Amheida 2012 - Object conservation

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The restoration work this year included bronze fragments, such as parts of Osiris statuettes, including head, chest, and leg pieces, and a sheet of copper; a decorated pottery cup covered with layers of clay mixed with salts; and bronze coins. The double hoard of billon coins from the area of the Temple of Thoth, however, demanded most of the time and is the focus of this report.

The hoards of coins

Although Amheida has a desert environment, enough moisture is present to interact with the soil salts, with the result that the movement of free ions produces chemical reactions. For example, CL- (chloride salts ions) is very active with moisture. Deterioration occurring to silver or copper in excavated objects is often attributed to the presence of chloride, and there is no doubt that most, if not all, corrosion products on archaeological artifacts contain chloride ions.

On the billon coins, the following formula describes what happens:

$Cu^{++} + 2Cl^{-} + Ag$ ___ $Ag\,Cl + Cu\,Cl$

The AgCl argent chloride is an unshaped crystal, which causes cracks in the metal of the coin. In addition, AgCl is an electrochemical conductor. Thus the argent chloride does not form a protective layer for the metal on the surface of the coin, like CuCl, the copper chloride (Nantokite), which causes the bronze disease.

In the alloy of the billon (silver and bronze) coins, the X-ray florescence (XRF) tests usually show some other elements present in the copper ores like tin (Sn) and lead (Pb) in significant amounts, alongside very small traces of iron (Fe), nickel (Ni), manganese (Mn), and arsenite (As). As a result of the electrochemical chain and the electrochemical reactions in the damp environment, the less noble elements rapidly decay; as copper and tin are less noble than silver, the coins are typically found showing a green color as a sign of copper corrosion.

The sandy soil at Amheida allows good penetration of air, because the large spaces between the grains of sand make it easy for air and moisture to pass through. As a result, the corrosion process becomes very active, and some coins display spongy corrosion.

The two parts of the hoard included traces of small pieces of linen cloth stuck to the coin masses, showing that the coins were originally kept in cloth bags. Some of the coins were found separately from the larger stuck-together masses. Groups of coins were covered with thick green corrosion layers mixed with soil particles and detritus. These disfigured and hid the inscriptions and the figures; in extreme cases, the metal was entirely gone. Some coins were covered with a circular black shape of corrosion as a result of the adhesion of two coin surfaces to one another.
With one exception, all coins in the hoard were made out of billon, an admixture of bronze and silver that when clean has an essentially silvery appearance.

Usually the surface of the billon coins was covered with a ruby red color, showing a streak color of cherry or purple (argent sulfates) called Proustite sulfites argent arsenate ($AgAsS_2$) and Pyrargyrite sulfites argent antimony ($AgSbS_2$). Sometimes there was a black color called Argentite (Ag_2S), argent sulfide.

Restoration work

The hoard was first disassembled into numbered clusters, the positions of which in the overall mass were recorded in photographs and drawings. The clusters were then into individual coins, each of which was given an inventory number; the cluster number was recorded for each coin. Separation was done successfully with careful use of metal tools.

The immediate aim of cleaning was that each side of the coin should be described with reference to its obverse and reverse, identifying the metallic alloy. Cleaning in addition was aimed at protecting the coins against further deterioration or damage; it did not aim at restoring the original shiny silver appearance. All of the coins were examined under a microscope and weighed. Comparison of weights allowed a preliminary determination the amount of metal under the corrosion and thus an assessment of the best method of cleaning. Separating the coins individually from each group by metal tools was made easier by immersion in a solution.

The coins were treated mechanically using a dremel for grinding the corrosion layers. A scalpel and metal tools were also used under a microscope or lens as needed. Chemical cleaning was carried out by immersion in a solution of citric acid 5%, used with care because the citric acid removes all corrosion layers, followed by formic acid 5%, which allows safe removal of the copper compounds of the green layers, and the argent sulfite or sulfide cherry red layers avoiding damages to the silver layer.

Immersion was followed by covering with cotton soaked in one of the solutions, which helps to break the bonds between the atoms in the corrosion layers; these are then more easily removed by mechanical cleaning with a hard brush or metal. After cleaning, the coin is then washed in distilled water for up to 48 hours to remove residual solutions. An application of silica gel was then followed by an application of Paraloid 72 at 3% for isolation.

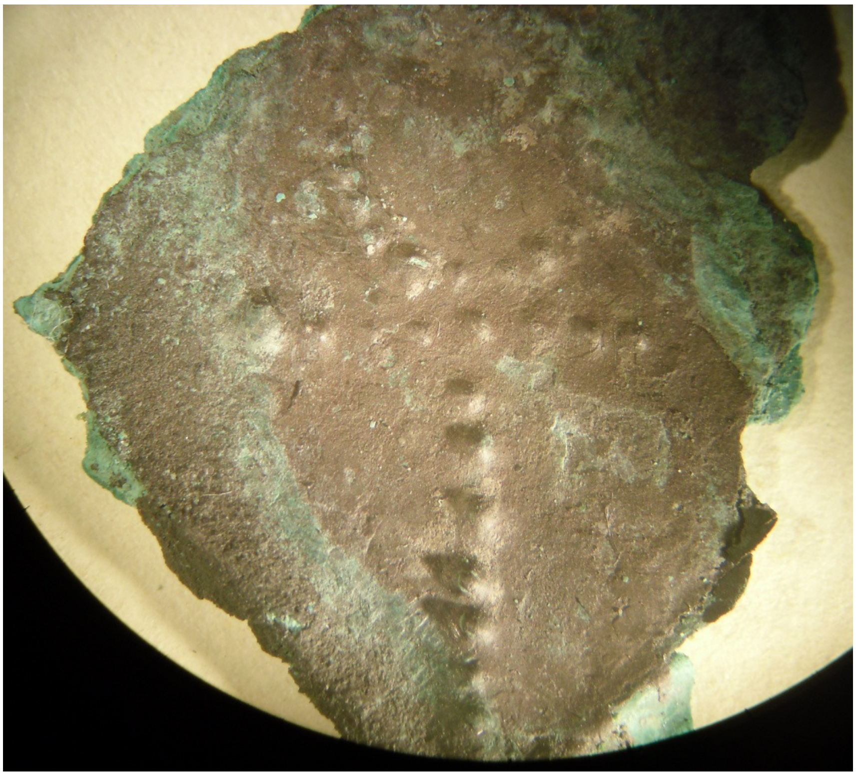

Figure 1: Unshaped sheet of copper alloy after treatment, showing ankh symbol.

Figure 2: Pottery cup after cleaning and removing the soil salts**.**

Figure 3: Obverse and reverse of a broken bronze coin after treatment.

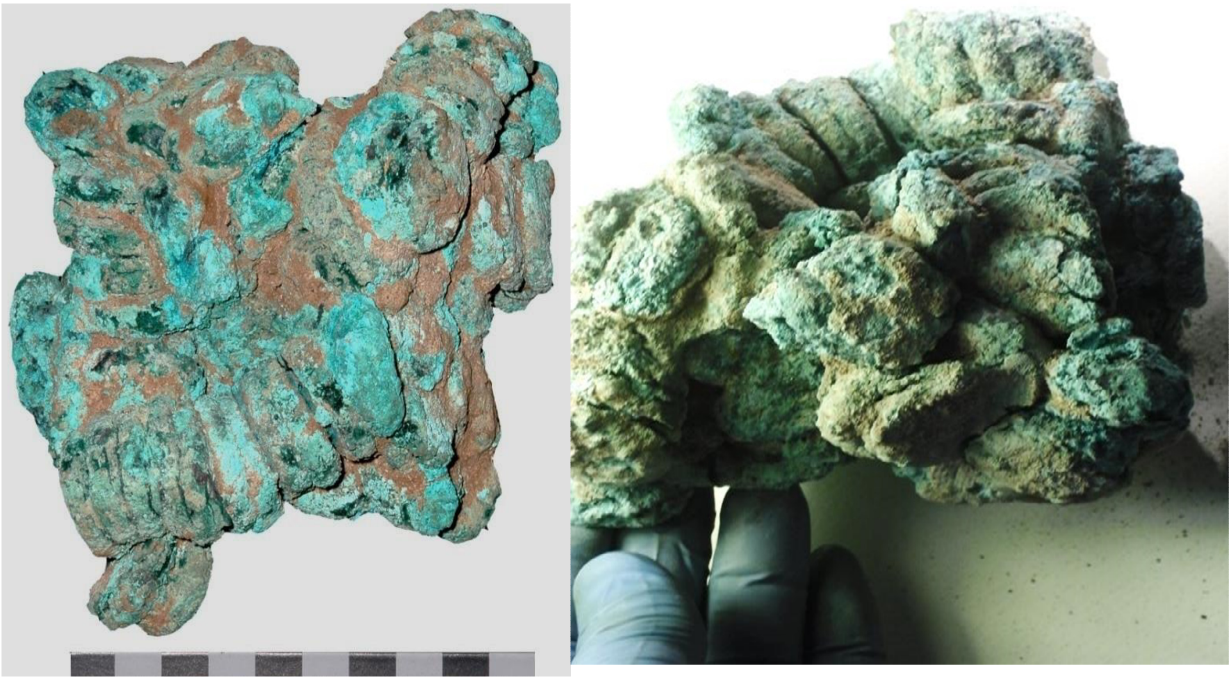

Figure 4: The coin hoards

Figure 5: Different types of corrosion and incrustation

Figure 6. Immersing a group of coins in formic acid 5%, to remove the green layer of copper compounds and the cherry red layer of argent sulfide or sulfite. Note the evaporation of the reaction under control to avoid making the silver shiny and to keep the antique color.

Figure 7. The transformation of the metal into corrosion.

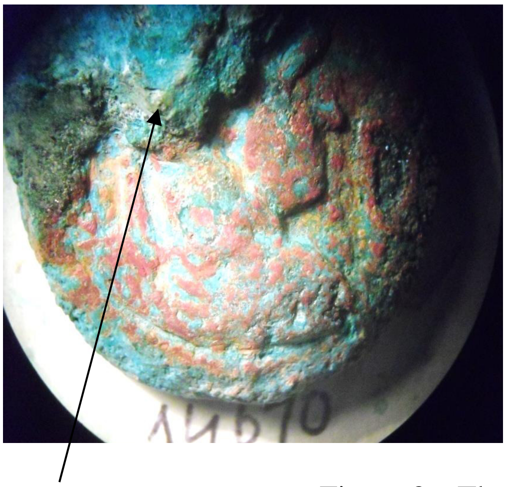

Figure 8a. The arrow points to the mass of green.
Figure 8b. After removal of the green layers, even with the red corrosion present, the coin becomes readable.

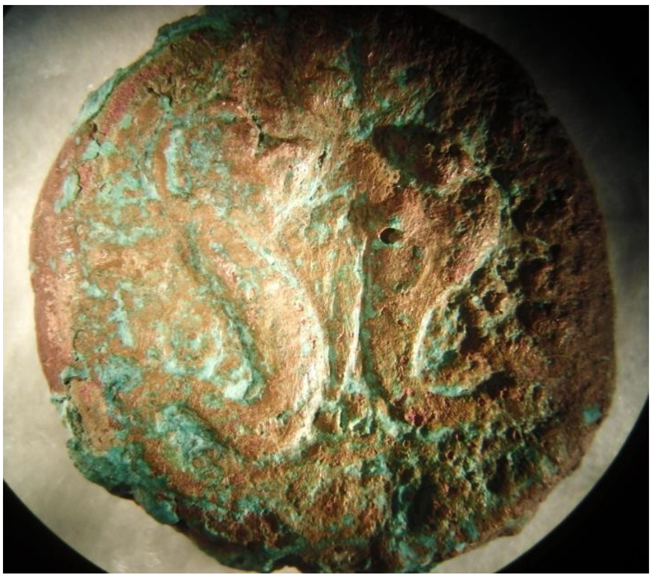

Figure 9a and 9b. A coin reverse during cleaning, stage 1 and 2.

Figure 10. Chemical cleaning by solution on carboxyl methyl cellulose (gel) to avoid the liquid effusion.

Figures 11a and 11b. Obverse and reverse of Group 28 from the coin hoard. The arrows point to places where two coins were stuck together.

Figures 12a and 12b. Types of deterioration on reverse sides, with defaced tops.

Figure 13. Group 29 before cleaning.

Figures 14a and 14b. Group 29 after cleaning.