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Improvisation and Collaboration in the Field: Mass Treatment of Metal Finds on the Sardis Expedition, Turkey

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Sardis, in western Anatolia, has a long history of excavation and conservation on site. This history is full of spectacular metal finds. Thus, a protocol for standard treatment of metals at Sardis has been established, tested, and refined over many years. This paper will discuss the ways in which specific circumstances during the 2015 season required the conservation team to evaluate these protocols and, at moments, contravene established practices.

Background

Sardis is located in the middle of the Hermus valley at the base of Mount Tmolus. As the capital city of the Lydian empire in the seventh and sixth centuries BC, it is often best remembered for the invention of coinage. Though the date is debated, the Greek historian Herodotus tells us that electrum coins were first minted at Sardis at the end of the seventh century BC (Herodotus, I, 94). Remains of a partially completed, monumental Hellenistic temple of Artemis still stand tall at Sardis today. In Roman times, the city was famous as one of the Seven Churches of Asia in the Book of Revelation. In the fourth and fifth centuries AD, Sardis boasted what is still the largest known synagogue in antiquity. Sardis flourished and continued to grow in the Late Roman period until its decline by the seventh century AD.

Conservation at Sardis

Archaeological excavations at Sardis began over a century ago. The current excavation is jointly associated with Harvard and Cornell Universities and has involved conservators each season since its inception in the late 1950s. There has also been a long history of training conservators at Sardis. Lawrence Majewski, an early chairman of the Conservation Center at Institute of Fine Arts at New York University, initiated the conservation training program at Sardis (Severson 2008, 171-172).

A two-year commitment is required of conservation students in order to ensure continuity from season to season. In 2015, the lab benefitted greatly from support for conservation from Harvard and Cornell Universities, the director Nick Cahill, and the entire excavation team. Not only was there financial support for a wide range of projects, but also a large conservation team made up of two American student conservators, five supervising conservators, and two Turkish student conservators.

This substantial commitment to conservation is important because the excavations at Sardis have uncovered some spectacular metal finds over the years. One example is an extremely important iron and bronze Lydian helmet, which was excavated in 1987 and conserved by Ann Heywood while she was a student at the Conservation Center. The cleaning and treatment of metals on site can be very time-intensive. Nevertheless, it is essential for the well being of this material, as it is under constant threat of bronze disease and weeping iron corrosion, which also have a long history in excavated material at Sardis.

Standard Conservation Treatments

In order to optimize conservators' time and preserve the maximum material, the conservation lab uses standard treatments for metals whenever possible. These standard procedures will be familiar for those who have worked on sites throughout the Mediterranean.

Most newly excavated copper alloy objects go through the following treatment: cleaning, desalination, passivation, and coating. Copper alloy objects are soaked in tap water for at least an hour to soften dirt and corrosion layers. They are then mechanically cleaned under the microscope with skewers, quills, brushes, and scalpels. After cleaning, copper alloy objects are soaked in deionized water and the conductivity is monitored. The water is changed once or twice daily and the levels recorded until the conductivity reaches below ~5 micro Siemens. If the levels plateau around 10-20 micro Siemens for several days, the water is checked for chlorides with a silver nitrate test. In these cases, if the test yields a negative for chlorides, the objects are moved on to the passivation stage. At this point, the wet copper alloy objects are dewatered with acetone. They are then soaked in benzotriazole (BTA) in ethanol, in the vacuum desiccator overnight. Once removed, objects are rinsed with an ethanol squirt bottle and dried in the sun in order to prevent excess BTA from crystallizing on the surface. Finally, copper alloy objects are coated by soaking in a Paraloid B44 dissolved in an ethanol-and-acetone bath under vacuum overnight. Objects are removed from the bath and dried without rinsing. Once dry, these objects are bagged and marked “Check Next Year” in the database. All metals that receive this mark are rechecked for active corrosion the following season and are locally retreated with silver oxide as necessary.

Newly excavated iron is handled similarly to copper alloy finds, with the exception of the desalination and passivation stages. Objects that are still damp from the trench and appear stable are generally soaked in tap water to loosen dirt and corrosion. Remaining soil and loose corrosion are then mechanically removed. The objects are dewatered in acetone and dried in the sun. Finally, the dry iron is bathed in B44 in acetone and ethanol, under vacuum, overnight.

Lead at Sardis is cleaned dry. There is a designated lead oilcloth and brush used to dry brush lead finds. This is always done in the courtyard with protective gear to reduce the risk of exposure.

These standard procedures do not deviate too far from the protocols at many sites throughout the Mediterranean. They were originally adopted at Sardis and modified empirically by Kent Severson almost two decades ago in order to meet the demands of the site. These standard protocols have been refined over the course of many seasons. Their consistency and simplicity aid in later retreatment, ordering materials, documentation, and translation of treatment reports into Turkish. In their current iteration, these treatments have been found to be quite effective at Sardis when implemented properly. In recent years, when care has been taken to fully clean and desalinate before passivation and coating, the numbers of objects requiring retreatment has dwindled. The downside of these procedures is that they are very labor- and time-intensive. This has historically been an acceptable compromise, because the conservation lab at Sardis is generally so well staffed.

In 2015, however, the amount of time and labor required by the procedures became problematic because of the huge quantities of metals that were excavated.

Excavation and Conservation in the 2015 Season

Conservation this season supported active excavation across over one thousand years of antiquity and addressed a number of site preservation issues. Small portions of the active excavation this season explored Hellenistic and Roman layers, but the majority of the open trenches were in Late Roman earthquake collapse. These excavations are happening in a portion of the site called Field 55.

In Late Roman strata in Field 55, an enormous trove of metal objects was discovered in a collapsed complex. Several hundred objects were uncovered on the floors of three rooms, buried under charcoal and ash. Mixed in with the debris were a huge number of large, well-preserved metal objects still in situ on the floor. Notable finds included a hoe, two scythes, a bucket, a pan, a polykandelon, decorated furniture fittings, an ewer, and most excitingly two large, complete bronze pitchers with iron handles. A couple hundred coins and several hundred nails were also uncovered.

Such a wealth of objects from such a great context is obviously thrilling to an archaeologist but for a conservator it is something of a nightmare. The first issue is simply getting them out of the ground safely. After centuries of burial, being ripped from the ground and exposed to a blazing Turkish summer can cause a great deal of damage to corroded copper and iron objects. The standard practice at Sardis is for the archaeologists in the field to lift all metal finds themselves and place them in plastic bags full of sifted soil. These are then brought back to the lab by the end of the day. The rapidity of excavation combined with the soil packing is meant to keep the metal finds from drying out.

When large numbers of large objects are discovered simultaneously, this simply isn't possible. From the conservator's point of view, once something has been exposed to the air it needs to be lifted. This ideal isn't shared by archaeologists: for them, removing things piecemeal is both inconvenient and detrimental to the overall project. Excavators prefer that things be left in place as long as possible so the whole trench can be photographed with all associated finds still in situ. Since these photographs will be used in publications and presentations, they are vital to the site's continued existence.

Collaboration

Sometimes the conservation lab was able to work with or around excavators, but often the team was forced to make compromises and leave finds in place for a substantial period of time. This was the case with the majority of the large bronzes. Early one morning the conservators went out to the field, carefully excavated the objects, and then reburied them under Tyvek pillows filled with soft dirt. This allowed the objects to stay damp and cool while the entire trench was prepared for photography, a process which took almost a month. After the pictures were taken, again early in the morning, all of the objects were lifted simultaneously and brought back to the lab. Examination of the objects post-excavation found no or limited damage had occurred.

Improvisation

Other issues arose during the actual treatment, where the particularities of the objects prevented following standard protocol. It has been found at Sardis that, in order for the BTA and B44 resin coating to be effective, the solutions have to be applied under vacuum. The vacuum desiccator on the site however was simply too small to be able to hold many of the most important objects that were found in Field 55. The conservation lab was forced to improvise and jerry-rig a series of vacuums from spare materials in the lab. The most successful iteration was a snap-lid plastic bucket, originally used to store lime putty, which was fitted with gasket made of a Thera-Band resistance band. A trashcan on the interior kept the bucket from collapsing into itself. Next year, the lab may look into having a local welder fabricate a more permanent chamber.

Such a chamber, or something similar, will be necessary, as there were a few objects too large even for the bucket. On the upper terrace of Field 55, four large, iron chair frames were found mixed in with rubble from a second-story collapse. Three of the frames were in fairly good condition. They still had substantial metal cores, and with a little care they were excavated and lifted without incident.

Lifting

One of the chairs, however, was in much worse shape. Unlike the other three, it was lying flat on the ceramic floor tiles. This likely slowed the rate of water drainage during burial and in turn may have caused it to completely corrode. It was discovered to have no metal core at all and was simply a pile of rust held together by friction, like a rotted log. It was covered in cyclododecane to be lifted. Cyclododecane is a temporary consolidant. It is applied hot, sets hard, and then slowly sublimes away at room temperature, theoretically leaving no residue. In order to use it in the field, the lab borrowed a night guard's portable tea stove and poured the molten wax onto the chair. Cloth strips, stiffened with cyclododecane, were used to support the fragile chair legs. Once the wax set and the chair had solidified, the chair was slid onto a piece of aluminum flashing that was found in the back of a garage.

Delayed Treatment

The chairs and many other large objects were found only a few weeks before the end of the season. Because of the time needed to treat this type of object, there simply wasn't enough time left to clean, desalinate, and coat them. As such, it was decided to clean them dry. This is slower and less effective than the standard practice at Sardis, which is to clean with water. However, since desalination wasn't an option, it was felt that using water was too much of a risk. Cleaning with ethanol was tried, as it is a common procedure on other sites, but the high heat and large size of the objects resulted in the conservators becoming too nauseated to work. After cleaning was finished, the chairs were packed up and impulse-sealed in giant desiccated bags. Unfortunately, this year's limitations are now next year's problem.

Non-Standard Conservation Treatment

For the finds just discussed, it was possible to adapt standard, proven methods to deal with new problems at only moderate risk. Sometimes, however, a find had no precedent on site to draw from. This was the case with a tiny roll of lead, which was found inside of a skull excavated from a Byzantine graveyard. Historically, curses or spells were scratched on sheets of lead. They were then rolled up and buried in a fresh grave. The standard treatment for lead at Sardis is to do nothing. As stated, archaeological lead is extremely stable and does not require much treatment beyond careful dusting. In this case however, the archaeologists asked that the scroll be unrolled in order to read whatever was written on it. The rarity of these sorts of objects means there simply hasn't been a standard treatment developed for them. Luckily Tony Sigel, a conservator at the Harvard Art Museums who has personally unrolled several similar scrolls, was on hand to offer advice. Nevertheless, because of the idiosyncrasies of this particular example, substantial trial and error was required to flatten the scroll.

Lead is normally very soft and ductile. It can be scratched with a fingernail. However, after centuries of burial, layers of lead carbonate and calcium carbonate were deposited between the rolled layers of the scroll. These carbonates are much less flexible than the metal, making the scroll extremely brittle. Had one simply tried to unroll it, without preemptive cleaning, the scroll would have shattered at every turning. It was necessary to remove as much of the mineralization as possible and then glue sheets of Japanese tissue paper onto the exposed, blank surface. The paper facing would mean that even if the scroll did shatter all the pieces would still be held together in their correct orientation.

Once the outside was fully faced, the unrolling could begin. Metal tools were avoided, as they would scratch up the lead beyond legibility. Special wedges made from bamboo skewers, of the type normally used for shish kabob, were used instead. In order to break up the carbonate deposits, a number of different acids were tested. Hydrochloric acid was ultimately chosen because it caused relatively little damage but still acted rapidly enough to be practical. The acid was dropped between the sheets, slowly dissolving the carbonates which cemented them together. With the carbonate shell gone the metal regained some of its former flexibility, and a small section of the scroll could be safely unrolled.

This process of acid treatment followed by mechanical cleaning followed by facing and finally unrolling proceeded in fits and starts. Only small sections could be worked on at any given moment as the scroll itself blocked access to more than one half at a time. The scroll was actually made of two pieces and after several slow days of unrolling it was possible to separate and flatten them. Completing the last turn, where the metal had been bent almost 180 degrees, was profoundly nerve wracking.

Once the scroll halves were separated and flattened, it was finally possible to begin studying them. Before burial the scrolls were repeatedly struck with a pick or needle, marked up with a few letters and dozens of "check marks," then rolled up together, and stuffed into a skull. Even when flat it was very difficult to read the marks, and Emily Frank performed Reflectance Transformation Imaging, or RTI, to help with their decipherment. Getting the scroll ready for RTI required even more aggressive flattening in order to prevent the cockling from self-shadowing. The images produced are currently being examined by specialists in magic. They were also used by the site's draftswoman to produce illustrations.

Conclusions

Standard treatment procedures can be extremely helpful, especially to conservators in training. However, archaeological conservation requires constant questioning, adaptation, and improvisation. How long can things safely stay in the ground? Is water safe for cleaning? Is desalination necessary? Is partial treatment better or worse than no treatment? The answers for one site may not be applicable to any other, or even from one season to the next.

Often the only thing certain is that some action is required. This past season produced problems for which there frequently weren't readymade solutions. There often wasn't even a good solution, only several moderately bad ones. Furthermore, the conservation team won't know if it made a mistake until it returns the next season. Only then will it discover if it was wrong to leave the bronzes in the ground so long, not coat the iron chairs, or unroll the scroll.

The standard procedures used by the Sardis lab have been broadly successful but they are still only a rule of thumb. What's ultimately required is a willingness to ask questions, work with others, experiment, and be ready to admit mistakes. If the conservators return in June and find mountains of rust, or billowing clouds of bronze disease, they will document that in their report. They'll do their best to fix the problem, the standard procedures will be revised and the work of the lab will continue, each successful treatment firmly built upon a foundation of failures.

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