Ongoing research projects

Corrosion characterization and treatment evaluations of iron artefacts recovered from the USS Monitor (TMM/ODU)

The National Oceanic and Atmospheric Administration (NOAA) is in charge of conserving over 230 metric tons of metal artefacts recovered from the USS Monitor. These artefacts include the ship’s iron gun turret, the engine and condenser, which were recovered between 1998 and 2002 (see BROMEC 5).

The Monitor conservation efforts are now expanding and will begin in earnest over the next year, with the completion of a dedicated conservation facility and the hiring of more support staff. Currently, the large metal artefacts, such as the engine, are stored in aqueous alkaline solutions or fresh water. The turret, which is in a mostly concreted state, has been stored in fresh water since recovery in 2002. It will be stored in this solution until archaeological excavation of its interior is completed. Scientists at Old Dominion University have been working with conservators on the project to study the corrosion characteristics of the turret and other iron artefacts. The focus of the work is to better understand the current preservation state of these artefacts and to determine treatment paths for the large Monitor artefacts.

Part of this work has involved the identification and characterization of corrosion products found underneath concretions covering the turret and corrosion products that form or are converted due to exposure to the fresh water storage solution and to air. Corrosion products on exterior surfaces that have been exposed to fresh water have been found to be composed mainly of siderite (FeCO₃), lepidocrocite (γ–FeOOH), and goethite (α–FeOOH). If this exterior surface rust is allowed to dry to any extent, akaganeite (β–FeOOH) will form due to the presence of the chloride ion.

The corrosion products that lie on the iron between the metal/concretion interface have been found to be comprised mainly of magnetite (Fe₃O₄) and fayalite (FeSiO₄). These corrosion products are deposited from the inclusions in the iron as it corrodes. High fractions of sulphur have been detected in the magnetite layer, owing to bacterial activity in a low oxygen environment.

The magnetite remains stable in its anaerobic environment, and is therefore somewhat protective of the iron, as long as the external corrosion products and concretions remain intact. Once the outer rust layer is ruptured, the magnetite can oxidize to maghemite, (γ–Fe₂O₃) and then to the iron oxyhydroxides mentioned above.

These results have shown that the conditions below the concretion are highly stable and have remained relatively unaffected by storage in freshwater over the past three years. The results have also shown the importance of keeping iron artefacts constantly wet during storage and treatment to prevent formation of akageneite. A final report of this work is, at the moment, underway and the results will soon be published.
Currently, the *Monitor* team is studying the microscopic corrosion patterns and distribution of free chlorides and chloride-bearing compounds in iron samples from the *Monitor*. Characterization of this type will aid in selecting and evaluating treatment methods for the iron *Monitor* artefacts. Concerning the latter, the *Monitor* project has teamed up with The Friends of the Hunley to further evaluate and refine the subcritical water treatment for marine archaeological iron. Members of both the *Monitor* and *Hunley* teams will present two papers on these topics at the 2005 Eastern Analytical Symposium in Sommerset, New Jersey.

Related Publications and Information:


Other information on the *USS Monitor* can be found on the following website: [www.monitorcenter.org](http://www.monitorcenter.org) and the scientific report: Investigation of the corrosion of *USS Monitor* artifacts ([www.rustdr.com](http://www.rustdr.com)).

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Editorial

Normally, you should have downloaded this new issue of our bulletin from the Metal Working Group homepage, but the ICOM-CC website and the WGs homepage are not currently accessible. In fact, the 2nd level of accessibility to the website has been implemented, but none of the ICOM-CC “official” members (voting members, Friends and student-Friends) have been given their username and password. You will understand then that BROME C16 is exceptionally sent to you through the former distribution manner - via email as an attached document.

We cannot guarantee that in the future the BROME C issues will remain freely accessible on the Metal homepage. There is some discussion at the moment at the Directory Board level on what will be fully accessible and what will be under restricted access. The new coordination team of the Metal WG has proposed to the Board to have all new issues of the BROME C accessible during the first 3 months. That means then that if it is accepted all current Metal WG members would keep access to the most recent information in the domain. Only the “official” ICOM-CC members will have full access to all past BROME C issues.

As regards this issue, some of the abstracts should draw the attention of all professionals involved in the conservation of archaeological iron artefacts. The two current ways of assuring the long-term conservation of these artefacts are presented in the two first papers: either by controlling the environment or through the extraction of active species (using the alkaline sulphite treatment which will be thoroughly reviewed through the completion of a PhD research project). A third abstract is essential since it presents a new corrosion product that might be responsible of active corrosion on iron artefacts from terrestrial sites and that is rarely mentioned in the conservation literature. The fourth abstract describes typical corrosion forms on large marine artefacts.

Two other abstracts deal with metals that deserve more research attention: aluminium and mercury. Aluminium alloys are commonly used in aircraft structures, but their precise composition and developed corrosion types require some investigation that will be carried out on the collection of the Air and Space Museum in Le Bourget (France). The project on mercury relates to the issue of the conservation of this dangerous metal in technical and scientific instruments. Such a topic cannot ignore the associated materials, the glass container in this case, and the ethical issues that will be examined.

Also, this issue marks the end of the first year of the EU PROMET project and reviews some of the major achievements up to now.
This bulletin is the first one of our new triennial period. It is hoped that it will remain an important tool of communication for the members. The coordination team of the Metal WG will do its best to maintain its quality, but it will depend too on you to maintain its activity. We are all conscious that without the voluntary, yet professional, contribution of the members and the active promotion of the national representatives of the Metal WG this bulletin would not exist.

As usual, we hope that you will find this issue as useful and as interesting as ever.

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