Electrochemical Analysis of Chloride Impacts on Passivation of Archaeological Iron in Desalination Solutions

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Abstract: Based on the passivation of iron in alkaline solutions, aqueous alkaline treatment has been taken as an effective desalination technique to increase the stability of archaeological iron. However, chlorides may destroy the passivation of iron artifacts, causing damage to the treated artifacts during desalination. In this study, electrochemical and microstructure analyses were used to evaluate the corrosion behavior of iron artifacts, and to quantify the impact of chloride ions present within both the rust layer and the alkaline solutions on iron corrosion. The study revealed that even with the presence of chloride within the rust layer, alkalinity ensures passivation, thereby limiting the corrosion rate of iron artifacts. However, the passivation weakens as the concentration of 'free' chloride ions in the alkaline solution increases due to their migration from the rust layer, leading to active corrosion. A chloride threshold value (CTV) of 355ppm in 0.1 mol/L NaOH solution was established as a chloride level for the replacement of the alkaline solution to ensure the safety of artifacts during desalination treatment. The determination of CTV during the desalination process is of practical importance, and can guide the timely replacement of the desalination solutions to prevent chloride-induced iron corrosion during desalination treatments.