



The role of relative humidity in the corrosion rate of copper in the presence of cuprous chloride: a risk-based approach

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Museums worldwide house collections of archaeological copper alloy (CuA) objects that are potentially unstable due to incorporation of cuprous chloride (CuCl) formed in the burial environment. With sufficient atmospheric moisture, post-excavation hydrolysis of CuCl, a process often referred to as 'bronze disease', forms voluminous basic copper chlorides (Cu₂(OH)₃Cl). These disrupt overlying patinas, degrading the artistic, aesthetic and technological value of collections.

To prevent the formation of Cu₂(OH)₃Cl and corrosion of unstable archaeological CuA objects, relative humidity (RH) levels around artefacts are often controlled to below published thresholds. Maintaining RH can be time consuming and resource-intensive, therefore a thorough understanding of the risk to unstable objects in a given environment is critical to produce sustainable management procedures tailored to preservation aims and budgets. Current guidelines for safe storage provide a range of RH targets without quantified evidence of corrosion risk relative to RH. This lack of definitive guidance has led to highly variable practices internationally in the management of desiccation for collections.

This paper presents the results of AHRC SWWDTP funded doctoral research which is building an understanding of the risk associated to unstable objects at different RH levels. To simulate post-excavation corrosion processes occurring in unstable objects, Cu and CuCl powder mixtures have been subjected to the RH range 20-90% and their corrosion rates measured quantitatively using the Cardiff University oxygen consumption technique^{1,2,3}. X-ray Diffraction and Raman spectroscopy have been used to examine the composition of the powders and the corrosion products formed. The results provide insight into the corrosion process of unstable objects and illustrate the efficacy of using RH to control post-excavation corrosion. A solid baseline for undertaking further measurements has been formed which will inform future management guidelines.

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3. Watkinson, D. and Emmerson, N. J. 2017. The impact of aqueous washing on the ability of βFeOOH to corrode iron. *Environmental Science and Pollution Research* 24(3), pp. 2138-2149. (10.1007/s11356-016-6749-3)