CSI Abydos: Conservation & Scientific Investigation of Wood Funerary Artifacts at the Abydos Middle Cemetery

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Introduction

Near the end of the 2009 field season, archaeologists at the Abydos Middle Cemetery Project (AMC) made an exciting discovery: a sealed tomb chamber, or serdab, filled with beautifully decorated wood figurines. Conservator Claudia Chemello was able to quickly stabilize and lift the jumbled figures, but the discovery brought into sharp focus an ongoing conservation dilemma at the site. (Fig. 1, 2)

Dry desert conditions like those found in Egypt often result in excellent preservation of organic materials like wood, but artifacts from the Middle Cemetery have suffered both insect and fungal attack. Most are so fragile that they can barely be touched without crumbling, yet they often retain their three dimensional shape, an outer shell of well-preserved gesso and pigment, and decorative elements such as textiles and metal and stone inlays. Small figurines like those discovered in 2009 are relatively simple to lift during excavation, but long-term preservation strategies for severely deteriorated wood are virtually non-existent. Furthermore, not all wood objects found at Abydos are small, and it is incredibly difficult to achieve successful excavation of large, unstable wood artifacts. (Fig. 3)

As we considered conservation and long-term preservation for the artifacts discovered in 2009, we realized that we needed a new approach for fragile wood objects at the site.

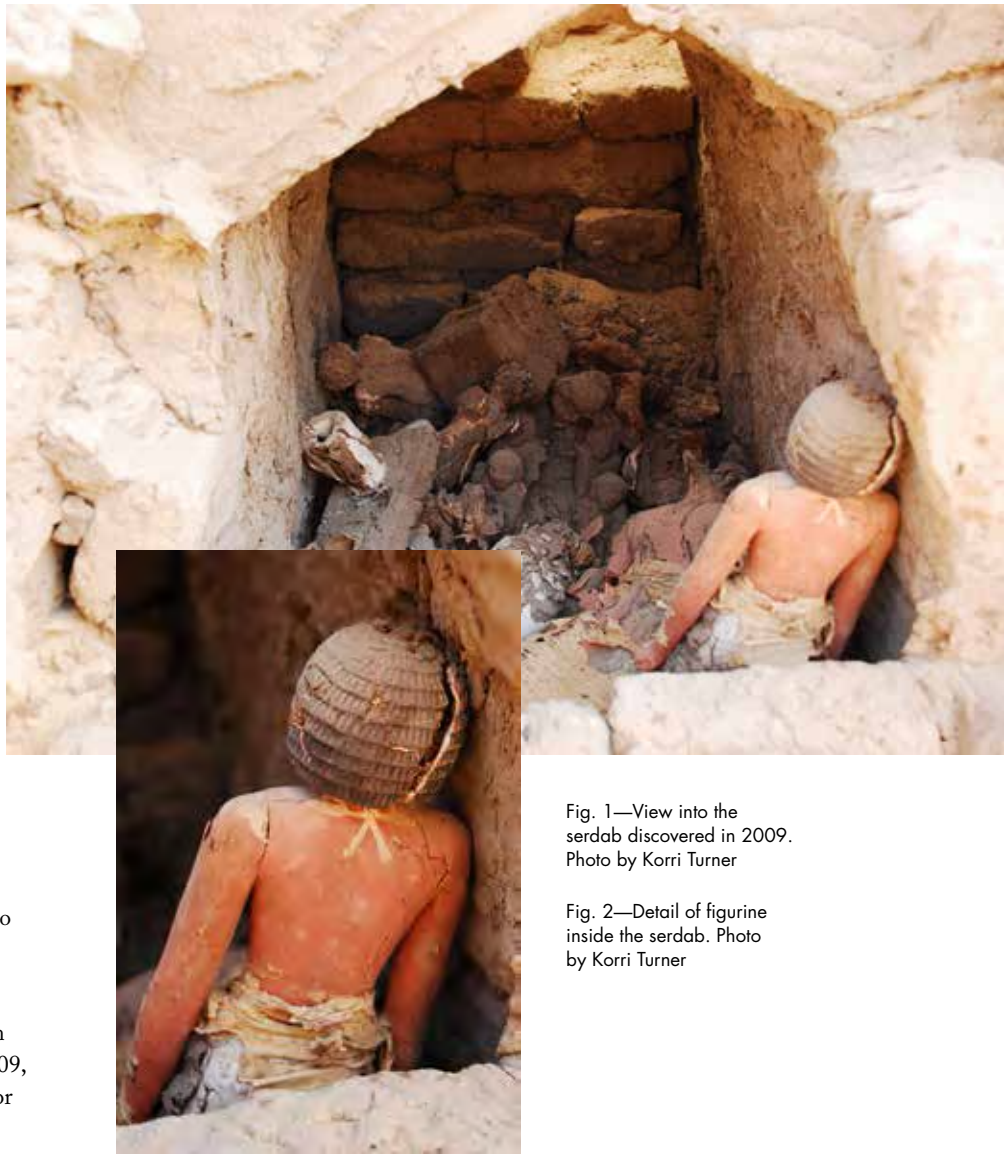

Fig. 1—View into the serdab discovered in 2009. Photo by Korri Turner

Fig. 2—Detail of figurine inside the serdab. Photo by Korri Turner

Fig. 3—Coffin emerging from the sand in the Abydos Middle Cemetery. Photo by Suzanne Davis

Fig. 4—Suzanne Davis prepares a coffin for cyclododecane. Photo by Claudia Chemello

Conservation at the Abydos Middle Cemetery

Abydos was a major town throughout Egyptian history and is situated at the western edge of the Nile floodplain in southern Egypt. Today the site has a number of major components, including the ancient town, huge cemetery fields in the surrounding low desert, and royal monuments from various periods. The University of Michigan, under the direction of Dr. Janet Richards, Professor of Egyptology and a Curator at the University's Kelsey Museum of Archaeology, investigates the late Old Kingdom and First Intermediate Period cemetery lying in the 50-hectare expanse known as the Middle Cemetery. Here, important officials of the central government in the mid-third millennium BCE built monumental graves within a carefully planned cemetery landscape.

The Middle Cemetery Project has been fortunate to have conservation support, with conservators from the Kelsey Museum on-site, for the majority of its excavation seasons. Project conservators provide conservation for the active excavation and also assist with large-scale preservation projects, such as condition surveys and rehousing for previously excavated finds. We and other conservators working at Abydos had excavated, studied, and attempted to treat severely degraded wood at site over multiple seasons, yet no existing treatment protocol seemed especially promising.

Investigation

Our research accelerated after the 2009 serdab discovery, and we began testing a variety of conservation materials and methods. Interestingly, many of the treatment options we considered came from colleagues working with waterlogged wood. The preservation of waterlogged wood, which is often severely structurally compromised at time of excavation, has been studied extensively. Current conservation literature does not adequately address the issues posed by structurally compromised dry wood, however. Until recently, objects this fragile did not survive excavation because they disintegrated during lifting. Now, however, a recent advance in field conservation practice, the use of a hydrocarbon wax called cyclododecane, allows excavators to quickly stabilize and remove delicate or fragmentary objects. The wax melts at a low temperature (60°C) and can also be dissolved in nonpolar solvents. It is dripped or brushed onto the surface of the artifacts, where it cools and hardens quickly, creating a solid, stable mass that can be lifted with relative ease. Later, if left exposed to the air, the wax will slowly sublime, moving directly from a solid state to vapor. (Fig. 4)

Cyclododecane is a temporary stabilization treatment, however, and once removed from the ground, Abydos wood artifacts continue to present myriad condition issues that need

Fig. 5—Claudia Chemello prepares to remove the serdab objects. Photo by Korri Turner

Fig. 6—Standing figure following excavation. Photo by Claudia Chemello

Fig. 7—(from left) Ahmed Abdel-Azeem, Harriet Beaubien, Suzanne Davis, Pamela Hatchfield, Robert Blanchette, Gregory Smith, and Claudia Chemello. Photo by Claudia Chemello using automatic timer

to be addressed. We were missing answers to many important questions. First, what exactly is the substrate? Once wood, it is now a crumbly mass made up of silica, termite frass, and, perhaps, degraded wood. Did enough wood remain for it to be identified? Were we dealing only with termite damage, or were additional factors (fungi) at work? At the heart of all of this of course, how could we best preserve what remained? Second, we wanted to know about the other original materials remaining on the AMC artifacts. Specifically, we were concerned that subsequent conservation treatment would adversely impact our ability to study the pigments, binders, and preparation layers for the paint. Third, many of the treatment materials we had previously tested had discolored the surface, and we wanted to preserve the original appearance to the best of our ability. On a related note, we wanted to make sure that any conservation materials we used now could be removed later, allowing the artifacts to be re-treated if necessary. (Fig. 5, 6) Finally, was there a better way to excavate wood at Abydos? Cyclododecane, dubbed "magic wax" by excavators at AMC, does not always produce satisfactory results during lifting. The wax is brittle and, even with additional layers of tissue or cloth, large artifacts often break during excavation.

With generous funding from ARCE's Antiquities Endowment Fund, we were able to assemble a "dream team" of conservators and scientists to assist in answering these questions. The team included two specialists in the investigation of wood: Dr. Ahmed Abdel-Azeem (Suez Canal University), a mycologist who studies the fungi of the Middle East and North Africa and who also has experience investigating microbial deterioration of archaeological wood; and Dr. Robert Blanchette (University of Minnesota), an internationally recognized expert in wood pathology and microbiology for archaeological artifacts. Dr. Gregory Smith (Indianapolis Museum of Art), a conservation scientist, joined us to study the decorative elements of the artifacts. We asked

Harriet F. Beaubien (Museum Conservation Institute, Smithsonian Institution), a conservator with expertise in the technical study, excavation, and conservation of severely degraded organic archaeological materials, to critique and improve our excavation techniques. Pamela Hatchfield (Museum of Fine Arts, Boston), a conservator with significant experience in the conservation of Egyptian artifacts, advised both on-site during excavation and in the lab, developing and evaluating conservation treatment protocols. The group met in Egypt to consult with conservators at institutions with similar materials, and then spent a week on-site at Abydos investigating the Middle Cemetery artifacts. (Fig. 7)

Outcomes

At Abydos, the group set up a small field laboratory in the dig house and got to work. Because they were on-site during an excavation season, they were able to examine previously excavated artifacts as well as observe the active excavation of new finds. Abdel-Azeem brought with him two microscopes, and with these he and Blanchette were able to examine the wood in detail, evaluate its current condition, identify the species for many artifacts, and even to isolate destructive fungi which were later identified using DNA sequencing. Their work produced a complete picture of fungi present at the site—in the air, in the soil, and in the artifacts. Several of the fungi found in the objects are known to cause soft rot in arid regions. Soft rot causes cavities to form inside the cell walls of the wood; in advanced stages, the remaining cell wall has little mass remaining and even slight pressure will cause it to break apart into dust.

The termite damage was also extensive and did even more to change the composition of the wood substrate; as they ate the wood, the termites left behind a silica/frass/saliva mixture. In fact, much of the artifacts' existing structural integrity is related to the last two intrusive factors, insect frass and saliva, which have bound the crumbly remains of the wood. In many cases, however, enough undigested wood remained for Blanchette to make identifications. Wood species identified in the Middle Cemetery artifacts include sycamore, juniper, acacia and an intriguing unknown hardwood. Thanks to the work of these scientists, we now have a more complete picture of the Abydos artifacts' original composition, their current structure, and the deterioration mechanisms at work. There is much more digested wood mixed with saliva and silica than we had realized. Furthermore, the original wood that remains exists in a highly degraded state due to fungal attack, and traditional wood conservation treatments are unlikely to be effective. (Fig. 8)

Fig. 8—Abdel-Azeem and Blanchette in the Abydos field lab. Photo by Suzanne Davis

Fig. 9—Smith in the Abydos field lab. Photo by Claudia Chemello

Fig. 10—(from left) Claudia Chemello, Pamela Hatchfield, Suzanne Davis, and Rae Beaubien test excavation methods on-site at Abydos. Photo by Korri Turner

While Blanchette and Abdel-Azeem explored the structural composition of the Middle Cemetery artifacts, Smith's work characterized the decorative elements on their surfaces. Because the analysis of ancient paints requires the ability to identify both inorganic and organic components, he brought with him equipment for elemental as well as organic analysis: a portable X-ray fluorescence unit (Bruker Tracer III-V) from the Indianapolis Museum of Art, and a small Fourier transform infrared spectrometer (Bruker Alpha with a diamond crystal ATR accessory) loaned by Bruker, the manufacturer. Dr. Tom Tague of Bruker instruments generously loaned the project the necessary software and spectral libraries for use with the latter. Smith also set up a small lab area for wet chemical analysis. Like most field housing situations, the Abydos dig house is not an ideal place to create a high-tech laboratory; frequent power outages, high temperatures, and equipment which had become misaligned during travel all conspired to create a challenging situation for scientific analysis. Yet Smith made it work and made a few surprising discoveries in the process. (Fig. 9)

One of his most interesting findings was that almost all of the artifacts were covered with arsenic. Arsenic is a component of the yellow pigment orpiment, which is often found on ancient Egyptian art and is present on the Middle Cemetery objects. Yet arsenic was evident in almost every analysis spot regardless of color. It was even present on the textiles, but the reasons for this widespread contamination are elusive. Smith speculated that the arsenic could come from a salt or oxide in other paints, or that it could be the result of decay or the action of the fungi. Whatever the reason for its presence, the arsenic explains why the Middle Cemetery artifacts have suffered so much termite damage to the wood, but almost none to the painted surfaces (in almost every case, a very thin shell of original wood remains just beneath the paint). Now we know why: the surfaces were poisonous.

Other pigments identified by Smith include yellow earth, Egyptian blue, iron ochre, and an interesting white pigment composed of the minerals huntite and anorthoclase. Various paint binders were also characterized, such as gelatin, gums, and beeswax. Metal inlays were copper sheet, with lead solders, and a pair of inlaid stone eyes proved to be calcite (or other calcium based rock) and obsidian. Obsidian is a volcanic glass not native to Egypt, and in the future Smith hopes to work with colleagues to identify the source of the Abydos Middle Cemetery obsidian. Technical studies of this kind are important for understanding not only the materiality of objects, but also ancient trade networks. Once conservation treatment has taken place, such studies are difficult to conduct because conservation can alter the original materials and confound analytical work. Based on Smith's results, we now have a good record of the objects' original decorative materials and are able to accurately predict how the painted surfaces will react to various solvents and conservation materials.

Of course, all of this information—wood preservation, original artists' materials—is only useful to us if we can remove the objects from the sand without destroying them. Enter Beaubien and Hatchfield, who spent hours

on-site every day testing different excavation methods and then followed this with even more hours testing conservation materials and techniques on previously excavated artifacts in the field lab. Our typical method of lifting artifacts on-site has been to use cyclododecane, reinforced in some situations with cotton gauze and/or acrylic resin. As previously noted, however, the wax is brittle and large artifacts break easily, even when gauze and other reinforcing materials are employed along with the wax. Acrylic resins such as Paraloid B-72, sometimes applied as a pretreatment before the cyclododecane, can also be helpful, but stain the painted surface. Another negative aspect of this method is that the wax can take weeks to completely sublime, frequently meaning that artifacts cannot be conserved in the same season they were excavated. This has obvious negative implications for timely documentation, photography, and publication.

To address these issues, Beaubien and Hatchfield developed a multi-step excavation protocol that protects the paint surface, results in more successful lifting, and allows the artifacts to be treated more quickly and easily once removed to the field lab. In short, this protocol consists of using dilute cellulose ethers in ethanol and water to protect the painted surface, and then facing the surface with tissue and, if necessary, with a stronger support to keep contiguous sections aligned during lifting. Cyclododecane, acrylic resins, and/or plaster jackets can be used, along with fabric or gauze, on top of the tissue facing to provide structural support. The paint surface remains protected, with little change to the color, gloss, or saturation of the pigments, but the supportive shell is strong enough to allow the artifacts to be handled, moved, inverted, and worked on from multiple angles including the reverse, which can be important for stabilizing the highly-deteriorated wood substrate on artifacts like painted coffins. (Fig. 10)

When conservators are ready to treat the painted surface, the upper supporting layers of this shell can be removed more quickly, since there is a protective barrier between the artifact and the wax or acrylic resin. The tissue facing, which is applied in strips or small sections, is also convenient for safely repositioning misaligned fragments. Admittedly, this protocol takes longer on-site at time of excavation than simply applying cyclododecane, but the results are far superior. Like all conservation work, it must be balanced with the ongoing needs of the excavation. In some cases, the amount of time required will not be worthwhile, but for artifacts with the potential to contribute important information to the project's research, it is a good option.

Hatchfield and Beaubien also brainstormed innovative consolidation solutions for the degraded wood substrate, the most interesting of which involves the use of alkoxysilanes. Typically used for stone conservation, these products form physical and chemical bonds to strengthen deteriorated stone. Recently they have been used for the conservation of earthen architecture, and in the case of the Abydos artifacts they would be used to consolidate the substrate by bonding with the high percentage of silica. This is a promising area for future testing. They also considered practical solutions for reconstructing and restoring fragmented objects. Some of these will be familiar to archaeological conservators, such as the use of acrylic resins bulked with glass micro-balloons, but other fill materials might not be: alpha cellulose (paper pulp) and/or long, thin strips of acid-free tissue, impregnated with dilute adhesive and gently crumpled or folded into place. Based on their work, one extremely fragmentary figurine from the 2009 serdab has now been partially reconstructed, with more work to follow in future seasons. Prior to this reconstruction, it was difficult to appreciate how finely made the figure was. Restoration of artifacts on an archaeological excavation might seem like a luxury, but in this case such work would allow the artifacts to be displayed in a museum, an outcome desired by community members in Sohag, the province where Abydos is located. (Fig. 11)

Fig. 11—Partially reconstructed figurine of the deceased as a child, from the 2009 serdab. Photo by Korri Turner

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Following the site work at Abydos, the team took six months to consider their observations in the field, and then met again at the Kelsey Museum of Archaeology at the University of Michigan in Ann Arbor. Much of what has been reported above was not fully synthesized until after the group had a chance to reflect, perform further research, and meet to discuss our work in person. As part of the visit, the group gave an extremely well-attended public presentation about the project. Lightning-round style, each individual presented his or her contribution in a lively evening of conservation, science, archaeology, and conversation. Because of a delay in his visa approval, Abdel-Azeem visited several months later and gave another public talk focused more specifically on fungal deterioration of cultural heritage. For the first time in its history, the Kelsey Museum lecture room was crowded not only with archaeology enthusiasts, but with mycologists and biologists! At both events, the Kelsey Museum was proud to be able to showcase its involvement in a project encouraging scientific and cultural exchange between the United States and Egypt.

Conclusion

The overall goal of our research was to develop better conservation guidelines and treatment protocols for severely deteriorated wood from the Abydos Middle Cemetery, and we are pleased to conclude that it was successful. We now have a much clearer understanding of the artifacts' original materials, their current composition, and the deterioration mechanisms that contributed to their delicate state. We also have better options for excavation and conservation treatment, as well as several new ideas to explore. It was highly beneficial to us to invite a team of external conservators and scientists to consider the problems we were facing; these individuals brought both valuable expertise and a fresh perspective.

The project was also an excellent case study, illustrating the complex and extreme condition issues that can occur in dry archaeological wood. The conservation issues involved are challenging, but successful preservation of fragile wood artifacts like those excavated at Abydos is desirable because such artifacts have great potential to contribute to the archaeological record. Because so little research has been conducted on the conservation of severely deteriorated wood from dry contexts, we believe this project has the potential to positively impact the conservation of archaeological wood worldwide. We are grateful to the Antiquities Endowment Fund and the American Research Center in Egypt for making our work possible.