Keeping a Promise to the Past

Copper Alloys

Copper alloy is a term used to describe a metal where copper is mixed with another type of metal to form "copper alloy." Two very common types of copper alloys are: brass (a combination of copper and zinc) and bronze (a combination of copper and tin).

Copper alloys are more resistant to corrosion than ferrous alloys. When brass decays in the ground, it is subject to selective corrosion, and the zinc component usually leaches out of the brass leaving behind a spongy brass matrix. Copper alloys are generally found discolored, obscured by corrosion products and brittle upon excavation. Unlike other metals which can easily be identified by their corrosion products, copper alloy corrosion can vary greatly between sites, features and contexts and can be found to be a wide range of green colors with purple, red and brown mixed in.

Some more common examples of copper corrosion found on archaeological sites such as those at Historic St. Mary's City are listed below. Factors which cause copper alloys to degrade during burial include water, oxygen, pollutants, micro-organisms and soluble and non-soluble salts found in the soil. Most of the corrosion products can be identified by a trained archaeologist or conservator or by someone who is familiar with archaeological objects. It is only through practice that you begin to recognize the features and types of corrosion that can form on objects. Due to the complex nature of many of these corrosion products, they can only be correctly identified after completing scientific analysis. It is better to describe what you see, and not to guess

Types of Copper Alloy Corrosion:

- Oxides –
    - Red- cuprite – forms on damp, aerated sites.
    - Black tennorite- usually found in waterlogged conditions

- Carbonates - Malachite/azurite –- green/blue –- can form in a variety of burial environments and may appear waxy/ smooth or grainy/ crystalline. Mixes of blue and green are often found together

- Bronze Disease - A term that is often used to describe very bright green and blue corrosion on bronzes. This is a typical phenomenon of outdoor sculpture, church steeples and architectural elements that turn "green" over time. In order for copper alloy corrosion to be correctly identified as bronze disease, the presence of cupric chlorides — often in contact with moisture — must be present. The term is used more widely these days, but should only be used to describe copper chloride corrosion. Bronze disease got its name from scientific studies which have shown that it can actually spread to nearby artifacts — so if your collections are infected, you may want to segregate them from nearby copper alloys. The very active corrosion, often seen in storage post-excavation, seems to literally "spread" to artifacts nearby causing a chain reaction!

Case Studies in Copper Alloy Conservation

Decorated Copper Object

Conservator's Notes

Copper alloy is a term used to describe any artifact whose primary component is copper. The object may be alloyed with a number of other metals such as zinc, tin, arsenic and mercury. Without analytical studies, it is impossible to know the exact composition of a copper alloy. In the conservation laboratory, copper alloys are seen in many different forms and colors. Their corrosion is much more complicated than that of iron or lead, because they can be composed of so many different metals. Identification of the corrosion products is complicated as well. It is for this reason that minimal cleaning and investigation of copper alloys is undertaken, so that future analysis using scientific equipment can be completed if necessary.

This handle was sent to the conservation laboratory for routine cleaning. The surfaces were fairly clean and were covered in a well adhered obscuring corrosion.

As with many coppers, the corrosion was colored green, brown, red and black. The object was not complete and had suffered some damage during burial. Some of the corrosion was very dense in the middle area. The object was mechanically cleaned and the corrosion was carefully removed under the microscope. During cleaning, a design appeared in the surface of the copper alloy. As more corrosion was removed, it became apparent that a maker's mark of some sort was impressed into the surface of the object. This mark revealed initials of "HL" in the surface as well as an emblem or symbol below. Because the object was damaged on the bottom half it is not clear whether the complete mark is revealed. As with so many objects, even though a mark like this is uncovered, it is still very difficult to identify what the mark means. But one thing is for sure, the mark is another clue to our past and is now available for further research and study.

Curator's Notes

Conservation often unmasks very valuable information hiding beneath a layer of corrosion. This specimen is the handle from a spigot and bears marks with the initial "HL" and some sort of creature, perhaps a dragon rampant. The object is the decorative handle for a stopcock like the one pictured below and of the type that would be used to tap a barrel of wine or other beverage.

Copper Alloy Bell

Conservator's Notes

When this small copper alloy bell was brought into the conservation laboratory for cleaning it did not seem any different than any of the other copper alloys from HSMC. Most of the copper alloy artifacts at HSMC are in good condition with core metal remaining. The cleaning process is straightforward, and involves mechanical cleaning of the surfaces under the microscope. Upon investigative cleaning of the bell however, we discovered something inside the bell. A small round iron clapper was still present inside the bell. The routine cleaning of this bell would suddenly take on a different direction.

When objects are composed of two or more materials they are referred to as "composites" in conservation. This is because the treatment of such objects will be different than that of an object which is only composed of one material. The bell would now be a more difficult treatment because the copper alloy and iron components would be cleaned differently. And the cleaning technique for one of the materials could potentially damage the other material. Conservation treatment of composite artifacts are more complicated and are always left to a professional conservator for this reason. Sometimes one of the materials is in much better shape than the other, and one of the materials may be sacrificed to the other to ensure the long-term stability of the entire object. This type of decision is not made without careful consideration, and the conservator will always lean toward the more sensitive and unstable material first for treatment.

Both the copper alloy and iron parts of the bell were in fairly good condition. This is very unusual as well. When dissimilar metals are in contact, a corrosion cell naturally occurs. The metal which is lower on the galvanic series (or the least noble metal) will corrode preferentially to the other metal. When copper and iron are in close contact and form this type of corrosion cell, the copper is always preserved much better than the iron. However, the iron in the bell remained in tact and contained a significant amount of core metal making it an excellent candidate for treatment.

The copper alloy part of the bell was cleaned in the usual manner. When the cleaning was completed it was time to clean the interior iron clapper which was heavily corroded and adhered to the inside of the bell. It was very difficult to get a tool inside the bell to clean the iron sufficiently. In the end it was decided to use a very small stream of air under low pressure to loosen the corrosion and release the clapper. Excess corrosion and dirt were removed from the interior of the bell using small blasts of air in localized spots. After cleaning, the bell was rinsed and degreased and left to dry. Upon moving the bell to complete treatment it was noticed that the clapper had loosened inside and "sound" was restored to the bell. While the intent of any conservation treatment is not to "restore" the object to its original form, especially artifacts whose historical integrity is tied to change during burial — this was as much a surprise to the conservator as it was to the curator. And one can't help but wonder if the sound of the bell is close to its original or not.

Curator's Notes

This small bell was of the type and size often traded to the American Indians in exchange for furs, corn, and other commodities. The American Indians particularly valued copper objects and these were some of the most successful exchange items in the early Chesapeake.

Copper Alloy Pin Case

Conservator's Notes

A visual examination of this object prior to treatment indicated the surface was covered in debris, especially the interior, which was filled with small stones and roots. Stable black-colored corrosion products were evident, but unstable light green spots of corrosion were also visible. Light green corrosion could be an indication of bronze disease, which is an active form of corrosion and must be removed to stabilize the object and ensure no further deterioration of the original material occurs. No analytical study was performed to confirm the corrosion was in fact bronze disease. In the X-ray, deep pitting was visible and these areas corresponded with the areas of green corrosion, indicating it's an active corrosion. To our surprise, the X-ray also revealed evidence of a surface decoration that was being completely obscured by debris.

Due to the light green spots of active corrosion, this artifact was deemed in unstable condition and in need of immediate treatment. The treatment goal was to stabilize the object by removing all active corrosion and debris

Surface dirt was removed using a small dry brush. The mass of small stones and roots on the interior space were removed using a scalpel. After the soil removal, the stable black corrosion layers on the exterior surface were removed using a fiberglass brush and steel wool swabs. To reach the interior corrosion, a steel wool swab was used. Under magnification, active light green corrosion spots were carefully removed using a micro scalpel. The object was then rinsed with acetone to remove cleaning debris and any remaining soil. The object was then coated with an acryclic resin, Acryloid B-72, to provide a moisture barrier and to protect from oils on hands when handling.

Curator's Notes

This pin and needle case is a great example of an artifact that is specifically associated with the presence of women at St. Mary's City during the 17th century. Most women came to Maryland as indentured servants and typically worked in and around the house, and occasionally, worked in the fields. Pins and other personal expenditures were considered luxury goods. They were obtained through an allowance of money given by a husband to his wife – hence the term, "pin-money."

19th-century pin cases

Clock Escapement

Conservator's Notes

The surface of this 19th- or 20th- century object had a large mass of deposits and orange corrosion products, which is evidence of corroded iron. When touched to a magnet, parts of this object had a strong pull indicating the presence of ferrous iron. But unlike iron, an X-ray showed high levels of core metal remained and that the object had a clear outline indicating no corrosion had been present, which is common with copper alloys. The object's "teeth" were in very stable condition and showed no signs of active corrosion and had no magnetic pull, indicating they were copper alloy. Therefore, based on our examination, this object is a "composite" artifact consisting of both copper alloy and iron components. The X-ray, however, could not confirm nor disprove the object's true identity. Due to the objects shape, it was temporarily categorized in the condition report as a spur rowel.

Since the cleaning technique for one of the materials could potentially damage the other material, careful consideration had to be made. For example, distilled water could not be used to clean the sections of iron and the copper could not be air abraded. Instead, air abrasion techniques with aluminum oxide powder were used to decrease both soil and corrosion products to the iron sections only. The iron was then treated with tannic acid, which is only a corrosion inhibitor for ferrous metal. Except for the use of distilled water, traditional copper cleaning techniques were used on the copper alloy sections, which included the removal of corrosion products with a fiberglass brush. Once all corrosion products were removed, the entire object was coated with Acryloid B-72.

Curator's Notes

This object is part of an escapement from a 19th- or 20th- century clock. Escapements regulate a clock and actually make the sound of the clock ticking. This escapement, however, was designed to regulate the the ringing of a bell in an alarm clock. Correspondence with the American Clock & Watch Museum in Bristol, Connecticut identified its special function.

Copper Alloy Handle

Conservator's Notes

Prior to treatment, this copper alloy handle was examined visually by a conservator to determine its condition. It was noted that lettering was visible, but partially obscured by a thin layer of dark green corrosion from burial. Presence of dark green colored corrosion is evidence that the corrosion products are stable and not an active threat to the object's materials and condition. Next, an X-radiograph of the object was studied. X-rays can provide essential information about the condition of an object and if the object is stable enough to proceed with conservation treatment. From these X-rays, various condition and corrosion levels can be seen. Fragile objects have faint or dark-colored spots indicating their weakened state. Light or white colored X-rays indicate the presence of a denser metal core on stable objects. We can also see any decorative details that are obscured or masked by corrosion products and soil accretions. The X-ray of this handle indicated that it has retained its solid metal core and there is no evidence of structural damage, so this object can withstand the treatment process. The X-ray also revealed that one end of the object was broken.

The goal for every treatment is to stabilize the object so that further deterioration of the original materials is terminated. All treatment materials applied to the object to further stabilize it must also be reversible. In this case in particular, revealing the lettering was important as well. Treatment started by soaking the object in a bath of distilled water to remove excess soil. A small soft brush was used to remove the soil and the corrosion layer was reduced mechanically using a fiberglass brush and scalpel under magnification. A quick rinse with acetone was used to remove any cleaning debris and to de-water the object. Once dry, two coats of Acryloid B-72 in acetone was applied to the entire object. The B-72 provides a moisture barrier and allows the object to be handled safely. The handle, like all objects treated, was repackaged in a clean and pierced, archival stable polyethylene bag.

The cleaning of this object revealed evidence of significant wear to the middle of the handle indicating the skillet this handle was originally attached to was often used. This object may have been used while the Calvert family occupied the house or when the house was being used as an inn. Although the words on the handle could not be deciphered, they would indicate the objects maker.

Curator's Notes

This copper alloy handle is either from a pot or a skillet. Similar handles with either maker's names or, occasionally, biblical quotes of affirmations occur in collections and have been recovered from 17th-century sites in both the United Kingdom and the U.S. Our specimen bears the name "Thomas" and what appears to be "Skeeg." Some colleagues have suggested that this might be of Dutch origin, given the name. However, to date no true match has been discovered.

Three small skillets by Thomas Palmar

Button Decorated with Windmill

Conservator's Notes

This highly decorative, machine stamped copper alloy and iron button has landscape imagery that was popular during the 19th century — a windmill. Upon initial visual inspection, the face of the button was covered in corrosion products common for copper alloys and had no magnetic pull. The back was made from iron. Very little iron remained, but red corrosion products and a weak magnetic pull confirmed its existence. Since the cleaning technique for one of the materials could potentially damage the other material, careful consideration had to be made.

In this case, the copper alloy section was very stable, but the iron section had almost completely deteriorated. Due to its deterioration, the iron corrosion had to be removed by mechanical means under magnification with a micro scalpel. The corrosion layers on the copper alloy side were removed with a micro scalpel, fiberglass brush, and steel wool swabs. After the corrosion was removed, the button appeared to be plated with a gold-colored metal, but no analytical study was performed to confirm the identity of this third metal. After being rinsed with acetone, the button received two coats of Acryloid B-72, which acts as a moisture barrier and will allow this object to be handled without the risk of damage caused by skin oils.

Curator's Notes

This button is decorated with the finely molded image of a windmill and a farm scene. It appears to date to the 19th or 20th centuries and would be related to the Brome occupation of the site from the 1840s into the early 20th century. Such decorative buttons could have adorned a variety of clothing. However, given its dimension it seems likely to be from outerwear. Intriguingly, a 20th- century outbuilding on the Brome estate was called the Dutchman's House.

This button is of a class called Victorian figural buttons and represent the type of buttons used on outerwear. Intriguingly, a search on Ebay© found very similar examples for sale.

two similar buttons from Ebay© and a coin bearing the same symbol