Preventive Conservator's Report: 2009 Field Season

Melissa L. MARIANO
California, USA

1.0 INTRODUCTION

The 2009 season brought many changes to the Conservation team at Kaman-Kalehöyük, including a brand new lab space in the recently completed buildings of the Japanese Institute of Anatolian Archaeology, new protocols for object conservation and storage, and for the first time, the addition of a preventive conservator to its staff. During her six-week stay, from July 6 to August 16, 2009, the author was able to carry out various preventive conservation tasks, including those routinely performed by conservation staff, such as a survey of the metals collection and environmental monitoring, as well as additional duties, for example the creation of anoxic and desiccant storage using the Revolutionary Preservation System™.

2.0 METALS SURVEY

An important element of the lab's preventive conservation effort is to conduct a survey of the sites metals collection each season. Due to the size of this collection, the policy has been to survey even years' finds on even years, and odd years' finds on odd years, or approximately half of the collection every season. While the procedure is rather streamlined, asking for only a naked-eye inspection, a basic "stable" or "unstable" classification, and conditioning of saturated silica gel, the collection continues to grow and it has become increasingly difficult for the lab to complete such a lengthy project. This was confirmed by the site's database, which showed that in the past several years, only a very small percentage of the collection was assessed each season, with the exception of 2008. The setup to conduct the survey contributes to the time constraint. Since there is very little natural light which enters the storerooms and no source of artificial light, as well as no computers with access to a database in the storage facility, containers of objects must first be carried to the lab, a few at a time, and accommodations made for lab space, man hours, and the lab's desktop computer which is normally networked to access the database.

The 2009 Metals Survey proved successful, though not without some obstacles. With a significant portion of the collection not inspected for several years, it was decided that the entirety of the collection was in need of assessment, approximately 7000 inventoried objects (not including non-inventoried objects and those unexplainably excluded in the survey list). The majority of the survey was conducted in the JIAA Anthropology Lab (located on the upper floor of the same building as the conservation lab) which offered ample free table space and remained unoccupied for much of the season. Also, as the survey progressed, non-inventoried objects (normally not included in the survey) and object mounts were evaluated, increasing the scope of the survey. Finally, as the Institute's buildings and lab were new, this also meant that the computer networking was not complete, thus all data entry was saved for the end of the survey and carried out on shared computers in registration and processing room.

2.1 Condition assessment

To begin the survey, a strategy was devised with help from Conservation Director Alice Boccia-Paterakis. At the site, metal objects are kept in resealable polyethylene bags, most within mounts constructed of Ethafoam® adhered to acid-free cardstock, which are then generally grouped according to material, year and location found and held in high-density polyethylene lidded containers of various sizes. Not all of these containers are labeled and thus there is no clear systematic method of reference. It was decided to first assign a temporary number to the containers sequentially as they were brought into the lab so that it would be easier to refer to the box once the survey was complete. Objects would be checked one container at a time and if one was found showing signs of active corrosion, it would be placed in a separate container (one for each storage cabinet) and its inventory number, conservation number, and temporary container number recorded. It was also determined that a quick but thorough visual examination of objects was sufficient to determine whether it was "stable" or "unstable" for the scope of this project, even leaving it in its re-sealable polyethylene bag if a clear view was possible. For an object of particular importance or if closer inspection was needed to be certain of its condition, it could be taken out of its bag and storage mount (*Fig. 1*).

By the end of the survey, approximately 300 inventoried objects were found to show signs of active corrosion and subsequently prepared for enclosure in the Revolutionary Preservation System (RP System™) to inhibit corrosion and stabilize the object. They were organized by cabinet and then by temporary container number, to allow for small and similar types of objects from the same container to be grouped together in Escal™ bags if possible and for easier dispersion of the enclosed objects back to their original location. Although not part of the standard metals survey procedure, non-inventoried metals were also assessed for the presence of active corrosion. In this case, objects or fragments were grouped together and their temporary container number recorded. These isolated objects were then passed on to Dr. Masako Omura, who would decide which objects should be inventoried and eventually placed in Escal™ bags with the RP System™.

Fig. 1 Inspection of a metal artifact during the condition assessment portion of the Metal Survey.

2.2 Database

The collection's FileMaker® Pro database was updated at the conclusion of the metals survey. Inventoried metal objects at the site have been included in a database created for the survey which is linked and automatically updates changes to the treatment database, and vice versa. Thus data entry for the survey was straightforward for most of the object records, updating the object's condition field as unstable ("2") for all of the approximately 300 objects showing signs of active corrosion and isolated during the survey. The remaining objects in the metals survey list were listed as stable ("1").

However, confusion arose when approximately 55 of the inventoried metals that were deemed unstable were not included in the metals survey database subcategory. These records were corrected and added to the metals survey subcategory with the exception of twelve, which gave irregular record information when updating was attempted. Rather than adding more confusion to an already existing problem, a list of these twelve objects was given to the Field Conservator to keep as documentation in the lab, with the hopes that more can be done to rectify these discrepancies during the next field season.

2.3 Reconditioning of silica gel and humidity indicator strips

Another side of the metals survey is the reconditioning of desiccant silica gel which has been placed in pierced re-sealable polyethylene bags within the lidded containers. Saturated silica gel is easily recognizable: clear gel has been mixed with cobalt blue indicating silica gel (which turns pink when satu-

Fig. 2 Melissa Mariano (left) and Jessica Arista (right) returning reconditioned desiccant silica gel to the polyethylene boxes storing contain metal artifacts during the Metal Survey.

rated) in an approximate 1:4 ratio. Since most of the indicating silica gel encountered had turned pink, all of the gel was recovered from the containers as the survey progressed. Two batches of gel were heated in the lab's small tabletop oven daily for approximately four hours each, and once cooled, put back into resealable bags and returned to the object containers (*Fig. 2*). As is customary, a piece of blue masking tape with "2009" was added to one of the outer sides of the box to indicate the last time that the silica was conditioned.

Also, humidity indicator cards located in the lab as well as those present in some of the object containers were collected and reconditioned by placing in a bag with desiccant silica gel. These cards whose paper tabs turned blue in color (also contain cobalt blue indicating salts) were ready to be re-used. Many were randomly placed in containers to indicate the maximum relative humidity reached within the container's microenvironment during the year. Others were included with objects enclosed in the RP System™, which will be discussed in section 3.0 to follow.

2.4 Mount-making and retrofitting

In addition to the condition of an object, its mount, if present, was also given a quick assessment. In recent years, the standard technique for object mounts has been to hot glue carved Ethafoam® onto acid-free cardstock, adding twill tape or other straps/reinforcements as needed. While these mounts have been carefully made in most cases, some were found to provide inadequate support or to possibly damage the object. Approximately 35 objects were set aside during the course of the survey in order to alter or construct more suitable mounts for them. While there is a significant number of additional objects which could benefit from new mounts (such as most of the awl collection kept on cotton wool beds within hard plastic containers), those isolated were perceived to have the most immediate need. Unfortunately, not all mounts could be finished by the end of the season since precedence was given to objects without any mounts to be enclosed in anoxic and desiccant storage that season season, but they were kept in a separate marked container in order to resume work next season.

2.5 Other Tasks

A few other unexpected tasks became part of the survey process. While scanning through boxes of non-inventoried objects for actively corroding metals, about 41 high-quality finds, including fibulae, pins and chain fragments, were set aside as possible candidates which could benefit from cleaning treatments. These and other objects or fragments found in exceptionally good condition were later inventoried and integrated into the lab's set of incoming objects for treatment.

Moreover, while inspecting objects a pink residue was repeatedly found on the surface of some finds. After consulting with Dr. Masako Omura, it was concluded that the residue was due to a putty-like material of the same color used by the site's drawing technician to keep the object stationary. Other materials and methods were recommended for the technician to use while drawing and the putty was removed as best as possible when encountered, using wooden sticks, scalpels and ethyl alcohol applied with cotton swabs as necessary.

The final aspect of the survey was the separation of non-metal finds such as ceramic, glass, shell and bone, from containers holding metal objects. These were set aside when found and given to the registrar for appropriate placement in storage.

3.0 REVOLUTIONARY PRESERVATION SYSTEM (RP SYSTEM™)

The Revolutionary Preservation System, or RP System™, is a packaging system manufactured by Mitsubishi Gas Chemical Company, Inc., which creates an anoxic and desiccant microenvironment suitable for the preservation and storage of metal artifacts. The packaging system is comprised of three main components: a gas-barrier film for creating bags, an oxygen indicator and gas adsorbing packets, all of which are safe for use with museum objects (Hickey-Friedman 2002). Plastic gas-barrier films with a low water vapor transfer rate (recommended at 0.01g/m^2/day) and oxygen transfer rate (less than 1ml/m^2) should be used for long-term storage, such as the transparent ceramic-layered film Escal™ or laminates with an aluminum layer like Marvelseal® 360 (Elert and Maekawa 2000, p. 5). These films also have a low density polyethylene inner layer allowing for the film to be easily heat-sealed. The oxygen indicator tablets contain methylene blue, which changes to pink in environments with less than 0.1% oxygen (essentially anoxic), or back to blue when the concentration of oxygen is greater than 0.5% (Mitsubishi Gas Chemical Company 1996, p. 8). Unlike other oxygen absorbing products which are typically iron-based, the RP System™ adsorbing packets compatible with metals (named RP-Agent A) consists of unspecified unsaturated organic compounds, mordenite (zeolite), calcium oxide, activated charcoal and polyethylene which together can not only adsorb oxygen but also water and corrosion-enhancing gases such as hydrogen sulfide and hydrogen chloride (Hickey-Friedman 2002). These effective and easily assembled micro-environments are highly suitable for the long-term storage of unstable archaeological metals at sites with variable environmental storage conditions and thus its use has become part of the preventive conservation program at Kaman-Kalehöyük.

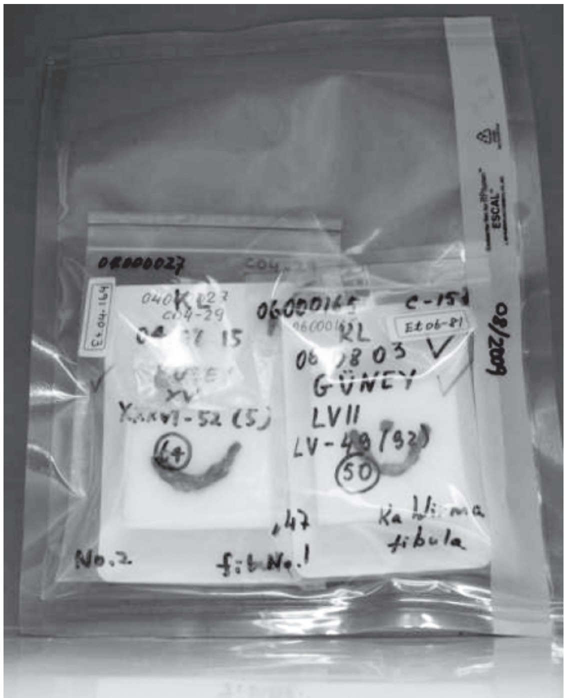
3.1 RP System™ at Kaman-Kalehöyük

Experimental enclosures using the RP System™ were first made at Kaman-Kalehöyük in 1997 by then field conservator Scott Caroll and later resumed and expanded by intern Laramie Hickey-Friedman during the 1999-2001 field seasons. Hickey-Friedman's investigation called for repeated monitoring over the next several field seasons of iron objects subjected to various treatment scenarios, including chemical baths, chemical baths and enclosure in the RP System™, and mechanical cleaning only with enclosure in the RP System™.

During her first year as conservation director in 2008, Alice Boccia-Paterakis assessed the condition of the iron artifacts in Hickey-Friedman's test groups and began to analyze the findings. She concluded that the RP System™ granted a distinct advantage in the long-term stability of the metals, as artifacts remained stable after eight years of enclosure. It also offered health and safety benefits for the conservation team versus the lengthy and/or toxic corrosion inhibition treatments using alkaline sulfite and benzotriazole (BTA). She decided to incorporate its use in the 2009 season metals treatments as well as for stabilization of actively corroding artifacts in the collection, which were identified and isolated by the author during the metals survey.

3.2 Preparation of micro-climate bags

Once all the iron and bronze objects or fragments were mounted and placed in a polyethylene bag, Escal™ bags were made in the appropriate size for the object, or objects, using rolls of the gas-barrier film of three widths (12mm, 17mm and 22mm) and heat sealing one end of the bag. At first, a batch of bags was made in predetermined sizes, but this approach was later abandoned since the objects are all different sizes. The bags were also cut a slightly longer length than necessary to allow for a clean seal and so that if an object needed to be accessed in the future, the film could be recycled and there would be enough room for another seal. For large objects which were too big to fit within the premade rolls



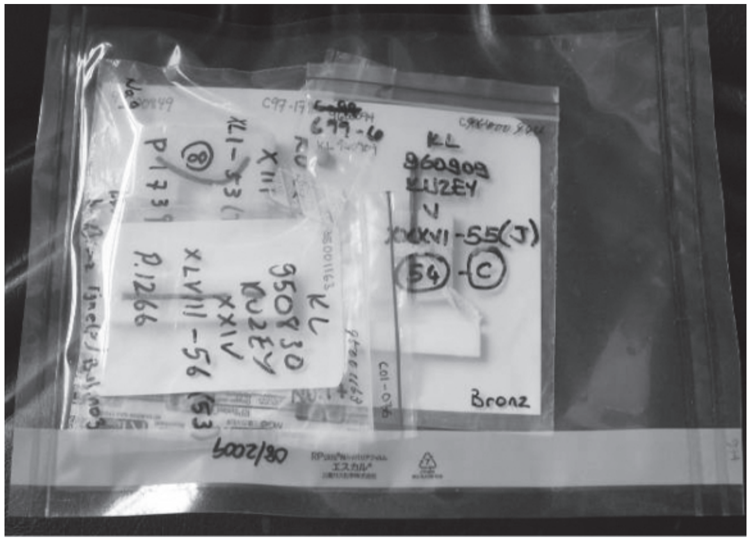


Fig.3 and Fig.4 **Completed RP System™ storage bags, each containing metal artifacts, RP Agent and an oxygen indicator. The objects and oxygen indicator are placed within the bag such that they are easily visible and the date of enclosure is inscribed on the writing strip.**

of Escal™, bags were made by heat-sealing together pieces of the Escal™ roll using a variable temperature hot-iron. This process was quite tedious and the bags themselves untidy, and although they appeared stable, the effectiveness of their seals can be evaluated next season. Sheets of Escal™ film would have been more appropriate to create these large bags and should be considered for purchase if more will be needed in the future.

After the bags were created, their dimensions (length, width and height) were taken to determine the volume within the bag and therefore size and amount of RP Agent packets necessary for each, according to the product instructions:

> Air Capacity (ml) = W(ml) x L(ml) x H(ml) – [weight(g)/specific gravity of the content]

In this case, calculations of air capacity did not take into account the object or material in the bag but only the total volume created by the bag (W x L x H) due to the fact that for most of the bags, the effect that the object, mount, etc., had on the overall equation was negligible, and that the scale available did not have the capacity to weigh many of the objects. Also, while the specific gravities of iron and copper are 7.9 and 8.9 respectively, the values for corroded metal would be less than that of the pure metal, a value which could vary depending on the condition of each. Calculating and debating all of these variables would be too time consuming and as mentioned already, has no significant bearing on the overall total of the air capacity for our purposes.

Only when the air capacity of all the bags was determined and written in pencil on the writing strip of each were the agent packets and oxygen indicators dispensed. This was done in batches as the agent must be used within 30 minutes once the pack is open or it will be spent and no long work properly. Two sizes of agent packets, 5A which conditions 500ml of air and 3A which can condition 300ml, were available for use and placed in the Escal™ bags as needed, as well as one oxygen indicator tablet. The bags were then heat-sealed closed with the use of a FoodSaver® heat sealer. This sealer produces a seal width of only approximately 4mm, whereas Mitsubishi recommends a seal width of 10mm for a completely hermetic seal, thus two seals were made, one parallel to the other to provide a more secure seal. The oxygen indicator was inspected prior to final storage to ensure the bags were properly sealed and that the correct amount of RP Agent was dispensed (*Figs. 3 and 4*).

Each bag was finally labeled with the date of enclosure and the object once again placed in the lidded container in which it was once kept. Those which could not be returned to their container due to lack of room were put in a plastic container together and placed in the last cabinet to be relocated the next field season.

4.0 ENVIRONMENTAL MONITORING

An important part of the conservation team's preventive efforts lies in understanding the environment in which objects spend their time, both long and short term. Data loggers recording temperature and relative humidity at variable intervals have been programmed in recent years to collect data for as short as one week and for as long as a year, allowing conservators to reach educated conclusions about the conditions in which the site's collection is exposed and the effectiveness of mitigations employed. During the season, HOBO® data loggers placed during the previous season to record over the course of the year are gathered and their data downloaded to a computer for interpretation and archiving purposes. When the HOBO®'s are ready to be reused, they are reprogrammed and repositioned in other strategic locations to record temperature and relative humidity for a determined amount of time.

4.1 2008-2009 Recovered Data loggers and Results

Two HOBO® data loggers set up during the 2008 season were recovered and their data downloaded and examined. The first was found in the previous conservation lab which had recorded points from July 2008 to July 2009. The data clearly confirmed suspicion that highly variable conditions were created within the non-permanent structure, with a dry environment in the hot summers and a significantly more humid one during the cold winters, a potentially dangerous situation for environmentally sensitive objects, like metals. On the other hand, the second HOBO® found in a lidded polyethylene container (numbered "133" during the metals survey) holding bronze objects within a metal and glass cabinet numbered "6", showed more promising findings. The relative humidity in the container stayed exceptionally stable (from 23.4% to 27.0%) while the temperature fluctuated as expected over the course of the year (a high of 78.1°F (25.6°C) in the summer months to a low of 31.72°F (-0.16°C) in January). This shows the effectiveness attainable with desiccant silica adsorbing water while working in combination with the barrier effects of the cabinet and container from the uncontrolled exterior environment. However, even with this data, the survey proved that the storage system is not without its flaws and that the opportunity for unstable environments is indeed often possible by the number of objects found with active corrosion. If the silica gel reaches saturation, it is no longer able to trap and hold water molecules, allowing humidity levels to rise without remedy and many of the polyethylene boxes and cabinets no longer have a tight seal, allowing frequent air exchange to take place.

4.2 Data loggers Placed for Data Collection in 2010

By the end of the 2009, only two of the six HOBO® data loggers the lab should possess were found, thus making only four available with the addition of two new HOBO®'s brought to camp by the conservation director at the start of the field season. Nonetheless, these four data loggers were put to good use, and will supply valuable information when downloaded in 2010. The first was placed within the new JIAA storage facility (north-west building), just recently finished in 2009 before the start of the field season. As opposed to the current storage facility in the basement of the main camp structure, some of these new buildings are also equipped with environmental controls. The frequent power outages experienced at the camp could impact the effectiveness of these controls, thus a clearer understanding of the natural environment within the structure would help the department understand the insulation of the building itself and its ability to independently sustain the environment within.

The three remaining HOBO®'s were placed in close proximity to one another in order to paint a clearer picture of the benefits of using the RP System™. One data logger was placed in an Escal™ bag containing an iron object (inventory number 90000598; conservation number C94-36) with an Ethafoam® and acid-free cardstock mount as well as the sufficient number of RP System™ Agent sachets, an oxygen indicator tablet, and humidity indicator strip. Another was placed in an Escal™ bag of similar size to the previous, with only RP System™ Agent sachets, an oxygen indicator tablet and humidity strip. Both of these bags were placed in the same polyethylene lidded container (labeled as containing HOBO®'s for quick retrieval next season), in which a third HOBO® was situated, and it was placed as usual in one of the metal and glass cabinets. The combination of these three HOBO®'s will reveal the possible influence that an artifact can have on the RP System™ microenvironment and the difference between being in one of these anoxic and desiccant microenvironment bags versus simply placed in the polyethylene container.

5.0 STAFF MEETINGS AND PRESENTATIONS

At Kaman-Kalehöyük, all staff and students convene daily to discuss progress made on-site and within the various laboratories. These sessions are also used as a platform for presentations, as a way to educate the team on fundamentals and working aspects of the diverse disciplines which create the excavation team. The author contributed two such presentations on behalf of the Conservation Department. The first was given on July 16, summarizing the general process of iron corrosion and options for its mitigation as well as the technical aspects of the RP System™ and its application by the department on the site's metals collection. The PowerPoint presentation given on July 31, "Packaging and Handling Techniques of Small Finds" described proper post-excavation procedures for recovered finds while outlining the role of the burial environment, inherent properties of artifact materials and measures taken specifically at Kaman-Kalehöyük. The presentation concluded with a hands-on lesson for archaeology students on the safe handling of finds during research and study.

6.0 2010 SEASON AND LONG-TERM GOALS

As the JIAA expands, preventive conservation measures which the conservation department will need to accomplish each year will increase as well, adding new responsibilities to an already busy season. Tasks predicted for the 2010 season include:

- Metals Survey of half the metals collection (even years' finds)
- Continuation of anoxic and desiccant storage for actively corroding objects using the RP System™
- Continuation of object mounts improvement campaign
- Environmental monitoring
- Relocation and integration of objects once housed at the Kırşehir Museum to the new site museum and storage building
- Transfer of on-site collections to new storage building
- Installation of objects and environmental monitoring within the new site museum

In addition to the above mentioned tasks, there are two important projects which should be considered priorities for the department to address in the near future, earthquake protection and emergency preparedness. Kırşehir province (to which the village of Kaman belongs) lies in an earthquake zone on the Akpınar Fault, where a damaging magnitude 6.6 (Richter Scale) earthquake hit in 1938 (Özmen, Bülent and Kocaefe 1999, p.2). There is currently no means of protection from earthquake damage in place for the shelves of objects in storage, such as foam and strap barriers. Also, an emergency preparedness plan has never been drawn up for Kaman-Kalehöyük. This is an essential document to guide orderly and effective response in case of a crisis or disaster, especially when the site is located in a seismic area.

7.0 CONCLUSION

Giving a member of staff specialized in this area the responsibility of implementing preventive tasks for the lab has not only proven more effective in completing such tasks before the end of the field season, but it has also allowed the field conservator and interns in the department to focus on other aspects of lab activities. This shift in responsibilities has also shown to be especially fruitful at a time of transition for both the conservation department and the JIAA as a whole.

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Melissa L. Mariano
melissa.mariano@gmail.com