Evaluation of Conservation and Preservation Practices in a Southwest Pottery Collection

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Evaluation of Conservation and Preservation Practices in a Southwest Pottery Collection

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Executive Summary:

A variety of materials and methods have been used to preserve ceramic vessels. Many have proven successful, while others are damaging. Monitoring and evaluation of past treatments is a documented research priority in the conservation field. The Arizona State Museum (ASM) has examined, recorded and analyzed the performance of past treatments on the museum's collection. Previous grant funds enabled a condition assessment of 20,000 southwest vessels and a modern storage facility. NCPTT funds were used to monitor and evaluate previous preservation treatments. This research has afforded the opportunity to look forwards and backwards to identify patterns in archaeological methods, museum management and conservation.

The collection of whole ceramic vessels at the Arizona State Museum (ASM) spans nearly 2000 years and encompasses all the major cultures and historical periods of the Southwestern United States. The survey including the examination of adhesives was undertaken and has resulted in valuable information about the conservation and repair history of the vessels. By using visible examination, chemical spot testing, UV auto fluorescence, and Fourier Transform Infrared Spectroscopy (FTIR) distinctive patterns of adhesive use have revealed how cultural groups, archaeologists, and conservators have used adhesives and repair techniques over time. Assessing the results will allow conservators to develop treatment strategies and prioritize conservation resources according to the needs of the collection. The opportunity to reconstruct early repair practices provides the museum conservators and curators with a valuable tool to evaluate, protect, and study this important collection.

Introduction

The Preservation Division at the Arizona State Museum (ASM), Tucson Arizona has undertaken a multifaceted project to upgrade the environmental storage conditions, treat, and relocate the Southwestern whole vessel collection. This project, initiated in 1999, is near completion and will see the entire collection surveyed, treated as necessary and moved into a new purpose-built storage area. The collection includes 20,000 vessels obtained through systematic archaeological excavation, ethnological study, donation and purchase.

Pottery vessel making in the Southwest is an ongoing tradition that spans about 2000 years (Haury, p.29). This pottery is known for its almost endless variations of texture, color, form and styles of decoration. Cultures throughout the American Southwest use a range of local clay materials to create brown, red, white, and yellow wares. Ground stone and clays provide mineral based colors and boiled plants provide the base for carbon black paints. Coils, paddles, carving tools, and polishing stones enable considerable diversity in both construction and finish. The designs seen in this collection seem to reinterpret traditional forms, create new styles, and even revive old ones.

An important aspect of the conservation survey has been the systematic identification of adhesives and residues found on the ceramics that are used to mend cracks, reconstruct broken parts, fill losses and seal damaged areas. The results from this effort provide valuable insight into the history of the collection and a useful planning tool for preservation and collections staff. In addition to assisting with a physical inventory, documentation confirmation, treatment scheduling and storage upgrades, the survey information has also enabled the identification of research projects (Schackle 2006, 2007), history of adhesive repairs (White et al. 2008 a, b, c,) (White et al. 2009), fund raising (Save-A-Pot program), tribal consultations (Moreno et al.) and the development of a new conservation tool (Frame, Sigelman, White 2006).

The identification of adhesives and residues on cultural objects allows us to understand indigenous approaches to repair and their ingenious use of local materials, as well as the development of a profile for repairs and treatments based on the materials used in the repair. A related literature survey provides known dates of the adhesive's introduction. Over 6,500 vessels with adhesive repairs were noted, with 98% of this number being modern and historic repairs. Approximately 3% of the vessels from the Southwest pottery collection retain original adhesives and repair residues from their period of use. By identifying the repair materials, we can establish a profile of the collection's treatment history that includes both native and museum repairs. We have also developed a scientific methodology for the evaluation of preservation technologies and their aging properties. The resulting history will provide a valuable tool for conservators and researchers, as well as facilitate the protection and use of the collection.

Methods and Materials

Repair materials using in the ASM collections range from modern museum conservation adhesives to original, native repairs in both archaeological and contemporary vessels. A significant number of the vessels in the Southwest pottery collection retain original adhesives from their period of use. Other vessels have subsequently been repaired during archaeological excavation or while at the museum. Our analysis of these materials includes UV and IR reflected light examination, chemical spot testing, FTIR spectroscopy, and other techniques that are recorded into a Microsoft Access® database.

The museum's catalog provides incomplete documentation about previous repairs or treatments for this collection that began over 100 years ago. Another conservation project that complements the condition survey is a comprehensive review of the conservation literature from 1900 to about

2005 that covers adhesives used to repair ceramics, glass, and stone. The review identifies over 20 different types of materials and over 400 variations based on chemical composition and physical form, carrier, and method of application. Our data allows us to determine patterns for the use of many types of adhesives on pottery and make comparisons to our collection.

Adhesive identification is part of the overall collection condition survey that assesses condition and sets priorities for treatments (White et al. 2008 abcd). Substances noted as possible adhesives or coatings are identified by conservators using a variety of techniques. The methods generally used include visual identification with UV autofluorescence, chemical spot testing, and Fourier Transform Infrared Spectroscopy (FTIR). The combination and targeted use of these techniques have allowed conservators to quickly and systematically document the adhesive history of the collection. The careful use of these techniques has resulted in a data set that reflects the material history of the collection repairs. The cost of performing these analyses in materials, sampling and analysis time is manageable for a large survey. Criteria for the development of our protocols included consideration of the large number of vessels in the collection, the need to minimize analysis time while generating reliable data, and the costs associated with collecting the data.

Adhesive Identification Techniques:

Visual examination and catalog documentation: Evidence of vessel repair can usually be verified by an experienced conservator's eye. Mended joins, shiny film, and discoloration provide clues to the condition and type of adhesives present. Excavation field notes, accession records, or catalog cards sometimes identify when and what was used to do a repair.

UV auto fluorescence: Some identification is performed using a portable long-wave, UVA source (Blak-Ray B-100A Long-wave UV; 100 W mercury lamp source) and comparing auto fluorescence colors to known ASM reference materials. This technique is particularly effective for large assemblages of uniform vessel types. It is also useful for detecting multiple repair re-treatments or unusual materials that are only evident when the multiple adhesives autofluoresce different colors. For example, Pine resin, creosote lac and bitumen are easily distinguished from most modern adhesives such as cellulose nitrate, polyvinyl acetate or acrylic resin. Pine resin exhibits a distinctive yellow-green fluorescence while bitumen and creosote lac both display an orange fluorescence. The fluorescence colours of creosote lac and bitumen are not sufficiently different to allow confident differentiation.

Chemical spot testing: Many adhesive repairs can be easily tested with standard chemical spot tests reagents and procedures (2005 Odegaard et al.). The tests for cellulose nitrate, rosin, and protein are the most common, and provide a relatively quick analysis of adhesive samples. A basic protocol for this pottery project has been developed to facilitate identifications. One common example is the use of the diphenylamine-based spot test to detect adhesives known as cellulose nitrate, celluloid, or nitrocellulose. Cotton swabs dampened with acetone solvent are a fast and non-damaging way to remove a very small amount of adhesive during the survey. Swab tips can be kept for later testing in batches under conservation lab conditions. Adhesive samples that produce a negative reaction are then moved along for alternative testing procedures. Likewise, adhesives that have proved insoluble or resistant to acetone are identified by alternative testing methods.

A variety of chemical spot tests were used to identify adhesives commonly associated with Southwestern cultures and early restoration materials. These adhesives include: Pine resin – tested for rosin using sulphuric acid (Raspail test) provided nearly 30% of the pine resin identifications. Protein – tested using the calcium oxide and pyrolysis test and the copper(II) sulphate (Biuret test). Also, other tests such as the test for poly (vinyl alcohol) using iodine/ potassium iodide or the test for complex carbohydrates using o-toluidine were used.

Fourier Transform Infrared Spectroscopy (FTIR): Adhesives that cannot be identified using the above methods were tested by FTIR. The ASM lab has a Thermo Nicolet Avatar 360, microscope, and an attenuated total reflectance (ATR) with a diamond cell. Scanning is performed in the mid-IR region between 400 and 4000 cm^{-1} at a resolution of 4 cm. On average, 5-7 minutes is required to completely characterize each sample using the FTIR. Commercial libraries, the Infrared and Raman Users Group (IRUG) Spectral Database (2000), and our own compiled library are used for comparative references. This instrument has been used primarily as a tool to confirm unusual or unexpected adhesives. The limitations of FTIR include difficulty in resolving complex mixtures and non-specific results for some classes of compounds. Charred samples have proved difficult to characterise using IR spectroscopy due to their altered composition (Regert 2007) and are categorised as 'unidentified'.

The FTIR has proved a useful analytical technique for this project. It is a reliable tool for identifying most of the materials in the pottery collection. The amount of time required for analysis is comparable to spot testing and the spectra provide documentation of the test and results for future interpretation. In total, over 400 spectra have been collected and interpreted, including the acquisition of representative library spectra for comparative purposes. These files represent approximately 40 hours of time on the FTIR equipment and resulted in *c*. 270 analyses with 225 successful identifications, a success rate of 83%.

Testing Procedure:

The use of these techniques was determined by several factors including speed, accuracy, and cost of the method. However the selection of an appropriate technique was always at the discretion of a professional conservator who was responsible for collecting accurate data while completing the project in a reasonable period of time. The large number of adhesive samples necessitated a uniform testing system to ensure accurate testing and recording. Within the standard procedure, significant latitude was allowed to perform further analysis for unique or unusual materials.

The protocol used at the ASM for assessing adhesive residues has developed and evolved over the course of the project. The terminology used in museum cataloguing and in archaeological and ethnological reference literature in the Southwest is generally inconsistent and reflects the popular language used at the time a particular study was done. For example, the use of the terms pitch, gum, resin, rosin, sap, tar, glue, and lac are often non-specific and interchangeable in much of the literature. Through a process of review and revision we have developed a system of procedures that actually identifies unique materials and is not slowed down by the large groups of homogeneous materials. The benefit of this system is improved efficiency in carrying out a large survey, while maintaining a constant workflow. This protocol eliminates some of the repetitive work and improves the accuracy and efficiency of a large collection survey.

Experience and judgment, much based on years of curatorial and conservation experience with the collection, have guided the decision-making processes and knowledge of the collection informed the evolution of procedures. For instance, it was well known that a large collection of *c.* 1,000 vessels from the Point of Pines site was primarily repaired with cellulose nitrate adhesives (based on first-hand accounts of archaeologists). Understanding this type of repair history allowed conservators to process large parts of the archaeological collections more quickly. Some portion of every collection was sampled and analyzed but, by knowing that certain sections were very likely homogeneous, greater attention could be given to the detection and testing of unusual materials as they were encountered (whether as a result of indigenous deposit or repair residues, the presence of cultural coatings, later treatments or contaminations from other sources). Because of the wide variety of considerations, the use of each technique has been discretionary for the individual surveyor/conservator. For archaeological vessels, spot testing is the preferred initial identification method. The characteristic rapid solubility of cellulose nitrate in acetone combined with the rapid reaction of the diphenylamine test make repairs on most of the

archaeological vessels easy to sample. When initial spot testing fails or is ambiguous, a sample is typically submitted for FTIR.

In the ASM collection, the frequency and diversity of materials on the ethnological vessels is greater than on archaeological vessels. Often the identity of an adhesive repair residue is suspected simply by visual appearance or solubility. Protein and pine resin adhesives can be readily confirmed using spot tests on adhesive samples removed from the vessels. For samples that are not immediately identified, the use of other spot tests or FTIR is available. Much of the efficiency of this system depends upon the skills and judgment of conservators who must understand the history of adhesives, their uses on the collection and be constantly vigilant for the sometimes minute traces of original repair materials.

Results and Discussion

Overall, the adhesives identified on the ASM pottery vessel collection are consistent with commercially available products at the time of use and what was recommended by archaeologists and museologists. A study of historic adhesives was initiated to identify adhesives cited in literature for ceramic, glass and stone stabilization and compared those recommended for use with the developmental history of commercial adhesive products. It serves as a reference for the adhesives used on the ASM vessel collection. This database, which defines adhesive types on the basis of their chemical composition and physical form, includes over 8150 entries.

The results of the study have revealed patterns of material use that correlate to the traditions of the cultural groups and to the professional practices of the conservation community. Native American repair practices vary by group and region, but in the Southwestern United States, plant related products are the most common methods of repairing damaged vessels. The project has identified over 170 vessels (approx 1% of the collection) that retain residues from original indigenous repairs. Modern conservation repairs, applied while the vessels were in the museum or archaeological excavation, have also been analyzed. Repair materials found in the collection include pine resins, creosote lac, animal protein adhesive, shellac, plasters and mortar, cellulose nitrate, polyvinyl acetate, and acrylic-based adhesives. The documentation of these repair materials and techniques will help the conservation staff reconstruct the treatment history of the collection. Systematic identification of these materials in combination with the condition survey will facilitate research on the collection and help prioritize conservation activities. Examples of adhesives found in the collection include:

- Acryloid® B-72 and B-67 acrylic polymers began to appear in ASM treatment reports around 1986. Since its introduction, B-72 has eclipsed all other conservation adhesives and its current failure rate is below 1%.
- Poly (vinyl acetate) or PVAC was used on slightly more than 1% of the repaired vessels. PVAC (including several grades and mixtures) use begins to appear in archaeological items in about 1984 and continues to appear in contemporary repairs to a small degree. Although the sample set is small, it is notable that over 12% of the PVAC-repaired ceramic vessels have since failed or become unstable. This is a significant failure rate and warrants further investigated on collections with more PVAC repairs.
- Cellulose Nitrate is the most widely used adhesive in this collection and is present on the majority of repaired vessels. It was used as early as 1915 at ASM, is the primary adhesive used by the 1920's and was used for 87% of the museum and archaeological field repairs. This is typical for archaeological collections that were acquired and

assembled in the first 75 years of the 20th century (Museum of New Mexico, 1938) (Denver Art Museum, 1939). Its easy use is offset by the shortcomings in material properties. Strength decreases and brittleness increases with aging (Selwitz, 1988). Currently, about 15% of the cellulose nitrate repairs have failed , and 4% are considered unstable. Of the vessels in the collection that have failed or are considered unstable 97% of them were repaired with cellulose nitrate.

- Hide or animal based glues were commonly used adhesives for repairs prior to the introduction of cellulose nitrate. The usage of hide glue appears to extend to 1938 when it was used on a few archaeological and ethnographic vessels. Approximately 5% of the identified hide glue repairs have failed and 19% have been labeled unstable by conservators. Museums have long recognized the shortcomings of hide glue as a repair material (Dowman, 1970: 79).

- Creosote Lac is the resin exuded by the insect, *Tachardiella larreae*, on the leaves and stems of the creosote bush (*Larrea tridentata)*. Both the bush and insect are indigenous to, and only found in, the Lower Sonoran Desert at elevations below 5,000 feet [*c*. 1500 m] (Kearney and Peebles 1960; Colton 1943a, 1943b). It exists as a reddish-amber coloured mass on the branches of the creosote bush and is removed by breaking (Coville 1892: 361). This material has provided a strong, adhesive resin for peoples living in the southwest for many centuries. The earliest example found during our survey was identified on an archaeological vessel from a cave site that had been radiocarbon dated to AD 1440-1640 (Shelly and Altschul 1989 p.75). This adhesive continues to be used in contemporary Native American pottery as an adhesive and lid sealing compound. There are relatively few incidences of creosote lac in the collection , but they illustrate a long and continuous tradition of ceramic repair among some Native American groups, including the Tohono O'odham, Pima, Seri, Mohave, and Maricopa tribes (Sutton 1990), (Felger and Moser 1985) . Creosote lac was identified with UV autofluorescence and confirmed with FTIR. Reference spectra were collected from several known examples within the ethnographic collection and additional reference spectra were provided by Michelle Derrick (Museum of Fine Arts, Boston).

- Pine resins, the distillation product of pine tree exudation (Mantell 1947: 73), from several species in the pinaceae family including Pinion and Douglas are used as both an adhesive and as a sealing/waterproofing compound (Bohrer, 1973). Pines are common and widely distributed in north and central Arizona, growing at intermediate elevations of 5,000–7,000 feet [*c.* 1500 – 2100 m] (Kearney and Peebles 1960: 52). The resin is obtained at wounds in trees where it appears as a white, opaque, sticky, crystalline mass or as darker pellet-like drippings exuding from the wounds. It consists of volatile oils (sesquiterpenes) and rosin (solid material). The resin becomes pitch or tar when heated (Fox, Heron and Sutton 1995: 364). Pitch may be mixed with other materials to provide a stronger binding medium although this was not confirmed during this survey. The use of pine resin is widely reported in the archaeological and ethnographic literature as a coating, waterproofer, binder with pigment and adhesive for repair. Its presence is usually indicated by a dark brown color and lustrous surface appearance. Navajo potters typically apply a thin coating of pine resin over the entire vessel by melting it onto the surface as the vessel emerges from firing (Bell 1987).The Apache, Hopi, Navajo, Tarahumara, and Zuni people all have vessels with identified pine resin repairs or coatings. This material has a long and continuing use among contemporary potters, where it is often used as a surface coating on Navajo vessels.

There remain a number of repair adhesives that appear in the ethnology literature but have not

been identified in the collection; conversely, at least one adhesive that does not appear in the literature was identified. Most of the unidentified adhesives in the survey are modern or historic era restoration materials. Most of these consist of a silicate or carbonate filler with an unknown binder. There are also approximately 40 vessels with indigenous repair materials that could not be identified, although efforts continue to do so by researching archaeological, ethnological, and ethnobotanical reference materials. Many examples exist of materials that cultural information suggests might be usefully tested against these unknowns.

- An exudate obtained from arrowweed (*Pluchea sericea*) was used to mend broken pottery by Maricopas (Spier 1933: 107–8).
- The juice of the blue yucca (*Yucca baccata*) was mixed with pottery paste among the Navajo (Vestal 1952: 21).
- Mesquite gum is used extensively on pottery among the Maricopa, Pima and Tohono O'odham (Fontana 1962; Castetter and Underhill 1935). Gum from the mesquite tree (*Prosopis sp.*) was used to make an adhesive for repairs as well as paint for decorating pottery among the Tohono O'odham, Maricopa, and Pima people. (Teiwes 1988), (Kearney, Peebles, 1960). Though reported in the literature, it has not been identified as an adhesive in the ASM pottery collections although is present as a painting material.
- The use of horn glue such as that derived from mountain goat (*Ovis canadensis*) is described as a mending material (Coville 1892; Stewart 1942: 266).
- A tar-like repair material produced from Pitahaya or Organ Pipe cactus (*Stenocereus littoralis*) is described as being made by grinding the dry pulp of the cactus to a powder and mixing with porpoise, sea-lion or horse oil, stirring to a gummy mass and boiling over a fire until the consistency is that of coal tar (Felger and Moser 1985).
- Bitumen is the most notable adhesive found that did not appear in ethnological literature. Bitumen is a viscous, black, oily by product of decomposed organic materials that is generally known as an adhesive, sealant and decorative material on pottery. Bitumen repairs were found only on five relatively recent ethnological vessels, all collected after 1968 and manufactured during the twentieth century. Two vessels are from the Tohono O'odham, one from the Mayo and three from the Tarahumara. The use of UV autofluorescence was useful to suggest the presence of bitumen but FTIR was required for confirmation. The origin of the bitumen is unclear, although some of the spectra indicate silicates, suggesting clay is present. Clay is a frequent additive of roofing compounds, which it is likely would be easily available.

Mixtures and multiple re-treatments are common in all repair traditions. Breaks may be repaired multiple times with different adhesives. Also, bulking agents and modifying compounds may be added to provide improved working properties. The identification of mixtures is significantly more complex than pure compounds. It is necessary to consider the limits of detection and the possibility of interactions among other components when evaluating the results of UV autofluorescence, chemical spot testing, and FTIR spectroscopy.

Many vessels in the collection have a complex mixture of adhesives bridging prehistoric and historic periods. Breaks may be repaired multiple times with different adhesives. In examples of ethnographic repair the relationships are relatively straightforward and readily visible with a UV lamp. Identification was performed with the FTIR and identified bitumen, with a later campaign of pine resin. A third compound without noticeable UV fluorescence was tentatively identified as a gum, although work is continuing to provide a more definitive identification.

Multiple adhesives used on the same vessel are found in only 4% of the collection. An example of creosote lac used as a sealing compound on a vessel illustrates a difficulty in identifying complex mixtures. What appears to be creosote lac at the rim should display a distinct orange fluorescence. However a later consolidation using cellulose nitrate has completely coated the exterior surface. The only orange fluorescence which remains is in areas where the creosote lac was directly adhered to the ceramic and has since detached, exposing the original adhesive fluorescence. Closer examination with the UV lamp revealed the surface coating of cellulose nitrate. Interpreting and identifying multiple repair re-treatments is a challenge when attempting to reconstruct the repair history of any object.

Other repair techniques

In addition to repair materials and residues, the survey was designed as a collaborative research project with curatorial staff to identify mechanical repair methods including drilled holes. Generally, these repairs consist of a pair of holes drilled on adjacent sides of a crack or break. A cord or similar lacing material was used to pull and hold the pieces together. Sometimes this provides a functional repair that returns the vessel to use and at other times it appears to have been done to restore form but not function. The holes were formed using a bow or pump drill with a stone-tipped bit to abrade through the ceramic. It is unclear if any other abrasive material was used to facilitate cutting. Drill holes formed in this way have a distinctive form that reflects their manufacture. The form of the bit and the likely drift in the cutting action creates a tapered hole. It appears that holes were almost always drilled from both sides of the surface and met in the middle, forming an hourglass profile. Previous studies of Southwestern drill holes and nine drill bits from southeastern Utah (Wylie 1975) suggest that a wide variety of hole sizes and depths (up to 1.5 cm) could be routinely achieved. This coincides with the general results of this survey, although there are a few large diameter repair holes in the ASM collections that would require use of the largest drill examples from the Wylie study. Within the survey database this technique is interchangeably referred to as drill holes or repair holes. The incidence of repair holes on all vessels was noted as part of the conservation survey and preliminary totals suggest that they are present on 1.2% of the vessels in the ASM collection.

The acquisition of this valuable data illustrates how a collection survey can augment curatorial records and benefit other groups within the museum. The preliminary data analysis suggests that approximately 82% of repair holes are used for the repair of bowls. A much smaller but still substantial number of repairs were found on jars and pitchers (*c.* 10% of the examples). The remaining pieces included, in order of descending frequency, seed jars, ladles, effigy jars, scoops, plates, mugs, lids, dippers and cups. The survey noted 216 vessels with repair holes in the collection, 96% of which are found on archaeological objects. Because the sample set for ethnographic materials consists of only nine examples, comments on the use and distribution of repair holes will be limited to the archaeological collections. It is unclear why the repair holes appear overwhelmingly in archaeological materials.

Most of the repaired ASM pottery vessel collection was done without filling losses. Rather, the vessels were reconstructed using only the extant fragments available. A smaller but significant portion of the collection has received at least some fills, and they appear to have benefited significantly from the additional structural support. The failure rate of ceramic repairs drops by over 50% when fills are incorporated within the vessel structure. The additional effort to provide fills imparts a measurable benefit to the collection and should be considered in order to prevent damage and prolong the life of treatments.

A limited number of ceramic vessels have supportive exterior lacing or ties used to support the vessel structure. Though generally noted on very large vessels, a range of plant fiber, rawhide, and modern iron wire materials have been recorded. These seem to be used to provide extra handling support to the structure, supplement adhesive repairs, or prevent structural damage.

Conclusions

This collection is actively used by researchers and is subject to significant handling, contributing to increased damage. The documentation of the collection's adhesives is a benefit for curators and conservators alike. Conservators benefit by gaining a better understanding of the materials used on the collection. Understanding the distribution of adhesive types, how they are aging, and how they function provides valuable guidance in developing preservation strategies for a large collection. The survey reveals how adhesives are used in the collection on an item level as well as the aging properties of repair techniques over time. For example, data from the survey suggest that repair failure has been a significant problem in this research collection. Insufficient records or earlier failures/repairs prevent truly accurate modeling of the past and likely future failure rates but general trends are illustrated. The uncertain longevity of cellulose nitrate suggests that a sustained campaign of reassembly may become necessary as these adhesives continue to age and an probable increasing failure rate will require substantial resources to address.

Curators and researchers benefit from the detailed, reliable information about residues and repairs in their collections. Sometimes this information can help link poorly documented items to an era of collecting, the activities of early collectors, or simply clarify the otherwise misleading appearance of surface or decorative areas on a vessel. Confident knowledge of this information helps curators understand the history of their objects and how materials, techniques and culture interrelate.

Cultural groups may gain greater understanding and depth to the object histories. During the Pottery Project, the conservation staff has conducted several consultation meetings regarding the study, condition, treatment, storage and exhibition recommendations of tribal members whose cultures are represented in the ASM collections. Information related to primary and secondary uses, storage and use strategies for food and water resources, as well as sentimental or ceremonial contexts are of interest and have provided guidance in the treatment and understanding of vessels and the context of their repairs.

The identification and correlation of adhesive and repair techniques to culture helps illustrate the cultural history of objects for curators and provides conservators with valuable information about collections. The cooperative gathering and sharing of information between curatorial and conservation staff benefits understanding and preservation of the collection. The systematic study of repair techniques as a continuation of object history adds further value to the objects in the collection.

Overall this project has proven that a conservation survey in combination with the research goals of an institution can provide copious information of benefit to the collection. The project and the data it produced have provided a large collection of information as a basis for future study by scholars of archaeology and anthropology. This project has successfully identified conservation problems based on observed and quantifiable trends in adhesive use. The data has also resulted in a significant new resource that links conservation treatments to a continuous tradition of ceramic repair. By measuring how well or poorly previous treatments behave, we can better predict the collection needs and confidently identify effective strategies. This research affords the opportunity to look forward and backward to identify patterns in archaeological methods, original repairs and conservation treatments.

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