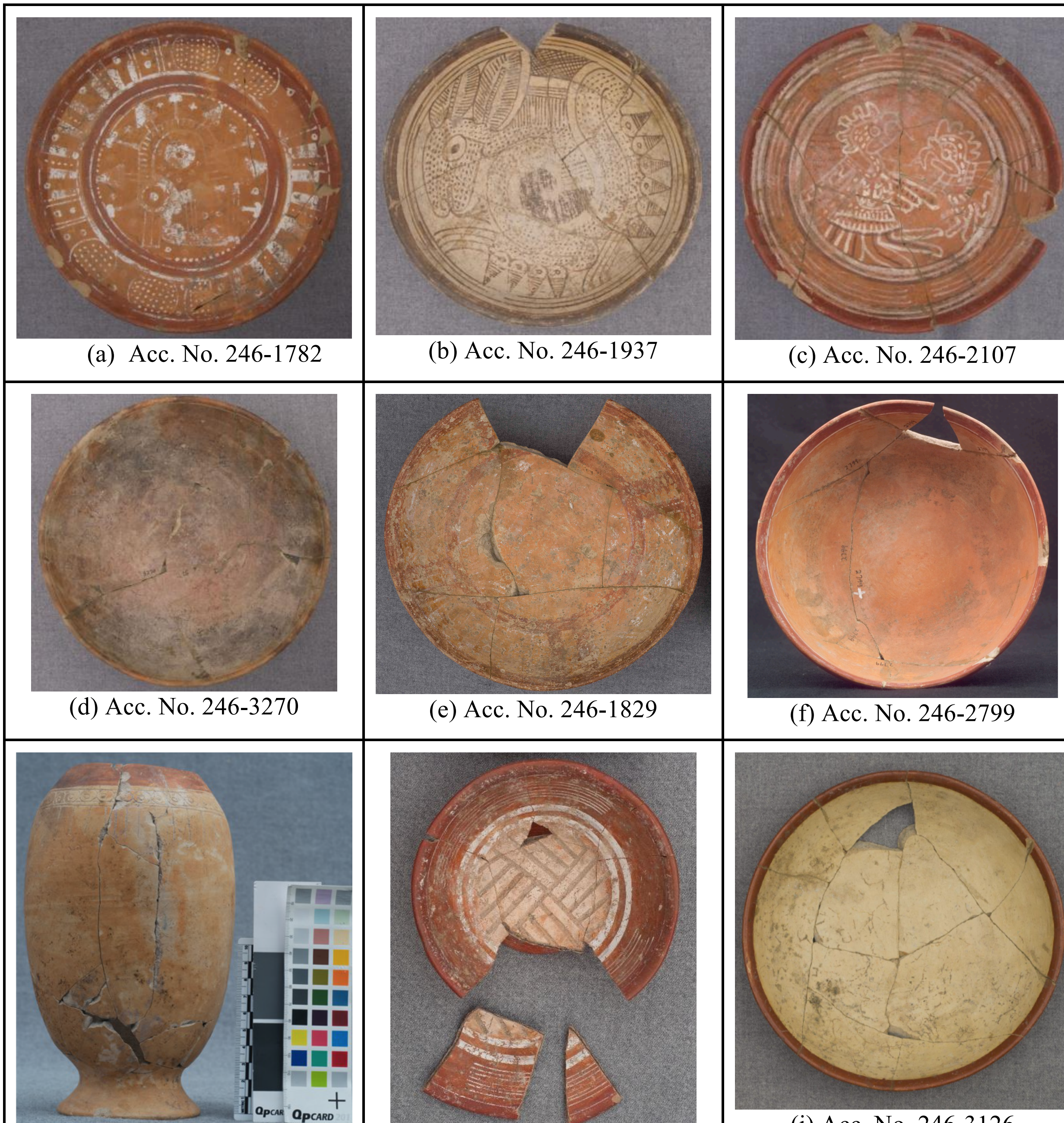
Chapter Five
Condition Assessment and Conservation

5.1 Condition Assessment and Conservation Implications

Due to interest in creating a publication and exhibition about the Amapa ceramics and the objects' need for conservation treatment, the Fowler Museum reached out to the UCLA/Getty Conservation faculty to use these pieces as teaching tools in the graduate students' coursework. In total, nine ceramic vessels (Fig. 5.1) were chosen by the Fowler Museum and professors David Scott and Ioanna Kakoulli for loan from the museum to the UCLA/Getty Student Conservation Laboratory at the Getty Villa. These ceramics would be used for documentation and/or conservation treatment during their 2015-2016 courses offered through the UCLA/Getty Master's Program in the Conservation of Archaeological and Ethnographic Materials.[3]

These nine pieces were chosen for several reasons. All were near-complete and featured some sort of decoration, whether painted or incised. The decoration would offer interesting results for different analytical imaging techniques used in Dr. Kakoulli's class. The similar condition issues of the vessels would ensure that all six conservation students would gain comparable ceramic conservation experience in Dr. Scott's class, and the Fowler Museum would benefit from the loan by receiving the ceramics back in an exhibitionable state.

[3] Three of these vessels (246-1782, 246-1937, and 246-3270) were documented and photographed using a variety of imaging techniques in Dr. Kakoulli's Fall 2015 class, CAEM 215: Imaging and Documentation. Six (246-1829, 246-2107, 246-2547, 246-2799, 246-3047, and 246-3126) were treated by conservation students in Dr. Scott's Winter 2016 course, CAEM 230: Conservation Lab - Ceramics, Glass, and Glazes. The three remaining, untreated pieces (246-1782, 246-1937, and 246-3270) were conserved by the author during a Summer 2016 internship at the Fowler Museum at UCLA.



(a) Acc. No. 246-1782
(b) Acc. No. 246-1937
(c) Acc. No. 246-2107
(d) Acc. No. 246-3270
(e) Acc. No. 246-1829
(f) Acc. No. 246-2799
(g) Acc. No. 246-2547
(h) Acc. No. 246-3047
(i) Acc. No. 246-3126

Figure 5.1: Diffuse light photographs of the nine ceramics chosen for examination and treatment (before treatment).

The chosen ceramics all had similar condition issues. On the surfaces, they all had small amounts of loose soiling and other particulate matter, in addition to some harder encrustations caused by plant roots growing in the soil where the ceramics were buried. More significantly, all of these ceramic vessels were incomplete. When they were excavated in 1959, each of these vessels were recovered as groups of sherds (see Fig. 5.2). The pottery sherds were washed by local women, and then sorted and numbered by UCLA graduate student, Gordon Grosscup (Grosscup, 1964). Joining sherds were glued together, restoring most of the vessels' original forms, but leaving gaps where fragments were missing or damaged. Whole and reconstructed vessels were examined and documented by fellow UCLA student, Betty Bell (Grosscup, 1964).

Figure 5.2: Photographs from the 1959 excavations at Amapa. Broken ceramics in situ *(top left)*, reconstructed vessels ready to be photographed *(bottom left)*, and the on-site ceramics work area, showing whole and reconstructed vessels excavated at Amapa *(right)*.
Photographs courtesy of the Amapa Archives, Fowler Museum.

While those on-site restorations aided in the documentation, study, and interpretation of the finds, the adhesive used at that time did not age well over the six decades since the vessels were excavated and reconstructed. For several decades in the early to mid-twentieth century, PVA emulsions, or ‘white glue,’ were often used to reconstruct and repair ceramics (Koob, 1986). Unfortunately, these adhesives tend to shrink and become brittle with age (Down, 2015). In several of the Amapa ceramics, the shrinking adhesive had caused delamination of the ceramic fabric along joins (Fig. 5.3).

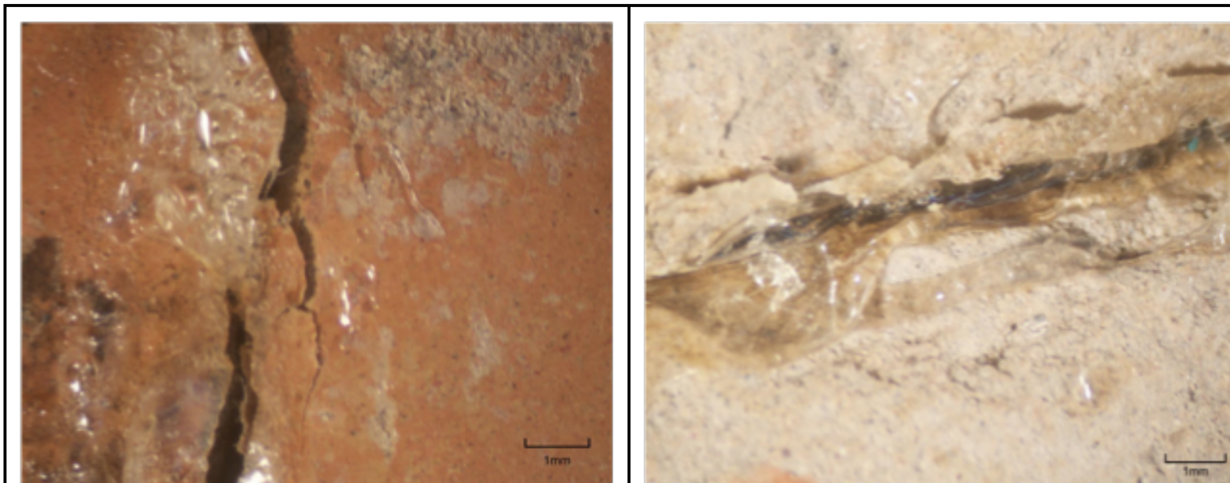


Figure 5.3: Photomicrographs showing delamination of ceramic material caused by shrinking adhesive along joins of 246-2107.

5.2 Conservation Treatments and Rationale

In order to restore the visual and structural integrity of these pieces and prepare them for potential exhibition and publication, all nine of the ceramic vessels underwent conservation treatment, carried out by the students of the UCLA/Getty Master’s Program in the Conservation of Archaeological and Ethnographic Materials. Treatment included surface cleaning, adhesive removal, desalination, readhesion of fragments, filling losses, and inpainting those fills to create a visual continuity between the original ceramic and the conservation materials.

The goal of the conservation work was never to make the ceramics appear pristine and new. As the Fowler Museum is primarily an anthropology museum, and these materials did come from an archaeological context, it was important to retain their archaeological aesthetic. In accordance with the Code of Ethics and Guidelines for Practice outlined by the American Institute for Conservation of Historic and Artistic Works (AIC, 2015), original ceramic material, slips, and painted decoration were never altered, removed, or obscured by modern restoration materials. Rather, conservation-grade adhesives, fill materials, and paints were used to stabilize joins between the pottery sherds and restore a visual continuity where fragments had been lost or destroyed during centuries of burial.

5.2.1 Cleaning

All of the ceramics had varying degrees of surface debris, from museum dust to soiling and accretions due to burial. The soiling detracted from the vessels' aesthetic quality, so it was decided to perform surface cleaning on all of the pieces. Loose dust and soiling were removed with a soft brush. Harder accretions were broken up and removed with small hand tools, such as wooden skewers, dental picks, and scalpels. Some rootlet encrustation over areas with white slip decoration were only reduced or left intact so that their removal would not damage the painted decoration underneath. Some areas were further cleaned with cotton swabs dampened with deionized water, ethanol, or a mixture of those two solvents, in order to restore the glossy finish of the burnished surfaces.

5.2.2 Adhesive Removal

In many places on the ceramics, the adhesive used in the original reconstruction had been applied excessively so that it had oozed out when sherds were adhered together and had also been smeared on the surface in several areas. The adhesive had softened at some point, attracting dust, which stuck to the adhesive and obscured the decorated surfaces. Along the joins, the adhesive was also shrinking and becoming brittle, causing the joins to become unstable. In some places, the shrinking adhesive even damaged the ceramic fabric, causing small cracks and delamination along break edges. In order to prevent further damage and create more stable joins, the old adhesive had to be removed and replaced with a conservation-grade adhesive that would age much better.

Samples of the old adhesive were taken from each ceramic and, along with the microchemical tests used to identify the unknown adhesive, solubility tests were also performed. All of the samples tested positive as being derived from polyvinyl acetate (PVA) or polyvinyl alcohol (PVOH). Many of the samples swelled in pure deionized water or a 1:1 mixture of deionized water and ethanol. Some adhesive samples were only soluble in acetone.

Cotton swabs dampened with acetone were used to clean the excess adhesive on the surfaces of the vessels. In order to soften the adhesive along the joins, strips of cotton wool were laid across the joins and then wetted with solvents. The vessels were covered with plastic cling film to slow the solvent evaporation and then left for 15-30 minute intervals. This process was repeated until all of the joins had come apart. Then the adhesive was removed from the break edges, using solvents and hand tools, such as cotton swabs, wooden skewers, dental picks, and tweezers.

5.2.3 Desalination

If present, soluble salts may cause serious condition issues in ceramics, especially when exposed to fluctuating levels of temperature and relative humidity. In their burial environment, archaeological ceramics may absorb soluble salts naturally present in the moist soil. These salts may travel through the ceramics' porous structure. After excavation, the ceramics dry out and the salts crystallize. Salt efflorescence on the surface of a ceramic may obscure or damage decoration, causing a loss of archaeological data. However, if salts crystallize inside the pores of the ceramic, they may cause structural damage that can be in the form of cracking, delamination, or powdering.

Because of the salts' hygroscopic nature, they may also resolubilize when the relative humidity rises, by pulling moisture from the air. This allows the salts to migrate through the porous ceramic fabric and recrystallize elsewhere after the humidity level drops. If their environment is not controlled, this process may repeat every time there is a significant fluctuation in relative humidity, causing more and more damage to the ceramics over time.

As discussed in Section 4.2.1, surface debris was sampled from all of the nine ceramic vessels in order to determine if they were at risk of damage due to salts. The samples were tested for the presence of soluble salts, including chlorides, nitrates, and sulfates. Of the nine ceramics, numbers 246-1829 (Paulson, 2016) and 246-2799 (Jefcoat Burton, 2016) tested positive for chlorides. The other seven ceramic vessels showed negative or negligible results for all salts tested.

Because the Fowler Museum's archaeological storage facilities are not climate controlled, changes in humidity could result in more damage to the artifacts. To prevent this possible scenario, ceramics 246-1829 and 246-2799 were desalinated through immersion in deionized water. Soaking drew the salts out of the ceramic and into the water. The diffusion of the soluble salts from the ceramic into the water was monitored through conductivity measurements of the water at regular intervals. After an appropriate period, the ceramic fragments were removed the water bath and allowed to air dry (Paulson, 2016; Jefcoat Burton, 2016).

5.2.4 Readhesion of Fragments

The next step in conserving the ceramics was to readhere the clean, dry fragments back together in order to restore the vessels' original forms and decoration. Because the previous adhesive used had aged so badly, it was extremely important to choose a new adhesive that would provide long-term, stable joins for these pieces. Several conservation-grade adhesives were considered and tested on modern terracotta flower pots that UCLA/Getty conservation students had broken and glued back together as a lab exercise. These adhesives included Paraloid B-72[4], HMG cellulose nitrate adhesive[5], Jade R[6], and Mowilith[7]. Ultimately, Paraloid B-72 was chosen because of its good aging properties, reversibility, and its widespread use in ceramic conservation over the last three decades (Koob 1986, 1998).

After the sherds were cleaned and all of the previous adhesives had been removed, the break edges of each sherd were consolidated with Paraloid B-72 (10%) in a 1:1 solution of acetone and ethanol. Consolidating the break edges before adhering the fragments together provides several benefits. Most importantly, this priming of the surface strengthens the porous ceramic substrate and greatly improves adhesion between the fragments. Furthermore, consolidating the break edges makes the substrates more compatible with the adhesive by interacting between the substrate and the adhesive. This reduces the amount of adhesive required

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[4] Paraloid B-72® is a registered trademark of Rohm & Haas for a clear, colorless, thermoplastic acrylic resin. Paraloid B-72 (formerly called Acryloid B-72 in the United States) is composed of an ethyl methacrylate (70%) and methyl acrylate (30%) copolymer. It has a Tg of 40° Celsius.

[5] HMG cellulose nitrate is a heat and waterproof adhesive designed for repairs to pottery, wood, metal, ivory, glass, or other porous materials, excluding rubber. This product has a glass transition temperature of approximately 56□. It does not have instant setting ability, which allows fragments to be readjusted. Surplus adhesive can be removed with acetone, and it is clear, making repairs virtually invisible.

[6] Jade® R is a multipolymer (PVA, EVA), water-reversible adhesive that is acid free and archival. It is pH neutral, dries quickly to a flexible film, is easily cleaned up with water, and is transparent when dry. It is used in bookbinding and repair, with cloth, wood, plastic, and ceramics.

[7] Mowilith® is the trade name for a series of polyvinyl acetate emulsions, sometimes used in conservation as paint binders, coatings, and adhesives.

to successfully join the fragments and results in improved adhesion, with stronger and more uniform bonds being formed (Koob, 1986).

After the break edges were consolidated, the sherds were adhered back together with Paraloid B-72® (40%) in acetone. The joins were supported with sandbags to prevent the pieces from slumping before the adhesive had fully cured. After all of the fragments had been reattached and the adhesive had cured, the ceramics were stable and much more visually appealing.

5.2.5 Fills

Even after reconstruction, all of the vessels had at least one area of loss that detracted from their overall visual appearance or structural integrity. The Fowler Museum desired that these gaps be filled in order to enhance the pieces' appearance and stability. Additionally, this task acted as a learning opportunity for the UCLA/Getty conservation students, allowing them to practice using different fill materials on their respective aforementioned broken flower pots before choosing an appropriate material for their own assigned Amapa ceramic.

Several conservation-grade materials were considered for the fills, including plaster, Pollyfilla,[8] epoxy putty, and Paraloid B-72 bulked with glass microballoons.[9] Ultimately, all of the fills were done with either Polyfilla or Paraloid and microballoons. Polyfilla mixed with deionized water was chosen for ceramics 246-1782, 246-1937, 246-2107, 246-3270, and 246-3126 (Figure 5.1 a-d, i) because of its working properties, textural similarity to clay, and ability to be painted easily. A solution of Paraloid B-72 (40%) in acetone, bulked with glass microballoons was chosen for ceramics 246-1829, 246-2799, 246-2547, and 246-3047 (Figure

[8] Pollyfilla® is a cellulose reinforced plaster-based filler that does not shrink upon drying.

[9] Glass microballoons are tiny, hollow glass spheres that form a fine powder. This product is commonly used in conservation as a bulking agent or thickener in thixotropic mixtures, such as resins.

5.1 e-h) because these ceramics showed more sensitivity to water. The use of Paraloid B-72 dissolved in acetone eliminated any chances of excess moisture adversely affecting the ceramics. This was especially important for 246-1827 and 246-2799, which had already undergone desalination treatments.

After the fills had fully cured, they were painted with washes made of Liquitex® Acrylic Artist Color Paints mixed with deionized water so that the repairs would blend in with the original ceramic material. This restored the visual integrity of the ceramic fabric and decoration so that the appearance of the fill would not detract from the overall appearance of the whole artifact.

5.3 Recommendations

If not going on display, the treated ceramics should be wrapped and stored in archival materials, such as Ethafoam sheeting or acid-free tissue paper. All of the Amapa ceramics, both treated and untreated, in the Fowler collections would benefit from new housing. Currently, the ceramics are wrapped in paper or ethafoam sheeting and stored in brown cardboard boxes, with multiple objects in each box. The cardboard boxes are not archival and may be off-gassing acetic acid vapors, which could react with minerals in the ceramics and form degradation products. As discussed in section 4.2.1, this may be how the calclacite formed on ceramic 246-2799.

Rather than being stored in cardboard boxes, the Amapa ceramics would benefit from being moved to clear plastic boxes with lids. It would also be helpful if each box was clearly labelled with the catalog number and a photograph of each object stored inside. While re-housing the objects would require an initial investment by the museum, it would provide a much safer and more stable storage solution for these ancient treasures. This solution would provide long-term benefits and cost-saving to the museum by prolonging the lives of the artifacts. The clear, hard plastic would more easily allow museum staff, volunteers, and researchers to see what is stored inside without having to remove the boxes from shelves, and they would provide more protection for the artifacts against such factors as mishandling, water leakage, flooding, and earthquakes.

Chapter Six
Conclusions

The Fowler Museum at UCLA houses an important collection of ceramics from Amapa, and many of the designs and animals depicted on the ceramics are one-of-a-kind. An exhibition and publication of these materials would be a significant contribution to the field of West Mexican archaeology. It would also honor both the ancient artisans who made these artifacts and the UCLA archaeologists and graduate students who painstakingly excavated, reconstructed, and studied these pieces.

This investigation has found that these ceramics were hand-built, using the coiling method. After forming the vessels, finishing techniques and/or decoration were applied, depending on the purpose of the vessel. Utilitarian pieces may have been slipped or left bare and then burnished to a smooth surface. Many of the unslipped vessels also feature some incised designs on their exteriors. Ceremonial pieces, which were most often found in burial contexts, usually had a slipped and burnished surface with painted slip decoration applied over the base slip. These slips were all composed of naturally-occurring inorganic materials, such as quartz, calcium sulfate, hematite, jarosite, goethite, pyrolusite, and other clay minerals.

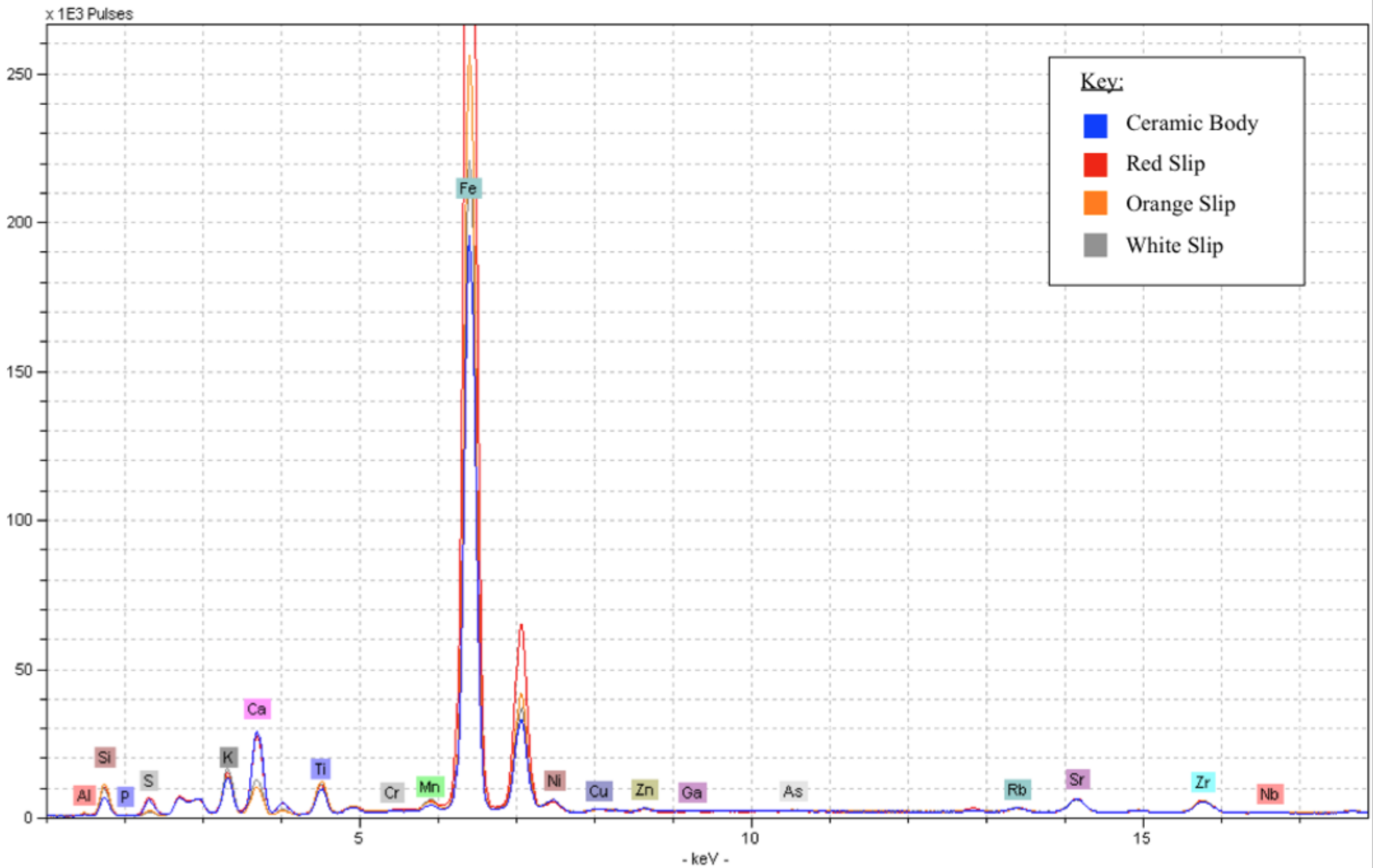
The adhesive used in the 1959 reconstructions was a PV(OH) or PVA-based adhesive that has aged poorly and caused multiple condition issues in the ceramics. The adhesive has become brittle and shrunk, causing delamination of the ceramic material along several joins. It was also applied excessively along some break edges so that the adhesive oozed out and smeared on the surfaces of the vessels. This excess adhesive has attracted dust and mold, obscuring some of the original painted decoration.

The nine ceramic vessels that were documented and treated by the students of the UCLA/Getty Master's Program in the Conservation of Archaeological and Ethnographic Materials Class of 2018 are representative of the hundreds of untreated Amapa ceramics in the Fowler's storage facilities. The research and analysis performed on this small subset are relevant to the rest of the collection and have identified the original materials and technology used to create these pieces, the adhesives used in the 1959 reconstructions, and the condition issues present because of those materials and their storage conditions. Therefore, this information and the treatment protocols outlined in this study could also be applied to other pieces in this collection. In selecting the best-preserved pieces and those with the most decoration, the Fowler Museum would be able to minimize the time needed for analysis and conservation treatment and be able to produce a high quality exhibition and publication about this collection.

Appendix 1

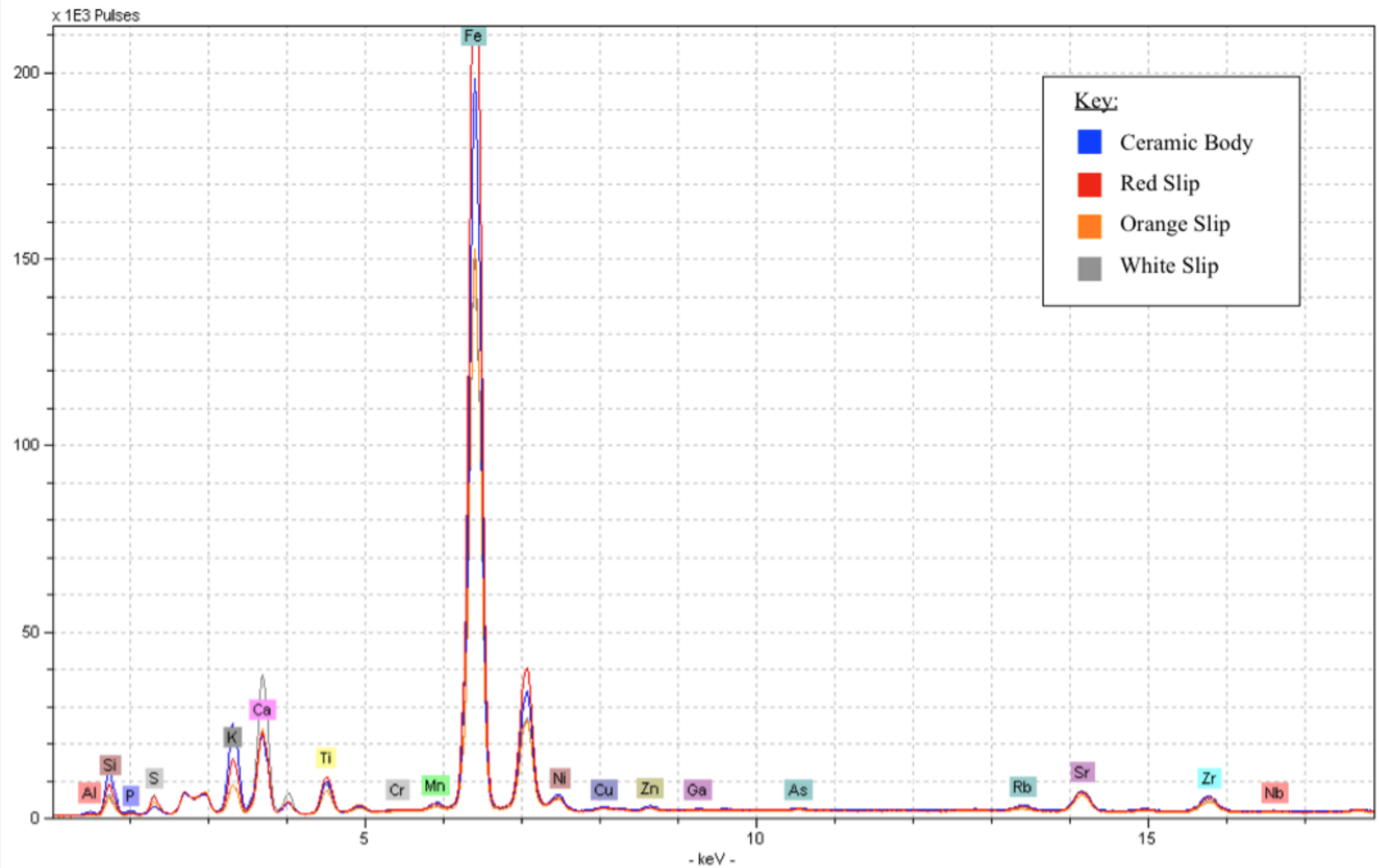
X-Ray Fluorescence (XRF) Spectra of Ceramic Fabrics and Slips

The following XRF spectra demonstrate the elemental composition of the ceramic fabrics and slips of Fowler Museum ceramic numbers 246-2107, 246-1782, 246-1937, and 246-3270.



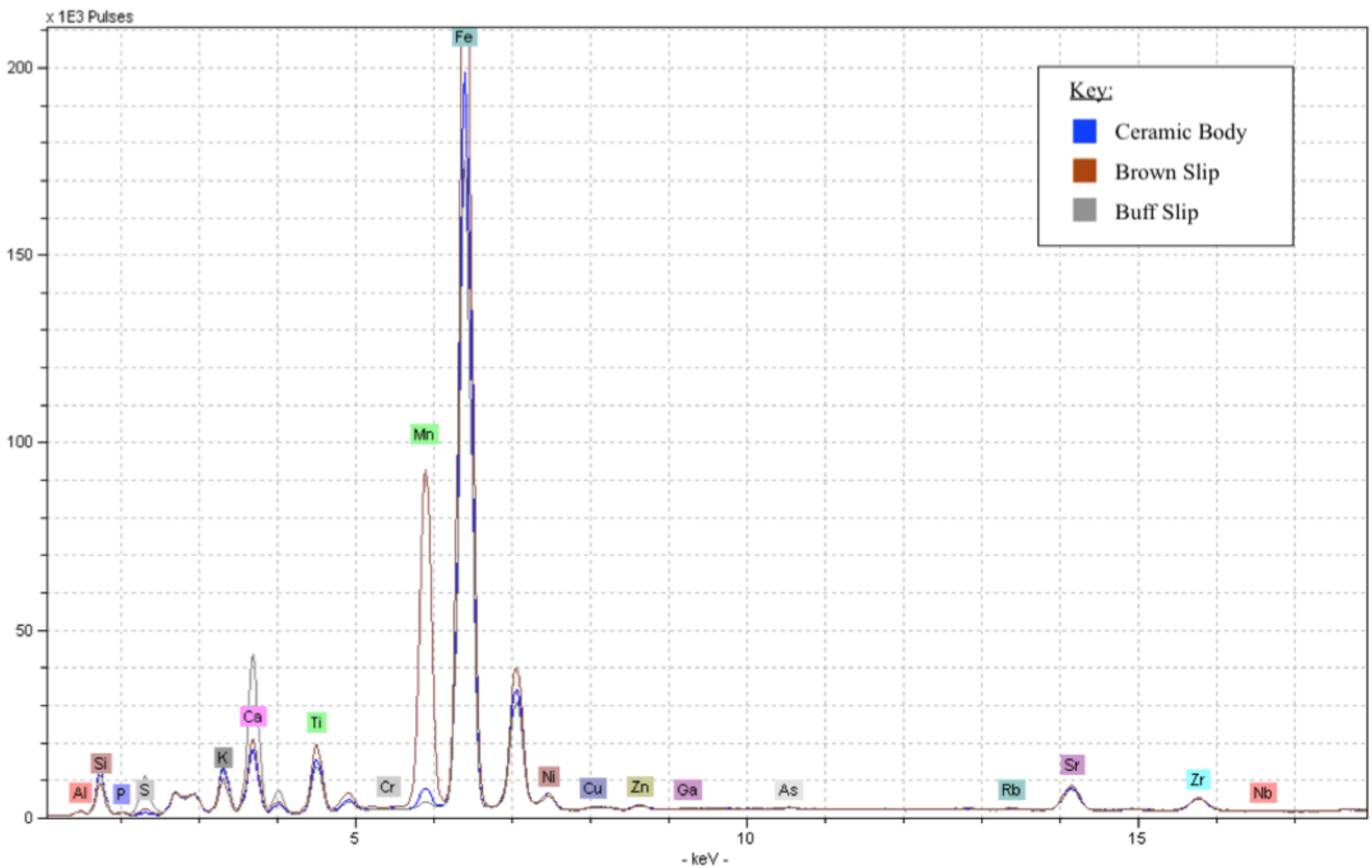
Spectrum overlay for ceramic 246-2107, comparing the ceramic fabric with the colored slips.

pXRF Settings: 40 kV, 11 mA, 120 seconds, no filter.



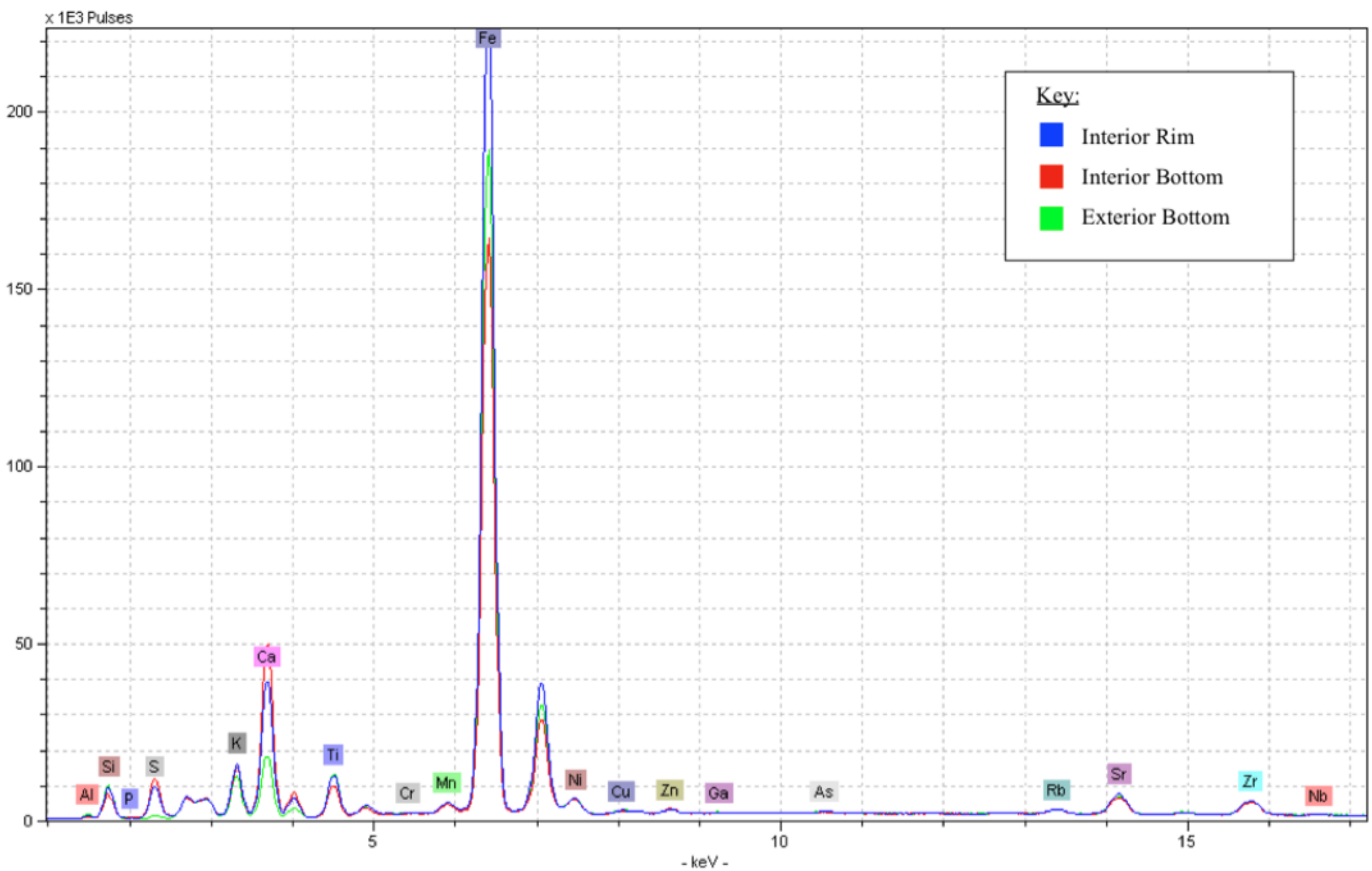
Spectrum overlay for ceramic 246-1782, comparing the ceramic fabric with the colored slips.

pXRF Settings: 40 kV, 11 mA, 120 seconds, no filter.



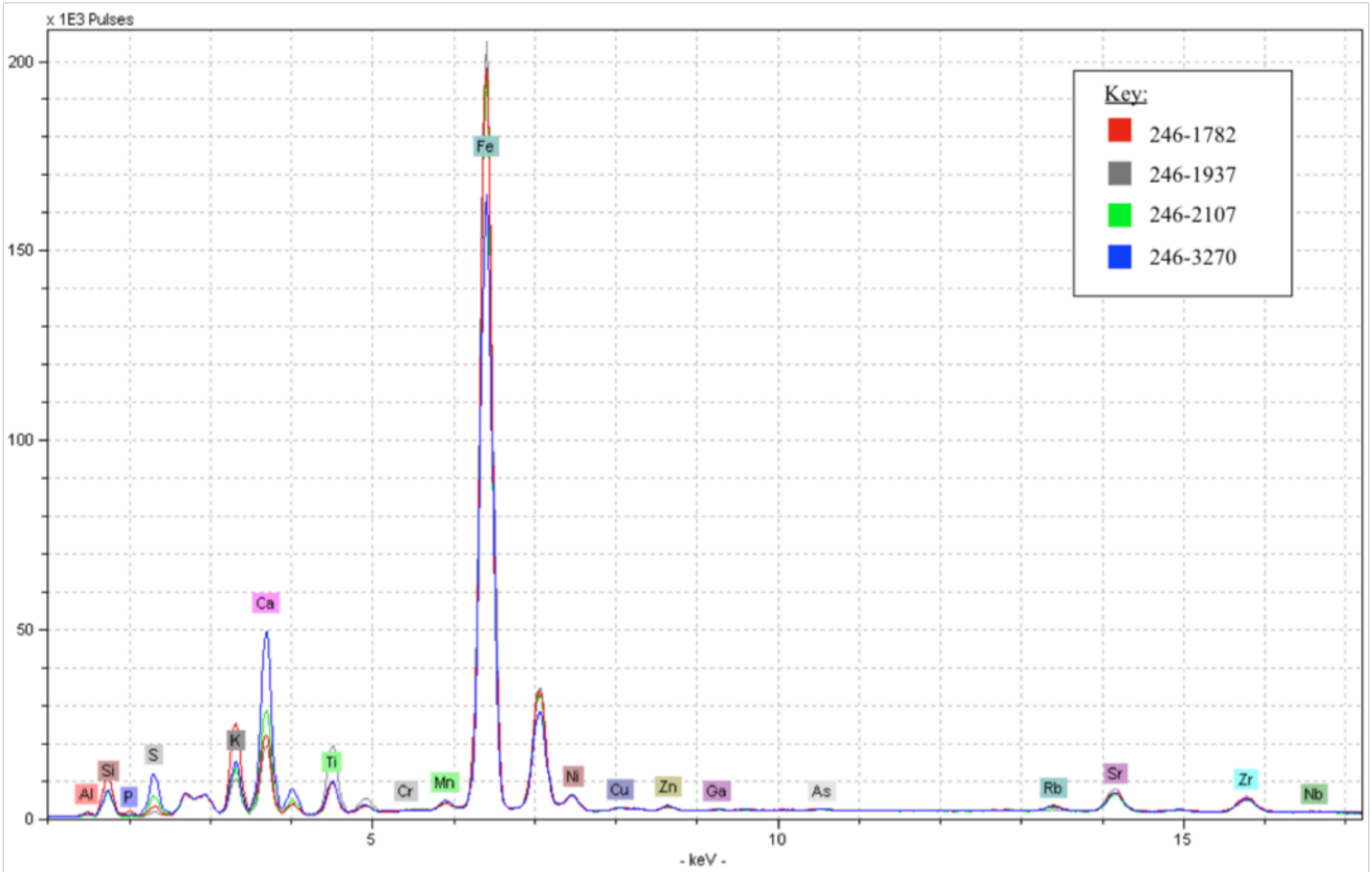
Spectrum overlay for ceramic 246-1937, comparing the ceramic fabric with the colored slips.

pXRF Settings: 40 kV, 11 mA, 120 seconds, no filter.



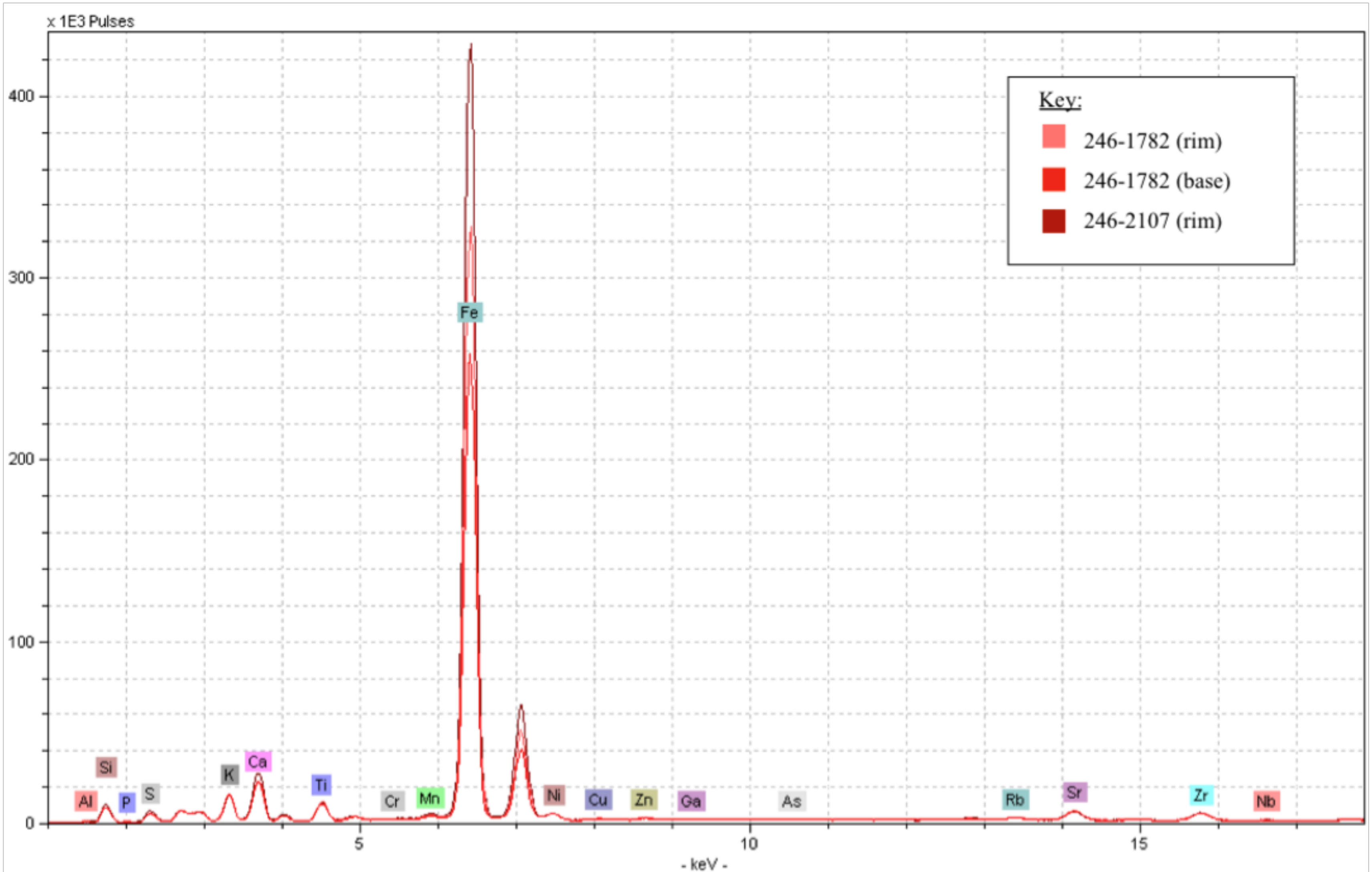
Spectrum overlay for ceramic 246-3270, comparing the ceramic surface in three different locations.

pXRF Settings: 40 kV, 11 mA, 120 seconds, no filter.



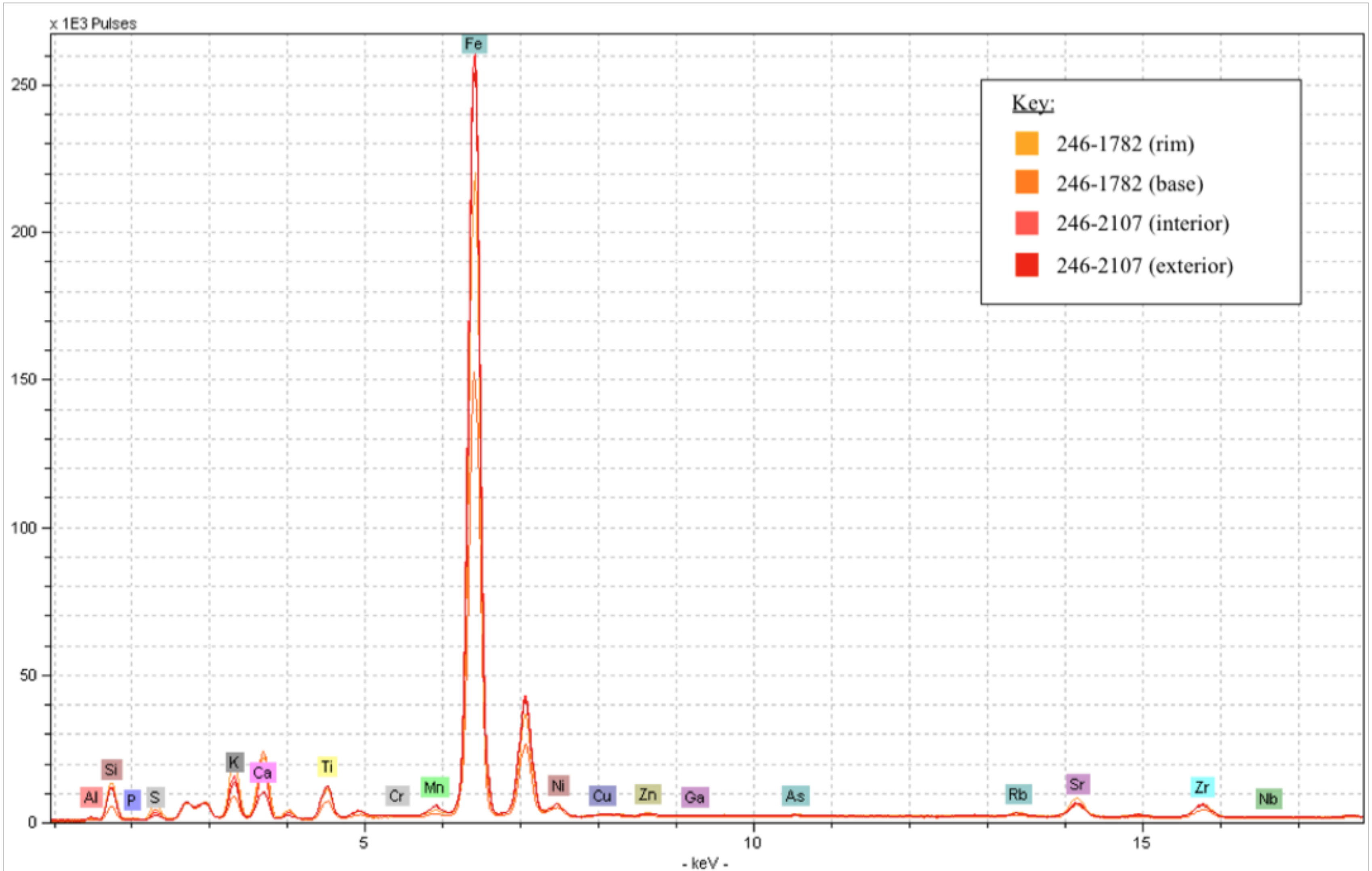
Spectrum overlay depicting the ceramic fabric of each ceramic studied.

pXRF Settings: 40 kV, 11 mA, 120 seconds, no filter.



Spectrum overlay comparing the red slips of ceramics 246-1782 and 246-2107.

pXRF Settings: 40 kV, 11 mA, 120 seconds, no filter.



Spectrum overlay comparing the orange slips of ceramics 246-1782 and 246-2107.

pXRF Settings: 40 kV, 11 mA, 120 seconds, no filter.

Appendix 2

Treatment Report for Ceramic 246-2107

Object: Mangos Polychrome Ceramic Bowl

Cultural Attribution: Amapa, Nayarit, Mexico; Late Period, Cerritos Phase (c. 750 – 1000 CE) or Ixcuintla Phase (c. 1000 – 1350 CE)

Identification Numbers:
246-2107 (Archaeological Number)
L2015.8.4 (Fowler Museum Loan Number)

Medium: Clay, Slip, Pigments

Dimensions:
Diameter: 22.3 cm (8.9 in.)
Depth: 5.0 cm (2.0 in.)

Current/Past Owners:
Fowler Museum at UCLA

Purpose of Examination:
Conservation Treatment

Date of Examination: October 19, 2015

Conservator: Lindsay Ocal

Fowler Museum 246-2107 Before (*top*) and After Treatment (*bottom*).

Object Description

The object (Fig. 1) is a round polychrome ceramic bowl from the site of Amapa in Nayarit, Mexico (Fig. 2).[1] The decoration on the interior depicts two birds. It is a Late Period type of ceramic, known as "Mangos Polychrome," that is characterized by low, open bowls that

[1] See Clement W. Meighan, ed, *The Archaeology of Amapa, Nayarit* (Los Angeles: The Institute of Archaeology University of California, Los Angeles, 1976), Plate 159a.

have decoration on the interior surface.[2] The surface is burnished and slipped an orange-buff color. The bottom (exterior) of the bowl is undecorated. The interior of the bowl is covered with white, red, and black painted decoration. The central scene shows two birds depicted in profile and facing each other. A series of concentric black and white circles radiate outward from the central scene on the bowl. The rim is painted a dark red color.

Materials and Techniques

There is no evidence for use of a potter's wheel at Amapa, so all ceramics were made by hand-building methods. The Mangos polychrome bowl was constructed using the coiling technique and finishing techniques probably included scraping, burnishing, and paddle and anvil thinning.[3]

Most ceramics from the site of Amapa, including this Mangos polychrome bowl, were made from a local clay whose paste ranged from a reddish-brown to gray color. A second type of clay used on the site was a white to cream color and was relatively free of iron.[4] This second type of clay was used as slip on Late Period ceramics from Amapa, so the white decoration on the Mangos polychrome bowl may not be paint, but slip from this iron-free clay. The red and black decoration may be pigmented slips that were painted on the surface before firing.

The ceramic core material is a uniform gray-tan color, indicating that the vessel was fired in an oxidizing environment. The temper material is of medium coarseness – neither very coarse nor fine. Sand was the main temper material used at the site of Amapa in the Early and Late Periods, with coarser material being used in the beginning and gradually becoming finer over time. Pumice was also frequently added to the temper, though this may have been a natural component of the sand at the site.[5]

Condition

Structural

The bowl is incomplete. It was excavated from the site of Amapa in the western Mexican state of Nayarit in 1959 by a team from UCLA.[6] The bowl had been broken into 13 separate fragments that were reassembled during a previous conservation treatment at an unknown time, possibly even while on-site during the excavations. Eleven of the fragments are labeled with the number '246-2107' written in black ink on the orange-buff slipped, exterior surface. The two fragments that are not labeled may have been broken during later handling or conservation treatment after initial excavation and cleaning. The pieces were excavated in 1959, and the reconstructed bowl is shown in Plate 159a (Fig. 3)in Meighan's 1976 publication of the finds from the site of Amapa, so the treatment was performed some time during that 17-year interval.

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[2] Meighan, 233.

[3] Ibid., 212.

[4] Ibid., 216.

[5] Ibid.

[6] Ibid., 1.

Two major areas of loss and three smaller gaps are present along the vessel's rim. There are several small areas of loss along the edges of the fragments. These losses are being exacerbated by the behavior of the adhesive that had been used during the initial reconstruction. The aging adhesive is now shrinking and pulling apart the ceramic fabric along the break edges (Fig.4). There are also multiple areas where excess adhesive oozed out from the joins and dried on the surface. The use of copious amounts of adhesive also resulted in a few uneven joins.

Surface

Both the interior and exterior surfaces of the vessel have areas of soiling and staining. The bottom of the bowl has several stains and accretions (Fig. 5) that formed during burial. These may be manganese dioxide and/or iron staining.[7]There is also soiling where excess adhesive is present. The fragments were not fully cleaned before they were joined together, so there is additional soiling in some places where dirt and dust have gotten trapped in the adhesive and darkened the surface (Fig. 6). There are also small globs and smears of adhesive visible in many places on the vessel's interior and exterior surfaces, especially along areas where fragments were joined together. This is especially evident when examining the object under ultraviolet light because the adhesive fluoresces (Fig. 7).

Under magnification, a fuzzy-looking material is evident on the surface, especially in cracks, on break edges, and stuck to the adhesive. This could be dust, mold, and/or salt efflorescence. Furthermore, there are a few white specks among the 'fuzzy' material in some gaps (Fig. 8). It is unclear whether these specks are salts or flakes of white paint or slip that have separated from the decorated surface. Some paint and slip has been lost, but the decoration that remains seems stable. It is not actively flaking or friable.

Condition Summary

The vessel is in fairly stable condition, although the uneven joins, excess adhesive, and soiling are visually distracting. The adhesive, while firmly holding the fragments together thus far, is also slowly shrinking and pulling the ceramic fabric apart along the break edges.

Proposed Treatment

1. The object will be fully documented before, during, and after treatment, using digital photography.
2. Samples will be taken of the adhesive used during the original conservation treatment in order to determine what the adhesive is and how to remove it.
3. Samples will be taken of the "fuzzy-looking" material present along cracks and break edges to determine whether it is just dust or if it contains salts and/or mold.
    a. If salts are present, the fragments may need to be desalinated before treatment.
4. The bowl will be disassembled and all surfaces of the fragments will be cleaned.
5. If the painted decoration becomes unstable during the bowl's disassembly and cleaning, the paint will be consolidated.

[7] Caitlin R. O'Grady, "Morphological and Chemical Analyses of Manganese Dioxide Accretions on Mexican Ceramics," in *Materials Issues in Art and Archaeology VII*. Pamela B Vandiver, Jennifer L. Mass and Alison Murray, eds. (Warrendale, Pennsylvania: Materials Research Society, 2004): 183-192.

6. The fragments of the bowl will be reassembled and adhered together with a conservation-grade adhesive.
7. The gaps will be filled and the fill material tinted to match the color of the bowl.

Treatment

First, loose dust and soiling were removed with a soft brush. Then, samples of the adhesive were taken from several areas of the bowl, both on the surface and within gaps and break edges. Microchemical tests[8] and solubility tests were performed on the samples in order to determine what the adhesive was and how to remove it (Tables 1 and 2). All adhesive samples tested positive for poly(vinyl alcohol) or one of its derivatives, such as poly(vinyl acetate), and dissolved readily in acetone.

Samples were also taken from several accretions on the ceramic's surface and soiling within gaps. Using both microchemical tests and spot-test papers, these samples were tested for the presence of various salts (Table 3).A negligible amount of chloride (<500 mg/l) was detected on one spot, but all other tests were negative for both soluble and insoluble salts. Therefore, desalination was not required, and adhesive removal commenced.

Since the adhesive samples were soluble in acetone, the excess adhesive on the ceramic's surfaces was removed by gently swabbing the surface with cotton swabs dampened with acetone. This worked well on the surface, leaving the decoration much cleaner and clearer. To soften the adhesive along the break edges, the joins were poulticed with cotton wetted with acetone, and then the ceramic was covered with plastic wrap. After one hour, some of the joins had come down. More cotton was added along those joins and all cotton was re-wetted with acetone. This process was repeated two more times, until all joins had failed.

While the adhesive on the smooth surfaces was easily removed by swabbing with acetone, the adhesive along the break edges was much more difficult to remove. This was due to both the unevenness of the rough break edges and to the behavior of the adhesive. Samples of this adhesive were taken and tested. They also tested positive for PVOH/PVAC, but the color resulting from the microchemical test differed from the other samples. This indicates that two different types of PVA-based adhesives may have been used in previous restoration work on this vessel or the adhesive may have degraded differently along the joins.

Swabbing with cotton dampened with acetone reduced this second adhesive. The remaining adhesive was removed through a series of cotton poultices dampened with solvents. Acetone successfully removed most of the adhesive. For the most stubborn areas, poultices with dimethylsulfoxide (DMSO) were used to remove remaining adhesive from the break edges. However, the DMSO also caused some adhesive to migrate into two of the sherds, causing darkening of the sherds' colors (Fig. 9).

In order to draw the adhesive back out of the ceramic fabric, these two sherds were immersed in acetone for one hour, and then removed and allowed to dry. This was partially successful in that the darkening was reduced, and the color of the acetone yellowed slightly. The sherds were immersed again in clean acetone. After two hours, they were removed and allowed to dry. One sherd was completely cleaned after the second immersion. The other sherd was immersed again for four hours. Upon drying, this sherd was also successfully cleaned.

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[8] Nancy Odegaard, Scott Carroll, and Werner S. Zimmt. *Material Characterization Tests for Objects of Art and Archaeology, Second Edition* (London: Archetype Publications, 2005).

After the sherds were cleaned and all of the previous adhesives had been removed, the break edges of each sherd were consolidated two times with Paraloid B-72®[9] (10%) in a 1:1 solution of acetone and ethanol. Then the sherds were adhered back together with Paraloid B-72® (40%) in acetone.

Major areas of loss were filled with Pollyfilla®.[10] Normally an off-white color, the plaster-based powder filler was mixed with dry pigments to tint the fills so that they would blend in with the rest of the ceramic. Upon drying, the color of the pigmented fills had lightened, so acrylic washes made with Liquitex® Acrylic Artist Color Paints and deionized water were painted over the fills so that they would blend in with the original ceramic material.

Supplies

Paraloid B-72®

Talas
330 Morgan Ave.
Brooklyn, NY 11211
Phone: (212)219-0770
http://www.talasonline.com/

Mineral Pigments

Kremer Pigments
247 West 29th Street
New York, NY 10001
Phone (212) 219-2394 or 1-(800)-995-5501
Fax (212) 219-2395
Email: info@kremerpigments.com
http://shop.kremerpigments.com/en/

Polyfilla®

Conservation Support Systems
P.O. Box 91746
Santa Barbara, CA 93190-1746
1 (800) 482-6299
info@conservationsupportsystems.com

Liquitex® Acrylic paint

Liquitex Artist Materials
P.O. Box 246
Piscataway, NJ 08855
1-888- 4-ACRYLIC
www.liquitex.com

[9] Paraloid B-72® is a registered trademark of Rohm & Haas for a clear, colorless, thermoplastic acrylic resin. Paraloid B-72 (formerly called Acryloid B-72 in the United States) is composed of an ethyl methacrylate (70%) and methyl acrylate (30%) copolymer. It has a Tg of 40° Celsius.

[10] Pollyfilla® is a cellulose reinforced plaster-based filler that does not shrink upon drying.

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Table 1: Microchemical Testing for Adhesive Identification

Name of Test	Sample Type and Location	Result
Test for nitrate (cellulose nitrate) using diphenylamine	Excess adhesive on interior surface	Negative
	Adhesive present along break edges	Negative
Test for poly(vinyl alcohol) using iodine/potassium iodide	Excess adhesive on interior surface	Positive
	Excess adhesive on exterior surface	Positive
	Adhesive present along break edges	Positive
	Scrapings of the white hazy film that appeared on the interior surface after solvent cleaning	Positive

Table 2: Solubility Testing of Adhesive Samples

Solvent	Sample Type and Location	Result
Deionized water	Excess adhesive on interior surface	Negative – no change
Ethanol		Some swelling of adhesive sample
Acetone		Positive – sample completely dissolved
DMSO	Adhesive along break edges	Positive – adhesive dissolved

Table 3: Microchemical Testing For Presence of Salts

Name of Test	Sample Type and Location	Result
Test for chloride ions using sulfuric acid	Surface accretions (rootlets), exterior	Negative
Test for chloride using silver nitrate		Negative
Test for chloride using spot-test papers		Negative
Test for nitrate using iron (II) sulfate		Negative
Test for nitrates and nitrites using spot-test papers		Negative
Test for sulfate using barium chloride		Negative
Test for sulfate using spot-test papers		Negative
Test for carbonate using hydrochloric acid and barium hydroxide		Negative
Test for chloride using silver nitrate	Soiling within gaps on interior surface	Negative
Test for chloride using spot-test papers		Negative
Test for nitrates and nitrites using spot-test papers		Negative
Test for sulfate using spot-test papers		Negative
Test for chloride using spot-test papers	Cotton poultice with distilled water placed on area of loss (exposed ceramic interior, no adhesive present)	Negligible (<500 mg/l)
Test for nitrates and nitrites using spot-test papers		Negative
Test for sulfate using spot-test papers		Negative
Test for chloride using silver nitrate	Scrapings of the white hazy film that appeared on the interior surface after solvent cleaning	Negative
Test for chloride using spot-test papers		Negative
Test for nitrates and nitrites using spot-test papers		Negative
Test for sulfate using spot-test papers		Negative

Figures:

Figure 1: The interior (*top*) and exterior (*bottom*) of the vessel before treatment.

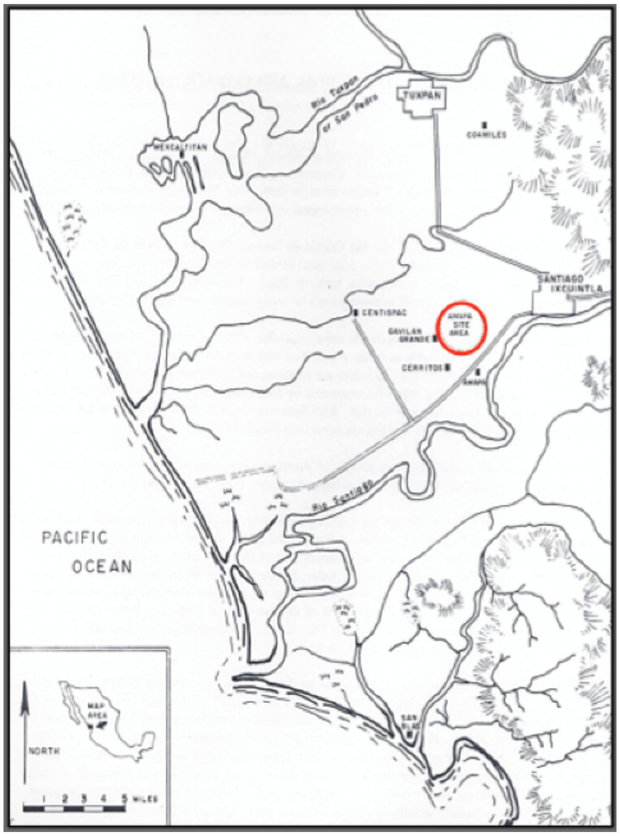

Figure 2: Map of Western Mexico with the site of Amapa circled in red. Map courtesy of Clement W. Meighan, ed, *The Archaeology of Amapa, Nayarit.*

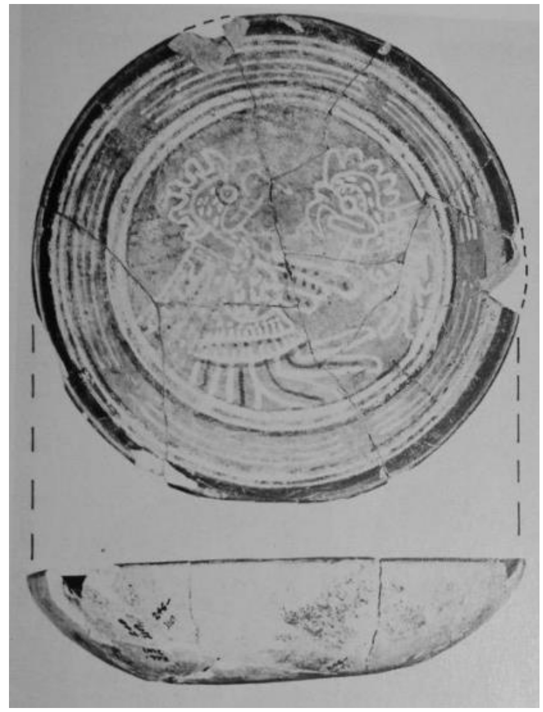

Figure 3: The bowl as it appears in Clement W. Meighan, ed, *The Archaeology of Amapa, Nayarit* (Los Angeles: The Institute of Archaeology University of California, Los Angeles, 1976), Plate 159a.

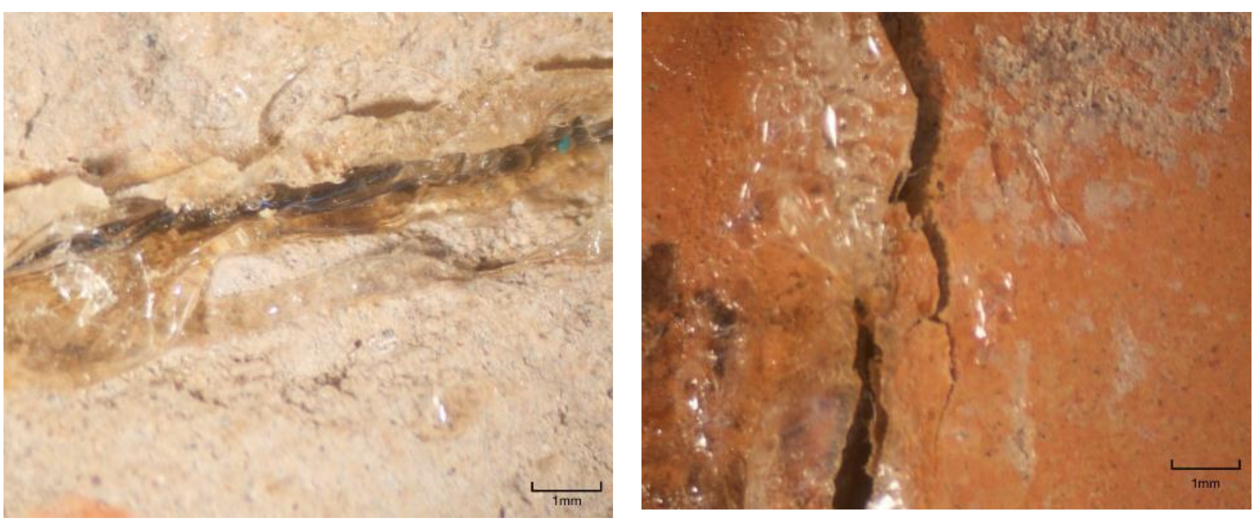

Figure 4: Photomicrographs showing that there is excess adhesive along the joins and that the adhesive is shrinking and pulling apart the ceramic fabric at the joins.

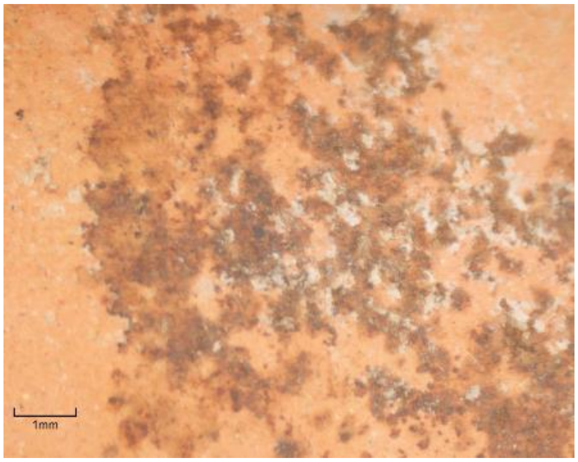

Figure 5: Photomicrograph showing staining and accretions on bottom of the bowl.

Figure 6: Photomicrograph showing soiling on due to dirt trapped within excess adhesive.

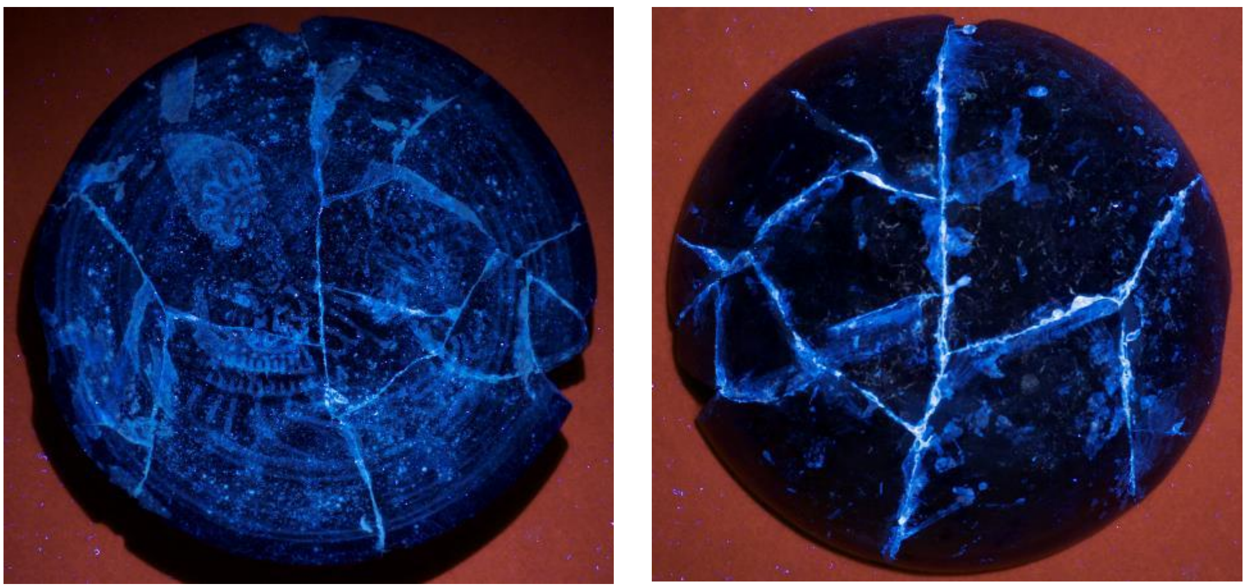

Figure 7: Ultraviolet-induced visible fluorescence of the bowl's interior (*left*) and exterior (*right*). UV-Induced (λ_{exc}max = 365 nm) / Vis Luminescence (λ 400 - 700 nm) before treatment. Captured with a modified Nikon D90 DSLR camera with a Peca 916 filter.

Figure 8: Photomicrograph showing a join with excess adhesive, dust/dirt, and white particulate.

Figure 9: The ceramic during treatment with all joins taken down and the surfaces cleaned. The two sherds sitting on plastic wrap are still undergoing treatment to remove adhesive that had migrated into the pores of the ceramic, darkening the sherd's color.

Figure 10: The bowl partially reconstructed. One sherd is immersed in acetone to extract adhesive that had migrated into the pores of the ceramic, darkening the sherd's color.

Figure 11: The interior (*top*) and exterior (*bottom*) of the vessel before treatment.

Figure 12: Exterior sides of vessel after treatment.

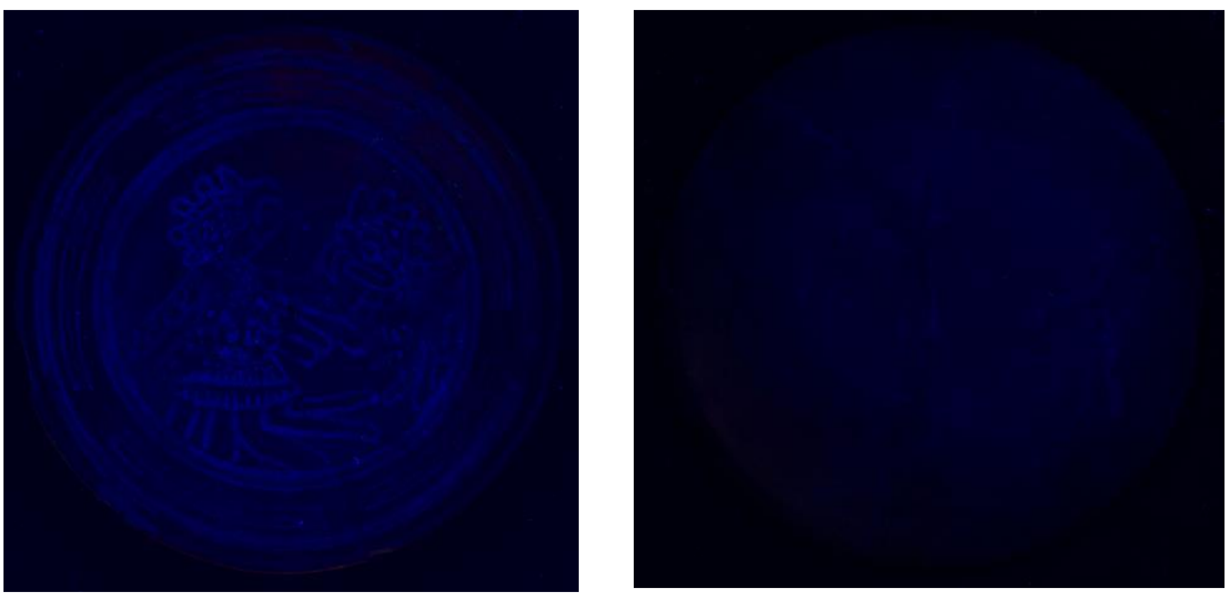

Figure 13: Ultraviolet-induced visible fluorescence of the bowl's interior (*left*) and exterior (*right*). UV-Induced (λ_{exc}max = 365 nm) / Vis Luminescence (λ 400 - 700 nm) after treatment. Captured with a modified Nikon D90 DSLR camera (f/8, 20.00 s, ISO 200) with a Peca 916 filter and an XNite BP1 filter.

Appendix 3

Treatment Report for Ceramic 246-1782

Object: Ixcuintla Polychrome Ceramic Bowl **Cultural Attribution:** Amapa, Nayarit, Mexico; Late Period, Ixcuintla Phase (c. 1000 – 1350 CE) **Identification Number:** Fowler Cat. No. 246-1782 **Medium:** Clay, Slip, Pigments **Current/Past Owners:** Fowler Museum at UCLA **Purpose of Examination:** Conservation Treatment **Date of Examination:** May 19, 2016 **Conservator:** Lindsay Ocal	 Fowler Museum Catalog Number 246-1782 (Before Treatment).

Object Description

Fowler Catalog Number 246-1782 (Figs. 1-2) is a circular vessel with a pedestal-type base and was excavated from the site of Amapa in Nayarit, Mexico (Fig. 3). The vessel has a red rim and an all-over orange burnished slip with red and white slips applied over the orange to form the decorated surfaces. The central design on the top shows the head of a skeletal being with darts and circular elements protruding from its head and face (Fig. 4). Circles and geometric patterns surround the central figure. The vessel's underside features three white circles, and the pedestal's exterior is covered with white geometric designs.

Materials and Techniques

There is no evidence for use of a potter's wheel at Amapa, so all ceramics were made by hand-building methods. These vessels were constructed using the coiling technique, and finishing techniques probably included scraping, burnishing, and paddle and anvil thinning.[1]

[1] Clement W. Meighan, ed. *The Archaeology of Amapa, Nayarit*, (Los Angeles: The Institute of Archaeology University of California, Los Angeles, 1976), 212.

Most ceramics from the site of Amapa were made from local clay, whose paste ranged from a reddish-brown to gray color. A second type of clay used on the site was a white to cream color and was relatively free of iron.[2] This second type of clay was used as slip on Late Period ceramics from Amapa, so the white decoration on the Ixcuintla polychrome bowl is probably not paint, but slip from this iron-free clay. The white decoration also appears raised, and in some places orange or red slip is visible underneath the white (Fig 5).

The ceramic core material is a uniform gray-tan color, indicating that the vessel was fired in an oxidizing environment. The temper material is of medium coarseness – neither very coarse nor fine. Sand was the main temper material used at the site of Amapa in the Early and Late Periods, with coarser material being used in the beginning and gradually becoming finer over time. Pumice was also frequently added to the temper, though this may have been a natural component of the sand at the site.[3]

Condition

Structural

The vessel is composed of several pottery sherds that were excavated from the site of Amapa in 1959 and reassembled on-site.[4] The reconstructed bowl is shown in Plate 449 (Fig. 5) in Meighan's 1976 publication of the finds from the site of Amapa.

Some of the smaller sherds along the rim had very little contact with the rest of the ceramic, and their joins failed, detaching during examination and handling (Fig. 6). The detached fragments were placed in a polyethylene bag until the entire vessel could be treated.

The adhesive used in the 1950 reconstruction is now becoming brittle and shrinking (Fig. 7). In some places, the shrinking adhesive is pulling apart the ceramic fabric where, previously, there had been secure joins. Furthermore, the adhesive must have a fairly low glass transition temperature, allowing it to become tacky in temperatures reached in the field or in storage conditions. This caused some joins to become misaligned and adhered dust and dirt to the object (Fig. 8).

Surface

The surfaces of the ceramic vessel are relatively clean and stable. There is light soiling and some accretions due to burial. There is also excess adhesive on some areas of the vessel's surfaces, especially along joins and break edges. This is especially evident when examining the object under ultraviolet light because the adhesive fluoresces (Fig. 9). In several places, there is dirt, dust, and sand stuck to the adhesive.

There is also significant loss of the white painted decoration on the vessel's interior. Much of the skull design has been lost, but there are remnants of white slip in these areas of loss. The white slip also fluoresces under ultraviolet light, so ultraviolet (λ_{exc}max = 365 nm) reflectance (λ 300 - 400 nm) photography shows the design more clearly (Fig. 10).

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[2] Ibid., 216.

[3] Ibid.

[4] Ibid.

Condition Summary

The vessel is currently unstable because the adhesive is slowly shrinking and pulling the ceramic fabric apart along some of the break edges. There are also some uneven joins, excess adhesive, and accretions on the surface are visually distracting.

Proposed Treatment

1. The object will be fully documented before, during, and after treatment, using digital photography.
2. Samples will be taken of the adhesive used during the original conservation treatment in order to determine what the adhesive is and how to remove it.
3. The bowl will be disassembled and all of the adhesive removed.
4. The fragments will be cleaned gently, where necessary.
5. If the pigments become unstable during the bowl's disassembly and cleaning, the paint will be consolidated.
6. The fragments of the vessel will be reassembled and adhered together using an archival adhesive.
7. The gaps will be filled and the fill material tinted to match the color of the ceramic.

Treatment

First, loose dust and soiling were removed with a soft brush. Harder accretions were broken up and removed with a wooden skewer or dental pick. Some rootlet encrustation over areas with white slip decoration were only reduced or left intact so that their removal would not damage the painted decoration.

Samples were taken from several accretions on the ceramic's surface and soiling within gaps. Because soluble salts can cause considerable damage in archaeological ceramics,[5] microchemical tests[6] were performed on these samples to test for the presence of various salts. All tests for soluble salts gave negative results (Table 1), so desalination was not required.

Samples of the adhesive were also taken from several areas of the bowl, both on the surface and within gaps and break edges. Microchemical tests and solubility tests were performed on the samples in order to determine what the adhesive was and how to remove it (Table 1). All adhesive samples tested positive for poly(vinyl alcohol) or one of its derivatives[7] and all dissolved readily in acetone.

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[5] Alice Boccia Paterakis, "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, July 1987, 6-10.

[6] Nancy Odegaard, Scott Carroll, and Werner S. Zimmt. *Material Characterization Tests for Objects of Art and Archaeology, Second Edition* (London: Archetype Publications, 2005).

[7] The test for poly(vinyl alcohol) using iodine/potassium iodide determines the presence of poly(vinyl alcohol) [PVA or PVOH] or one of its derivatives, such as poly(vinyl acetate) [PVAC or PVAc] or a poly(vinyl ketal).

Table 1: Results of Microchemical Tests.						
		Soluble Salts			Adhesive Type	
Photo of Ceramic	**Fowler Museum Cat. No.**	**Chlorides**	**Sulfates**	**Nitrates**	**PVOH**	**Cellulose Nitrate**
	246-1782	-	-	-	+	-

Since the adhesive samples were soluble in acetone, the excess adhesive on the ceramic's surfaces was removed by gently swabbing the surface with cotton swabs dampened with acetone. This worked well on the surface, leaving the decoration much cleaner and clearer. To soften the adhesive along the break edges, the joins were poulticed using cotton wetted with acetone, and the ceramic was covered with plastic wrap. After one hour, some of the joins had come down (Fig. 11). More cotton was added along those joins and all cotton was re-wetted with acetone. After 30 more minutes, all joins had failed.

Poulticing dissolved much of the adhesive and softened the rest so that it could be peeled and picked off of the break edges manually, using hand tools and tweezers. To ensure that all adhesive had been removed, the break edges were cleaned once more with cotton swabs dampened with acetone (Fig. 12).

After the sherds were cleaned and all of the previous adhesives had been removed, the break edges of each sherd were consolidated two times with Paraloid B-72®[8] (10%) in a 1:1 solution of acetone and ethanol. Then the sherds were adhered back together with Paraloid B-72® (40%) in acetone.

Major areas of loss were filled with Pollyfilla®.[9] Normally an off-white color, the plaster-based powder filler was mixed with dry pigments to tint the fills so that they would blend in with the rest of the ceramic. Upon drying, the color of the pigmented fills had lightened, so acrylic washes made with Liquitex® Acrylic Artist Color Paints and deionized water were painted over the fills so that they would blend in with the original ceramic material.

[8] Paraloid B-72® is a registered trademark of Rohm & Haas for a clear, colorless, thermoplastic acrylic resin. Paraloid B-72 (formerly called Acryloid B-72 in the United States) is composed of an ethyl methacrylate (70%) and methyl acrylate (30%) copolymer. It has a Tg of 40° Celsius.

[9] Pollyfilla® is a cellulose reinforced plaster-based filler that does not shrink upon drying.

Supplies

Paraloid B-72®

Talas
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Brooklyn, NY 11211
Phone: (212) 219-0770
http://www.talasonline.com/

Polyfilla®

Conservation Support Systems
P.O. Box 91746
Santa Barbara, CA 93190-1746
1 (800) 482-6299
info@conservationsupportsystems.com

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247 West 29th Street
New York, NY 10001
Phone (212) 219-2394 or 1-(800)-995-5501
Fax (212) 219-2395
Email: info@kremerpigments.com
http://shop.kremerpigments.com/en/

Liquitex® Acrylic paint

Liquitex Artist Materials
P.O. Box 246,
Piscataway, NJ 08855
1-888- 4-ACRYLIC
www.liquitex.com

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O'Grady, Caitlin R. "Morphological and Chemical Analyses of Manganese Dioxide Accretions on Mexican Ceramics." In *Materials Issues in Art and Archaeology VII*. Pamela B Vandiver, Jennifer L. Mass and Alison Murray, eds. (Warrendale, Pennsylvania: Materials Research Society, 2004): 183-192.

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, July 1987, 6-10.

Figures

Figure 1: Interior (*top*) and Exterior (*bottom*) of Fowler Catalog Number 246-1782 Before Treatment.

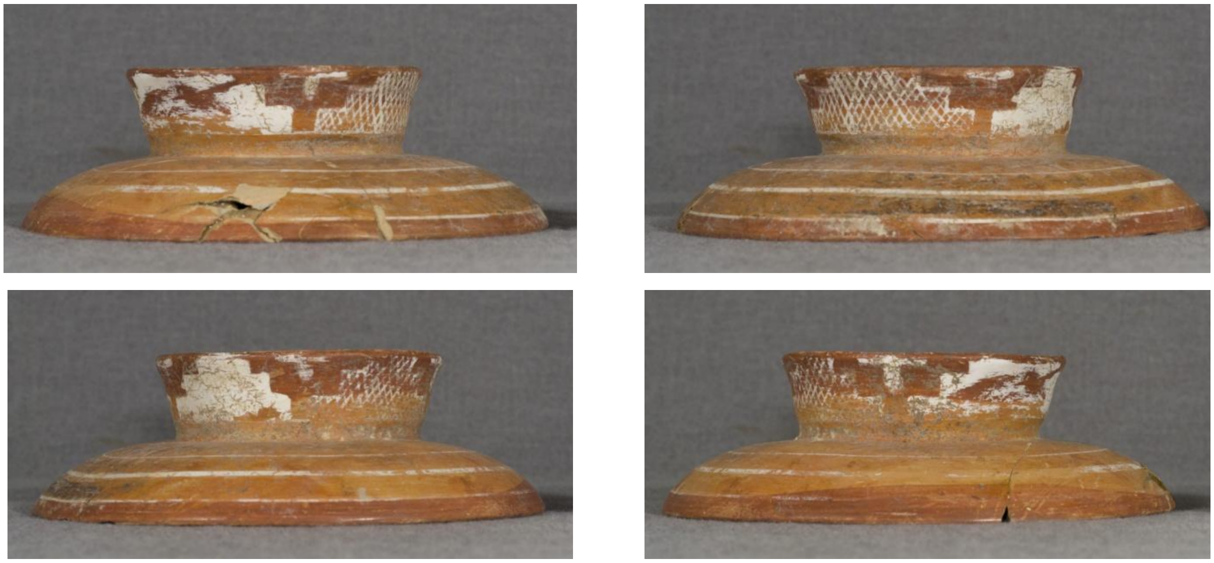

Figure 2: Exterior side views of Fowler Catalog Number 246-1782 Before Treatment.

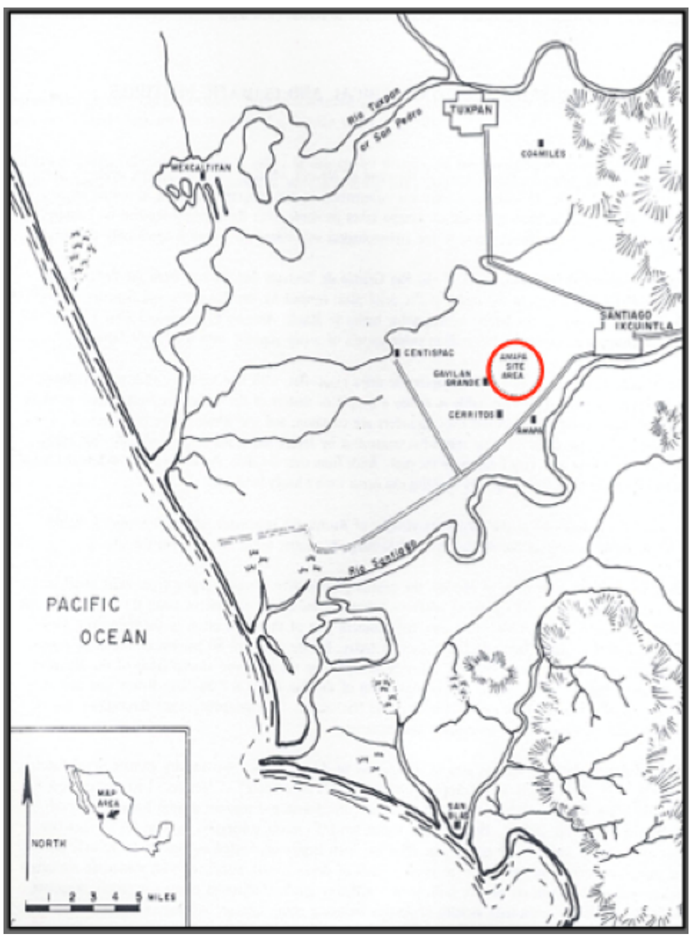

Figure 3: Map of Western Mexico with the site of Amapa circled in red. Map courtesy of Clement W. Meighan, ed, *The Archaeology of Amapa, Nayarit.*

Figure 4: Line Drawing of the Skeletal Being Depicted on Fowler Catalog Number 246-1782.
Drawing by Michael Mathiowetz after Bell 1960: fig. 51. Courtesy of Michael Mathiowetz, Polly Schaafsma, Jeremy Coltman, and Karl Taube, "The Darts of Dawn: The Tlahuizcalpantecuhtli Venus Complex in the Iconography of Mesoamerica and the American Southwest."

Figure 5: Detail of white slip painted decoration under diffuse (*top*) and raking (*bottom*) light.

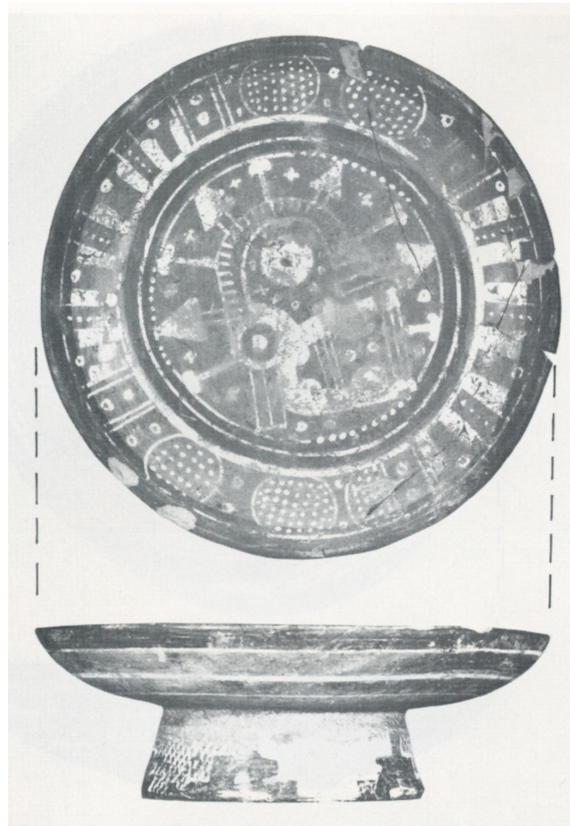
Figure 6: The bowl as it appears in Clement W. Meighan, ed, *The Archaeology of Amapa*, Plate 449.


Figure 7: X-rays of the ceramic vessel.
(Left) Settings: 50 kV, 8.15 mA, 120 sec. Shot from above.
(Right) **Settings:** 45 kV, 7.70 mA, 90 sec. Shot at an angle to better capture pedestal base.

Figure 8: Three very small fragments detached from along the rim and were placed in a polyethylene bag for storage until the ceramic could be treated.

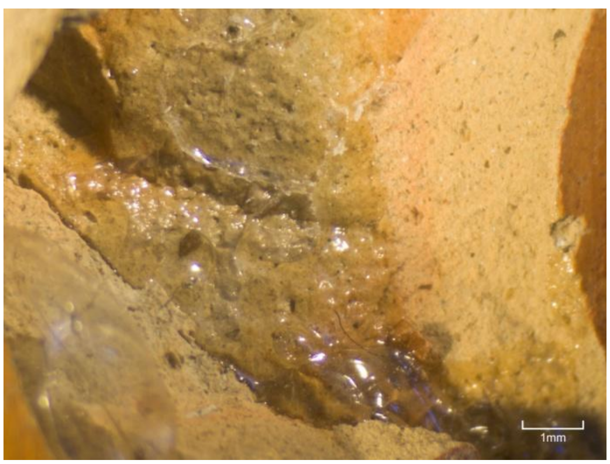

Figure 9: The adhesive has become brittle and joins are failing.

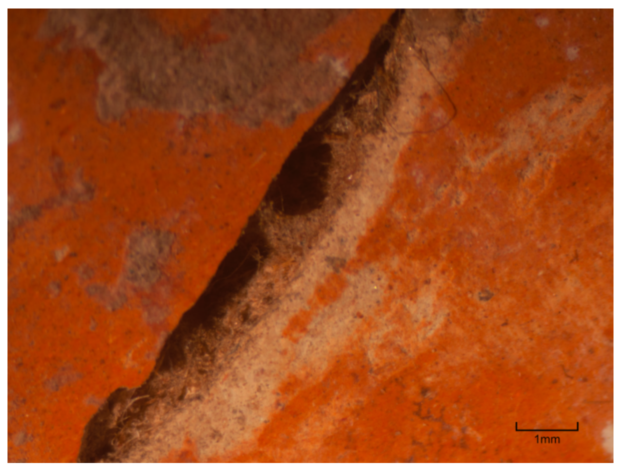

Figure 10: A void along a break edge that has dust accumulated and adhered to the degraded adhesive.

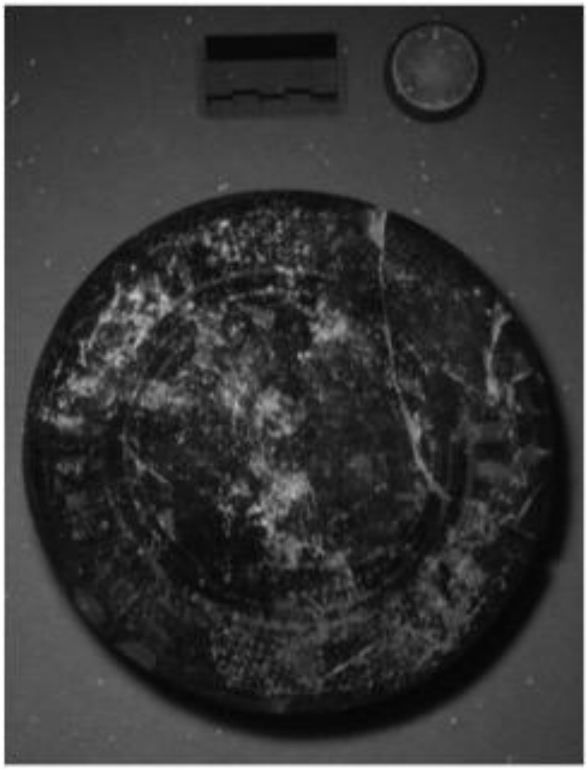

Figure 11: Ultraviolet (UV)-induced (λ_{exc}max = 365 nm) visible fluorescence (λ 400 - 700 nm) of the bowl's interior before treatment. Captured with a modified Nikon D90 DSLR camera with a Peca 916 filter.

Figure 12: Ultraviolet (λ_{exc}max = 365 nm) Reflectance (λ 300 - 400 nm) of the bowl's decoration before treatment. Captured with a modified Nikon D90 DSLR camera with a Peca 900 filter.

Figure 13: Poultices of cotton and acetone were applied over joins to soften the adhesive.

Figure 14: All joins were taken down and cleaned.

Figure 15: Fowler Catalog Number 246-1782 After Treatment.

Appendix 4

Treatment Report for Ceramic 246-1937

Object: Botadero Black on Buff Ceramic Bowl

Cultural Attribution: Amapa, Nayarit, Mexico; Late Period, possibly Cerritos Phase (c. 900 – 1100 CE)

Identification Number:
Fowler Cat. No. 246-1937

Medium: Clay, Slip, Pigments

Current/Past Owners:
Fowler Museum at UCLA

Purpose of Examination:
Future Conservation Treatment

Date of Examination: May 19, 2016

Conservator: Lindsay Ocal

Fowler Museum Catalog Number 246-1937 (Before Treatment).

Object Description

Fowler Catalog Number 246-1937 (Fig. 1) is a shallow bowl. It is buff-colored with dark brown decoration. The interior portrays a feathered serpent that is in a coiled position. The central figure has three thin circles around it and a thicker band of dark brown around the entire rim of the vessel.

Materials and Techniques

There is no evidence for use of a potter's wheel at Amapa, so all ceramics were made by hand-building methods. These vessels were constructed using the coiling technique, and finishing techniques probably included scraping, burnishing, and paddle and anvil thinning.[1]

Most ceramics from the site of Amapa were made from a local clay whose paste ranged from a reddish-brown to gray color. A second type of clay used on the site was a white to cream

[1] Clement W. Meighan, ed. *The Archaeology of Amapa, Nayarit*, (Los Angeles: The Institute of Archaeology University of California, Los Angeles, 1976), 212.

color and was relatively free of iron.[2] This second type of clay was used as slip on Late Period ceramics from Amapa.

The ceramic core material is a uniform gray-tan color, indicating that the vessel was fired in an oxidizing environment. The temper material is of medium coarseness – neither very coarse nor fine. Sand was the main temper material used at the site of Amapa in the Early and Late Periods, with coarser material being used in the beginning and gradually becoming finer over time. Pumice was also frequently added to the temper, though this may have been a natural component of the sand at the site.[3]

Condition

Structural

The bowl is composed of several sherds that were excavated from the site of Amapa in 1959 and reassembled on-site.[4] Due to the fragmentary nature, the bowl has several cracks and some areas of loss (Figs. 1-2). There is one significant area of loss along the rim that detracts from the decoration.

The adhesive used in the reconstruction is now becoming brittle and shrinking. In some places, the shrinking adhesive is pulling apart the ceramic fabric where, previously, there had been secure joins. Furthermore, the adhesive must have a fairly low glass transition temperature, allowing it to become tacky in temperatures reached in the field or in storage conditions. This caused some joins to become misaligned and adhered dust and dirt to the objects.

Surface

The surface of the ceramic vessel is relatively clean and stable. There is light soiling and some accretions, including rootlet encrustations, due to burial. There is also excess adhesive on some areas of the vessels' surfaces, especially along joins and break edges. This is especially evident when examining the object under ultraviolet light because the adhesive fluoresces (Fig. 3). In several places, there is dirt, dust, and sand stuck to the adhesive.

Condition Summary

The vessel is in fairly stable condition, although some uneven joins, excess adhesive, and accretions on the surface are visually distracting. The adhesive, while firmly holding the fragments together thus far, is also slowly shrinking and pulling the ceramic fabric apart along some of the break edges.

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[2] Meighan, 216.

[3] Ibid.

[4] Ibid.

Proposed Treatment

1. Samples will be taken of the adhesive used during the original conservation treatment in order to determine what the adhesive is and how to remove it.
2. The bowl will be disassembled and all of the adhesive removed.
3. The fragments will be cleaned gently, where necessary.
4. If the pigments become unstable during the bowl's disassembly and cleaning, the paint will be consolidated.
5. The fragments of the bowl will be reassembled and adhered together using an archival adhesive.
6. The gaps will be filled and the fill material tinted to match the color of the bowl.

Treatment

First, loose dust and soiling were removed with a soft brush. Harder accretions were broken up and removed with a wooden skewer or dental pick. Some rootlet encrustations over areas with white slip decoration were only reduced or left intact so that their removal would not damage the painted decoration.

Samples were taken from several accretions on the ceramic's surface and soiling within gaps. Because soluble salts can cause considerable damage in archaeological ceramics,[5] microchemical tests[6] were performed on these samples to test for the presence of various salts. All tests for soluble salts gave negative results (Table 1), so desalination was not required.

Samples of the adhesive were also taken from several areas of the bowl, both on the surface and within gaps and break edges. Microchemical tests and solubility tests were performed on the samples in order to determine what the adhesive was and how to remove it (Table 1). All adhesive samples tested positive for poly(vinyl alcohol) or one of its derivatives[7] and all dissolved readily in acetone.

Since the adhesive samples were soluble in acetone, the excess adhesive on the ceramic's surfaces was removed by gently swabbing the surface with cotton swabs dampened with acetone. This worked well on the surface, leaving the decoration much cleaner and clearer. To soften the adhesive along the break edges, the joins were poulticed using cotton wetted with acetone, and the ceramic was covered with plastic wrap (Fig. 4). After one hour, most of the joins had come down. More cotton was added along those joins and all cotton was re-wetted with acetone. After 30 more minutes, all joins had failed.

Poulticing dissolved much of the adhesive and softened the rest so that it could be peeled and picked off of the break edges manually, using hand tools and tweezers (Fig. 5). To ensure that all adhesive had been removed, the break edges were cleaned once more with cotton swabs dampened with acetone.

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[5] Alice Boccia Paterakis, "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, July 1987, 6-10.

[6] Nancy Odegaard, Scott Carroll, and Werner S. Zimmt. *Material Characterization Tests for Objects of Art and Archaeology, Second Edition* (London: Archetype Publications, 2005).

[7] The test for poly(vinyl alcohol) using iodine/potassium iodide determines the presence of poly(vinyl alcohol) [PVA or PVOH] or one of its derivatives, such as poly(vinyl acetate) [PVAC or PVAc] or a poly(vinyl ketal).

After the sherds were cleaned and all of the previous adhesives had been removed, the break edges of each sherd were consolidated two times with Paraloid B-72®[8] (10%) in a 1:1 solution of acetone and ethanol. Then the sherds were adhered back together with Paraloid B-72® (40%) in acetone.

Major areas of loss were filled with Pollyfilla®.[9] Normally an off-white color, the plaster-based powder filler was mixed with dry pigments to tint the fills so that they would blend in with the rest of the ceramic. Upon drying, the color of the pigmented fills had lightened, so acrylic washes made with Liquitex® Acrylic Artist Color Paints and deionized water were painted over the fills so that they would blend in with the original ceramic material (Fig. 6).

Table 1: Results of Microchemical Tests.

Photo of Ceramic	**Fowler Museum Cat. No.**	**Soluble Salts**			**Adhesive Type**	
		Chlorides	**Sulfates**	**Nitrates**	**PVOH**	**Cellulose Nitrate**
	246-1937	-	-	-	+	-

<u>**Supplies**</u>

Mineral Pigments

Kremer Pigments
247 West 29th Street
New York, NY 10001
Phone (212) 219-2394 or 1-(800)-995-5501
Fax (212) 219-2395
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Paraloid B-72®

Talas
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Brooklyn, NY 11211
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http://www.talasonline.com/

Liquitex® Acrylic paint

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Piscataway, NJ 08855
1-888- 4-ACRYLIC
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Polyfilla®

Conservation Support Systems
P.O. Box 91746
Santa Barbara, CA 93190-1746
1 (800) 482-6299
info@conservationsupportsystems.com

[8] Paraloid B-72® is a registered trademark of Rohm & Haas for a clear, colorless, thermoplastic acrylic resin. Paraloid B-72 (formerly called Acryloid B-72 in the United States) is composed of an ethyl methacrylate (70%) and methyl acrylate (30%) copolymer. It has a Tg of 40° Celsius.

[9] Pollyfilla® is a cellulose reinforced plaster-based filler that does not shrink upon drying.

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________. “The Use of Paraloid B-72 as an Adhesive: its Application for Archaeological Ceramics and Other Materials.” *Studies in Conservation* 31 (1986): 7-14.

Mathiowetz, Michael, Polly Schaafsma, Jeremy Coltman, and Karl Taube. “The Darts of Dawn: The Tlahuizcalpantecuhtli Venus Complex in the Iconography of Mesoamerica and the American Southwest.” *Journal of the Southwest,* 57, No. 1, Spring 2015, 1-102.

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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, July 1987, 6-10.

Figures

Figure 1: Interior (*top*) and Exterior (*bottom*) of Fowler Catalog Number 246-1937 Before Treatment.

Figure 2: A small area of loss and excess adhesive along joins.

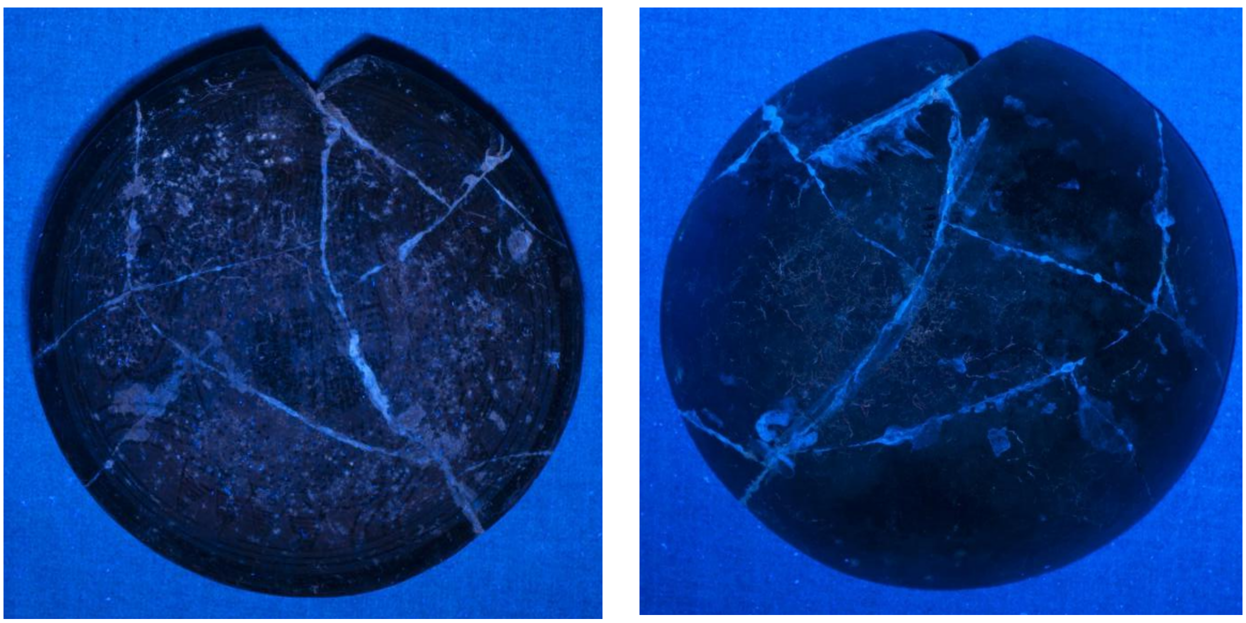

Figure 3: Ultraviolet (UV)-induced (λ_{exc}max = 365 nm) visible fluorescence (λ 400 - 700 nm) of the bowl's interior (*left*) and exterior (*right*) before treatment. Captured with a modified Nikon D90 DSLR camera with a Peca 916 filter.

Figure 4: Poultices were used to soften the adhesive along the break edges.

Figure 5: Once softened, the adhesive could be picked and peeled off of the break edges.

Figure 6: Fowler Catalog Number 246-1937 After Treatment.

Appendix 5

Treatment Report for Ceramic 246-3270

Object: Tuxpan Engraved Ceramic Bowl

Cultural Attribution: Amapa, Nayarit, Mexico; Late Period, possibly Cerritos or Ixcuintla Phase (c. 600 – 1350 CE).

Identification Numbers: Fowler Cat. No. 246-3270

Medium: Clay

Dimensions:
Diameter: 22.3 cm (8.9 in.)
Depth: 6.0 cm (2.4 in.)

Current/Past Owners: Fowler Museum at UCLA

Purpose of Examination: Conservation Treatment

Date of Examination: May 19, 2016

Conservator: Lindsay Ocal

Fowler Museum Catalog Number 246-3270 (Before Treatment).

Object Description

Fowler Catalog Number 246-3270 (Figs. 1-2) is a simple bowl that was probably utilitarian in nature. The interior is undecorated. The exterior has a band of engraved spiral designs along the outer rim, but no other decoration. The surface coloration is varied and smoke blackening covers much of the bottom.

Materials and Techniques

There is no evidence for use of a potter's wheel at Amapa, so all ceramics were made by hand-building methods. These vessels were constructed using the coiling technique, and finishing techniques probably included scraping, burnishing, and paddle and anvil thinning.[1] Most ceramics from the site of Amapa were made from a local clay whose paste ranged from a

[1] Clement W. Meighan, ed. *The Archaeology of Amapa, Nayarit*, (Los Angeles: The Institute of Archaeology University of California, Los Angeles, 1976), 212.

reddish-brown to gray color.[2] The ceramic core material is a uniform gray-tan color, indicating that the vessel was fired in an oxidizing environment. The temper material is of medium coarseness – neither very coarse nor fine. Sand was the main temper material used at the site of Amapa in the Early and Late Periods, with coarser material being used in the beginning and gradually becoming finer over time. Pumice was also frequently added to the temper, though this may have been a natural component of the sand at the site.[3]

Condition

Structural

The bowl is composed of several sherds that were excavated from the site of Amapa in 1959 and reassembled on-site.[4] This adhesive is now becoming brittle and shrinking. In some places, the shrinking adhesive is pulling apart the ceramic fabric where, previously, there had been secure joins (Fig. 3). Furthermore, the adhesive must have a fairly low glass transition temperature, allowing it to become tacky in temperatures reached in the field or in storage conditions. This caused some joins to become misaligned and adhered dust and dirt to the objects. Also, due to the fragmentary nature of the ceramic, there are some small areas of loss.

Surface

The surfaces of this ceramic vessel is relatively clean and stable. There is light soiling and some accretions due to burial. There is also excess adhesive on some areas of the vessels' surfaces, especially along joins and break edges. This is especially evident when examining the object under ultraviolet light because the adhesive fluoresces (Fig. 4). In several places, there is dirt, dust, and sand stuck to the adhesive.

Condition Summary

The vessel is in fairly stable condition, although some uneven joins, excess adhesive, and accretions on the surface are visually distracting. The adhesive, while firmly holding the fragments together thus far, is also slowly shrinking and pulling the ceramic fabric apart along some of the break edges.

Proposed Treatment

1. Samples will be taken of the adhesive used during the original conservation treatment in order to determine what the adhesive is and how to remove it.
2. The bowl will be disassembled and all of the adhesive removed.
3. The fragments will be cleaned gently, where necessary.

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[2] Ibid., 216.

[3] Ibid.

[4] Ibid.

4. The fragments of the bowl will be reassembled and adhered together using an archival adhesive.
5. The gaps will be filled and the fill material tinted to match the color of the bowl.

Treatment

First, loose dust and soiling were removed with a soft brush. Harder accretions were broken up and removed with a wooden skewer or dental pick. Samples were taken from several accretions on the ceramic's surface and soiling within gaps. Because soluble salts can cause considerable damage in archaeological ceramics,[5] microchemical tests[6] were performed on these samples to test for the presence of various salts. All tests for soluble salts gave negative results (Table 1), so desalination was not required.

Samples of the adhesive were also taken from several areas of the bowl, both on the surface and within gaps and break edges. Microchemical tests and solubility tests were performed on the samples in order to determine what the adhesive was and how to remove it (Table 1). All adhesive samples tested positive for poly(vinyl alcohol) or one of its derivatives[7] and all dissolved readily in acetone.

Since the adhesive samples were soluble in acetone, the excess adhesive on the ceramic's surfaces was removed by gently swabbing the surface with cotton swabs dampened with acetone. This worked well on the surface, leaving the decoration much cleaner and clearer. To soften the adhesive along the break edges, the joins were poulticed using cotton wetted with acetone, and the ceramic was covered with plastic wrap. After one hour, most of the joins had come down. More cotton was added along those joins and all cotton was re-wetted with acetone. After 30 more minutes, all joins had failed (Fig. 5).

Poulticing dissolved much of the adhesive and softened the rest so that it could be peeled and picked off of the break edges manually, using hand tools and tweezers (Fig. 6). To ensure that all adhesive had been removed, the break edges were cleaned once more with cotton swabs dampened with acetone.

After the sherds were cleaned and all of the previous adhesives had been removed, the break edges of each sherd were consolidated two times with Paraloid B-72®[8] (10%) in a 1:1 solution of acetone and ethanol. Then the sherds were adhered back together with Paraloid B-72® (40%) in acetone.

Some small areas of loss were filled with Pollyfilla®.[9] Normally an off-white color, the plaster-based powder filler was mixed with dry pigments to tint the fills so that they would blend

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[5] Alice Boccia Paterakis, "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, July 1987, 6-10.

[6] Nancy Odegaard, Scott Carroll, and Werner S. Zimmt. *Material Characterization Tests for Objects of Art and Archaeology, Second Edition* (London: Archetype Publications, 2005).

[7] The test for poly(vinyl alcohol) using iodine/potassium iodide determines the presence of poly(vinyl alcohol) [PVA or PVOH] or one of its derivatives, such as poly(vinyl acetate) [PVAC or PVAc] or a poly(vinyl ketal).

[8] Paraloid B-72® is a registered trademark of Rohm & Haas for a clear, colorless, thermoplastic acrylic resin. Paraloid B-72 (formerly called Acryloid B-72 in the United States) is composed of an ethyl methacrylate (70%) and methyl acrylate (30%) copolymer. It has a Tg of 40° Celsius.

[9] Pollyfilla® is a cellulose reinforced plaster-based filler that does not shrink upon drying.

in with the rest of the ceramic. Upon drying, the color of the pigmented fills had lightened, so acrylic washes made with Liquitex® Acrylic Artist Color Paints and deionized water were painted over the fills so that they would blend in with the original ceramic material (Fig. 7).

Table 1: Results of Microchemical Tests.

		Soluble Salts			Adhesive Type	
Photo of Ceramic	**Fowler Museum Cat. No.**	**Chlorides**	**Sulfates**	**Nitrates**	**PVOH**	**Cellulose Nitrate**
	246-3270	-	-	-	+	-

Supplies

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P.O. Box 246,
Piscataway, NJ 08855
1-888- 4-ACRYLIC
www.liquitex.com

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Figures

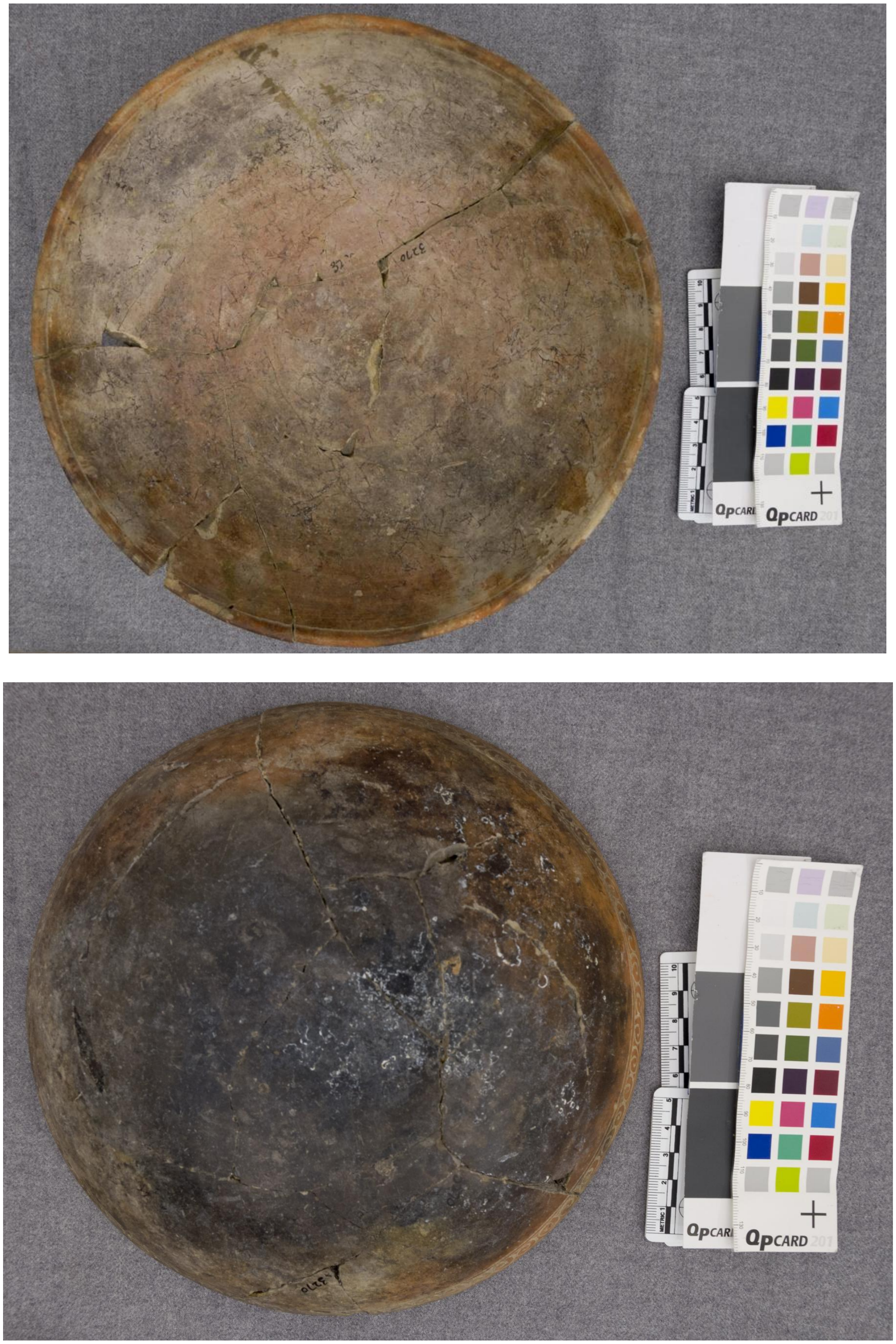

Figure 1: Interior (*top*) and Exterior (*bottom*) of Fowler Catalog Number 246-1937 Before Treatment.

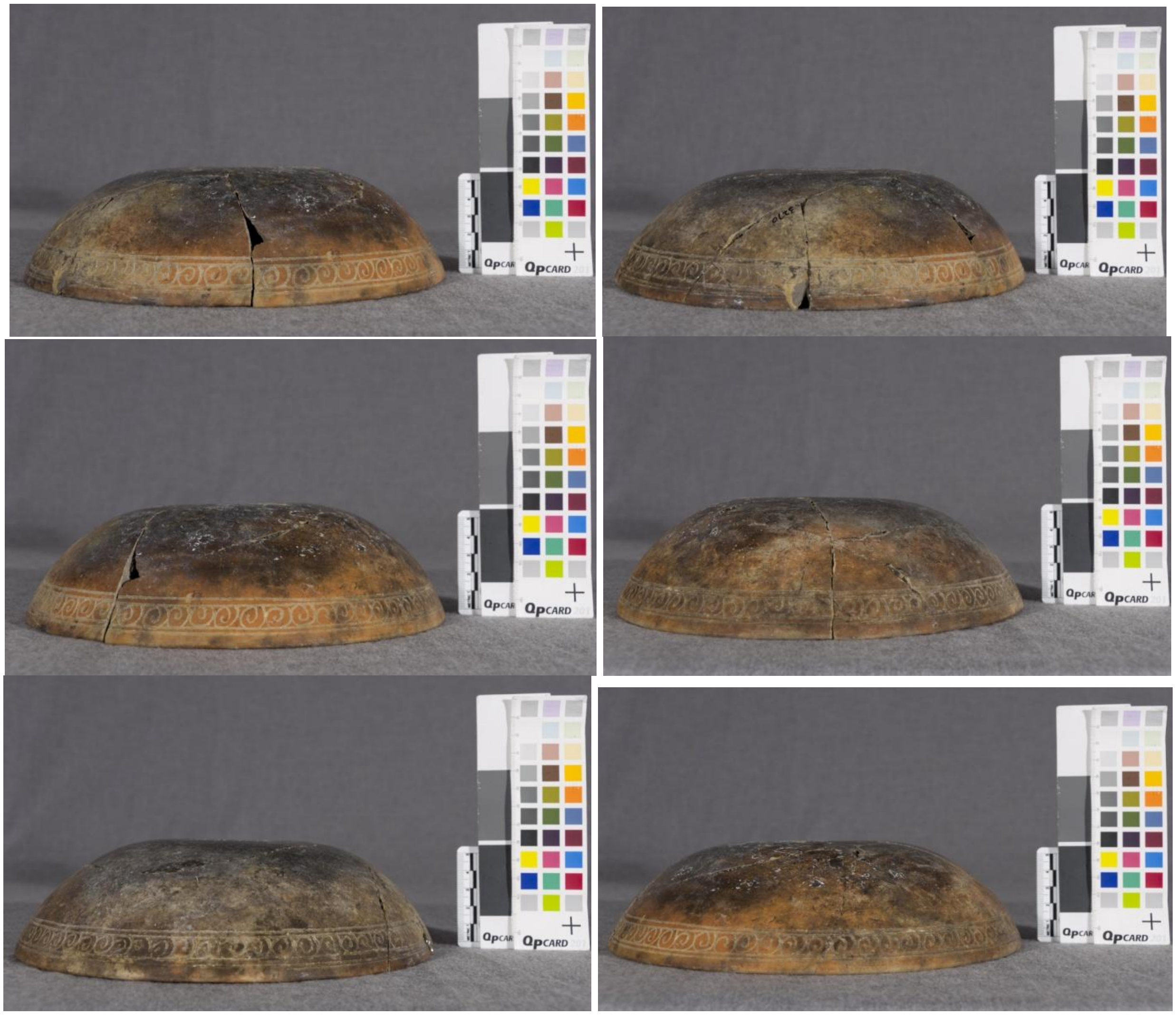

Figure 2: Exterior side views of Fowler Catalog Number 246-1937 Before Treatment.

Figure 3: Delamination of ceramic material in a crack.

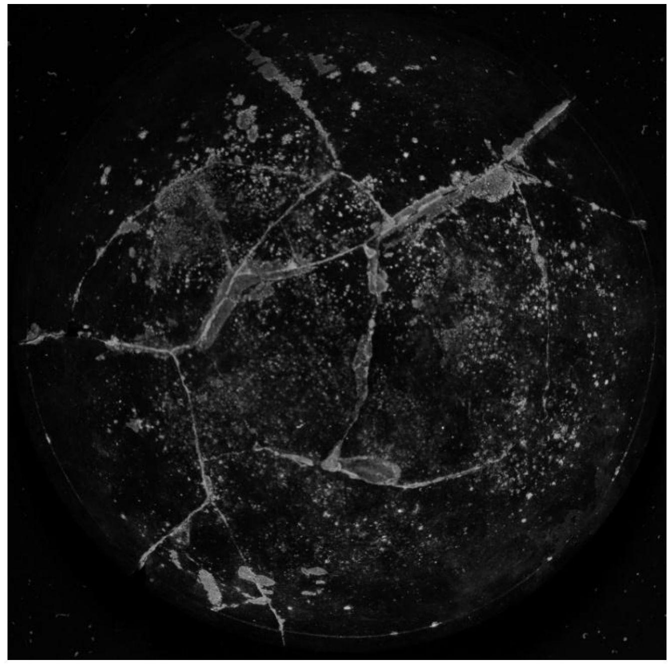

Figure 4: Top of the Bowl, UV-Induced (λ_{exc}max = 365 nm) Visible Fluorescence (λ 400 - 700 nm). Captured with a Nikon D90 (modified) camera with a Peca 916 filter and X-Nite BP1 filter. Image converted to black and white.

Figure 5: Poulticing softened the adhesive, allowing the joins to be dismantled.

Figure 6: Once softened, the adhesive could be picked and peeled off of the break edges.

Figure 7: Fowler Catalog Number 246-1937 After Treatment.

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