CONSOLIDATING TREATMENT OF CARBONATIC ROCKS
BY USING DIAMMONIUM HYDROGEN PHOSPHATE (DAHP):
INFLUENCE OF APPLICATION TECHNIQUES ON THE PENETRATION DEPTH

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INTRODUCTION AND OBJECTIVES
The consolidation is one of the most critical phases in restoration of decayed rocks making up the building structures of historical-architectural interest, which requires the verification of different parameters for proving their real effectiveness. For this aim, recently, the diamonium hydrogen phosphate (DAHP) has been proposed as an inorganic consolidant to favor the formation of calcium phosphates, mainly hydroxyapatite (HAP). The objective is to obtain a stone consolidating material suitable to restore the decayed carbonate rocks. A fundamental parameter, for assessing the effectiveness of the consolidating treatments, is the penetration depth of the newly-formed strengthening mineral phases. Furthermore, the methodologies and techniques of application of the consolidant products, as well as the operating conditions, all can play a fundamental role on the outcomes of treatments.2

MATERIALS
A systematic experimentation was carried out through the application of aqueous solution DAHP on two different carbonate lithotypes: Carrara marble (Marmo Statuario Michelangelo) and a biomictic limestone, collected in Tuscany and central Sardinia (Santa Caterina di Pittinuri), respectively.

METHODS: artificial damaging
The accelerated aging of the stone samples, artificially induced for obtaining decay conditions, was obtained by the application of thermal stress processes. The samples were heated to 600°C for 7 hours.

METHODS: application techniques
The aqueous solution DAHP was applied on the stone sample surfaces, using three different methodological techniques: brushing, immersion and poultice. The three treating methods were tested on artificially damaged stone samples, during 2 hours at room temperature.

METHODS: characterization
For Optical Microscopy (OM) and Fluorescence Microscopy (FM) were used polarised light microscope Olympus BX 5 and mercury lamp fluorescence Olympus U-RP-T; for Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectrometry (EDS) was used JEOI JSM 6400; for Porosimetric Analysis (MIP) was used AutoPore IV 9520 porosimeter, Micromeritics; for measurement the Ultrasound Propagation Speed (US) was used Pundit, Cns Electronics; for Hardness Test (Leeb value) was used Rebound microdrometer Leeb Equotip 3D, Proceq.

RESULTS

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The analytic results showed that the thermal treatment has had a negative effect on the physical and mechanical properties of both the studied lithologies, in comparison with the untreated materials. The DAHP aqueous solution has improved the parameters analyzed, through the three different techniques studied, with only small variations between them.

CONCLUSIONS
The present study confirmed that the thermal treatment is a good method for artificially damaging carbonate stone samples. The penetration depth of the new formed phase of calcium phosphate was verified by SEM-EDS analysis: between the application techniques used the poultice has been resulted the most promising. The new formed mineral phase, in both lithologies studied, was concentrated mainly in the first millimeter of thickness. Furthermore, the presence of calcium phosphates was detected up to 5 mm in marble and up to 10 mm in limestone.

References

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