

Analyzing and Retreating Copper Alloy Artifacts from the USS *Monitor*

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Introduction

The USS *Monitor* was an American Civil War ironclad ship that sank in 1862, roughly sixteen miles off of the coast of Cape Hatteras, NC. Archaeological excavations at the site from the late 1990s to the early 2000s resulted in approximately 210 tons of material being recovered. All artifacts were transported to The Mariners' Museum (TMM) in Newport News, VA for conservation and exhibition. While rehusing the conserved portion of the collection, circular areas of white powdery bloom were discovered on the surface of some of the previously treated copper alloy artifacts. These artifacts were isolated to await documentation, analysis, and retreatment.

There were several hypotheses as to the source of the white bloom. Residual chlorides may have been reacting with the bentriazole (BTA) coating that was applied as a corrosion inhibitor. Another possibility was that the white bloom was the result of dezincification.

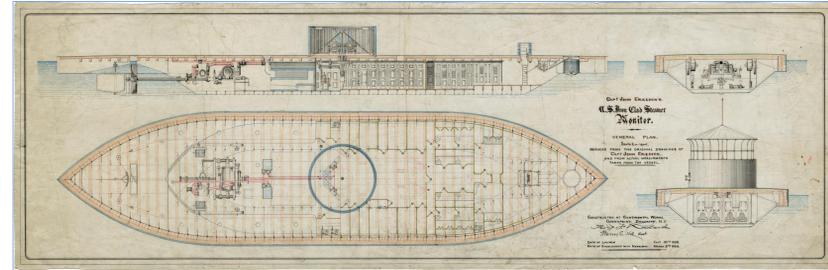


Figure 1: Overall plan of the USS *Monitor*. Image courtesy of The Mariners' Museum.

Method

Fourteen samples of the white powdery bloom were taken from thirteen artifacts. The samples were analyzed using scanning electron microscopy with energy dispersive x-ray spectroscopy (SEM-EDS) at Newport News Shipbuilding Laboratory Services in Newport News, Virginia.



Figure 2: Artifact MNMS.2001.003.014, a copper alloy bearing block before retreatment. This object represented the most extensive blooming. Image courtesy of The Mariners' Museum.



Figure 3: Artifact MNMS.2002.001.469B1, a copper alloy wheel before retreatment. The largest areas of white bloom are indicated with a red circle. Image courtesy of The Mariners' Museum.



Figure 4: Artifact MNMS.2001.003.219, a copper alloy bearing before retreatment. The white powdery bloom is visible on both the exterior and interior surfaces. Image courtesy of The Mariners' Museum

Results

Analysis showed that twelve out of fourteen samples were sodium based. Some of these samples also contained sulfur, probably in the form of sulfates, copper and potassium. The remaining two samples contained mostly copper and zinc. Chlorides and sulfides were also found in these two samples. See Table 1 for complete results. Carbon and oxygen were detected in all samples.

The sodium based samples were most likely sodium carbonate based on the presence of sodium, oxygen and carbon in the sample. This was confirmed by placing several drops of hydrochloric acid on a sample of the white bloom taken from artifact MNMS.2001.003.014. The sample fizzled, producing carbon dioxide confirming the presence of sodium carbonate.

Conclusions and Next Steps

Reviewing the treatment records for these artifacts revealed the likely source of the sodium carbonate. To facilitate chloride extraction and concretion removal most copper alloy artifacts from the USS *Monitor* are placed in a sodium sesquicarbonate solution and undergo electrolytic reduction (ER). It is likely that after ER these artifacts were not rinsed long enough to completely remove all of the sesquicarbonate. The lack of chlorides indicates that the desalination of these artifacts was successful. The lack of nitrogen indicates that the BTA coating was not the cause of the bloom.

Current plans are to retreat these artifacts by removing their wax or acrylic coatings with appropriate solvents and then rinse in deionized water to remove the sodium carbonate. The artifacts will then be recoated with an acrylic-based coating.

The two artifacts with samples containing copper, zinc, sulfides and chlorides will have to undergo more rigorous retreatment as it seems the initial desalination was not entirely successful. Conservators will remove the acrylic coatings and place the objects in a 1% w/v sodium sesquicarbonate solution for ER. Once they are completely desalinated they will be rinsed, dried, cleaned as necessary, and recoated.

Table 1: Results from SEM EDS Analysis

| Sample Number | Artifact Number | Deposits | Other Elements Detected |
|---------------|---------------------|-----------------|-----------------------------|
| 1 | MNMS.2004.001.002 | Sodium Based | Sulfur, Potassium |
| 2 | MNMS.2001.003.219 | Sodium Based | Sulfur |
| 3 | MNMS.2001.003.011 | Sodium Based | - |
| 4 | MNMS.2001.003.014 | Sodium Based | - |
| 5 | MNMS.2001.003.013 | Sodium Based | Sulfur, Potassium |
| 6 | MNMS.2001.003.013 | Sodium Based | - |
| 7 | MNMS.2001.003.267A1 | Sodium Based | Copper |
| 8 | MNMS.2004.001.003 | Sodium Based | - |
| 9 | MNMS.2001.003.148 | Sodium Based | Copper |
| 10 | MNMS.2002.001.469B1 | Sodium Based | - |
| 11 | MNMS.2001.003.016 | Sodium Based | - |
| 12 | MNMS.2001.003.015 | Copper and Zinc | Sulfur, Chlorine, Potassium |
| 13 | MNMS.2001.003.012 | Copper and Zinc | Sulfur, Chlorine |
| 14 | MNMS.1998.001.020A | Sodium Based | Sulfur |

References and Acknowledgements

Scott, D. 2002. *Copper and bronze in art: corrosion, colorants, conservation*. Los Angeles, California: Getty Publications.

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