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Prolonging the Durability and Conservation of Historic Materials by Microclimatic Monitoring in the Archaeological Areas

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1 Introduction and Aim of the Paper

Many factors have to be considered for the proper conservation of cultural heritage, in particular, the exposition of the object/site to open air, as the archaeological sites have. The risk factors can be intrinsic (durability of materials, construction and decorative techniques) and extrinsic (environmental and microclimatic conditions). The consideration of the conservation issue regarding the second has to take into account the effects the microclimatic parameters on the objects and the variation of microclimate for the use, as well as the modification due to the improvement of accessibility, safety and installations (for example plant and architecture addition/modification). In fact, the main objective of the conservation/fruition of the archaeological areas is achieving the project choices most integrated, functional and adequate to meet the needs of conservation. Monitoring and diagnostics are a necessary condition to be able to correctly define the design choices. The proposed contribution aims to specify how monitoring the microclimatic values play a fundamental role in the whole process of conservation, since the early study to the management of the site, to ensure the greater conservation and durability of the material and, ultimately, the best fruition at present and in the future. Diagnostics and monitoring are therefore a fundamental activity for understanding and mitigating risk factors that affects the durability of goods and sites (Rosina *et al.,* 2011; Cecchini, 2012; Rosina, 2012; Camuffo *et al.,* 2015, Rosina *et al.,* 2019).

2 Methods and Materials

In the following, the paper presents the investigation, monitoring, management of an underground Roman tomb in the Necropolis of Tuvixeddu in Cagliari. The tomb is built inside a limestone bench and the internal surfaces are decorated with wall paintings and lime mortar stuccos. The cognitive phase of the site regarded several aspects: materials (surface sampling and chemical analysis for the characterization), degradation (sampling and chemical and biological investigations), archaeological (excavation and acquisition of results), environmental and microclimatic. The latter, which began in July 2017, includes continuous monitoring of microclimatic values (still in progress) and various psychrometric and thermographic campaigns. The goal is to understand the behaviour of the site microclimate at static conditions how it varies during the seasons, the effects of opening and presence of visitors inside it. Regarding this last aspect, continuous monitoring has allowed the recording and analysis of data also during the phases of archaeological excavation and restoration of the

surfaces, when up to 10 people remained inside for many hours a day. The monitoring lasted during the discovery of new burial environments and the lowering of the walking surface to the original height, that changed of the air volume. The measurement made it possible to verify the trend of the microclimatic parameters as the volumetric conditions changed, as well as the variations due to the ventilation conditions and the presence of people. The microclimatic data were cross-checked with the results of the chemical and biological analyses, that supported also the choice for design and size of the light system (type, lighting localization and time), air conditioning and control to be installed. Besides, prolonging the continuous monitoring after opening the site will allow acquiring the information necessary to correctly manage the installed plants.

3 Discussion and Conclusion

The availability of scientific literature and the present capability to conduct more appropriate restorations with the investigation of the chemical-physical properties allowed to safely open some tombs, through the study of air control and the management of the number of accesses. The environments resulted with good thermal inertia due to the thickness and the quality of the rocks. On the contrary this determines that the environments are particularly humid and, with scarce possibility to reduce the humidity. The major thermal unbalances are located near the entrances and during their opening. Therefore, to improve the durability of historic materials in such severe ambient condition, the scientist and competent authorities took the choice to open only the tombs with more durable materials at open air and provide a consistent plan of conservation for periodic inspection and preventive activities.

Moreover, special care has been devoted, design the entrance room, with the aim to create a double space isolate the microclimate from the external variation and guarantee an intermediate space for disables. Nevertheless, the design of the accessibility and its boundary remains one of the central focus of the conservation of archaeological sites, although sharing experiences and knowledge is far from any possible standardization of the solutions. What is possible, instead, is to share the best practices for acquiring data and monitoring, starting from the preliminary overview up to the maintenance and regular inspection after the restoration.

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