Master's Thesis Abstract

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Title

A conservation scientific study of archaeological waterlogged wood using a reinforcing agent impregnation method with controlled solvent evaporation rate.

Archaeological wood that is unearthed in a waterlogged state has a very deteriorated wood cell wall. When this wood dries, it undergoes significant deformation and does not revert to its original shape. Therefore, archaeological wood in a waterlogged condition requires preservation.

Generally, the prevalent impregnation method involves soaking water-saturated wood in an aqueous solution containing a strengthening agent. This process, replacing the water within the wood with a moist solution, facilitates the impregnation of the strengthening agent into the wood's interior. However, this approach prolongs the preservation timeline.

Numerous archaeological woods are excavated in waterlogged conditions by local governments and other institutions. However, archaeological woods that have not undergone preservation are stored in waterlogged conditions, posing a significant issue. To address this issue, a novel method for impregnating the reinforcing agent has been developed. This new technique, controlling the rate of solvent evaporation during the reinforcing agent impregnation process, enables active and expedited impregnation, mitigating the duration of this phase. Since there are still only a few examples of verification of this method, it is necessary to increase the number of examples of verification through experiments for practical use.

In this study, the practicality of this preservation approach was examined from four distinct perspectives. These encompassed the efficacy of active impregnation, the impact of simplified equipment on treatment outcomes, the influence of multiple reinforcing agent impregnations on treatment efficacy, and the optimal selection of reinforcing agents for this methodology.

First, the apparatus for impregnating reinforcing agents using controlled solvent evaporation rates was simplified and reproduced with inexpensive equipment. Experiments were conducted using this apparatus to impregnate cedar woods with polyethylene glycol (PEG), trehalose, and methylcellulose. Methylcellulose, due to its high polymer content and viscosity, posed challenges for conventional impregnation methods. Post-preservation treatment evaluations focused on weight ratios, volume of impregnated agent within the wood's voids, and dimensional changes, serving as indicators. The results confirmed that the method with controlled solvent evaporation rate resulted in a greater amount of reinforcing agent being impregnated per day than the previous method of soaking the wood in an aqueous solution. This confirms the reproducibility of the result that the method by controlling the solvent evaporation rate is effective in actively impregnating the reinforcing agent. The method by controlling the rate of solvent evaporation revealed that the shape of archaeological wood affects the effectiveness of the preservation treatment and that more reinforcing agents can be impregnated by increasing the number of times the wood is impregnated.

However, challenges persisted concerning achieving equivalent agent impregnation levels as conventional methods, managing post-treatment storage environments, and elucidating distinct agent properties. To clarify this, in this study, subsequent analysis using X-ray CT's brightness histogram underscored the even distribution of PEG throughout the wood, contrasting with trehalose's uneven distribution due to its higher melting point, rendering it unsuitable for treatments utilizing controlled solvent evaporation rates.

Finally, the results and discussion of the above experiments are summarized, and recommendations are provided for institutions currently considering the introduction of a new preservation process. In the future, it is hoped that an increase in verification cases using the solvent evaporation method will allow for the identification of conditions yielding favorable outcomes. Additionally, there is an expectation for the advancement in developing evaluation methods for the solvent evaporation technique, such as X-ray CT analysis. Moreover, there is anticipation for the development of preservation methods capable of addressing various challenges in the conservation treatment of waterlogged archaeological wood.