

# The Nerja Cave as a conservation model for the subterranean Cultural Heritage

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**ABSTRACT:** The Nerja Cave is one of the main tourist and cultural resources of the province where it is located. The preservation of the cave and its heritage for future generations requires interdisciplinary research. In recent years an interdisciplinary research project has been carried out with numerous external researchers aiming to: (1) determine the pressures in the cave, especially the anthropic impact and its relationship with microclimate changes and biodeterioration factors, (2) characterize the cultural heritage of the cave and the surroundings with the specific preservation of the rock art and (3) design a management model for the adequate conservation of the heritage and with the tourist nature of the cave. The results of this project have provided the Nerja Cave Foundation with mechanisms, tools and valuable information, indispensable for the development of a rational management plan for this Asset of Cultural Interest, based on conservation, research and dissemination of its heritage.

## 1 INTRODUCTION

With about 450,000 visitors every year, the Nerja Cave represents a very important natural and cultural resource for the tourist industry of the region where it is located. The cave, with a surface of 35,000 m<sup>2</sup>, has been declared as an Asset of Cultural Interest with the category of Archaeological Zone and houses one of the most important archaeological sites of the Iberian Peninsula with rock art that maybe the most abundant and oldest in southern Europe. In addition, the Nerja Cave has an exceptional natural heritage with large halls and spectacular speleothems of great scientific interest where, moreover, a unique ecosystem has developed with endemic species. At the beginning, a few months after the discovery of the cave, the research projects were focused on the archaeological excavations, however this soon widened to include geological and biological research.

The preservation of the cave and its heritage for future generations requires interdisciplinary research and, in recent years, the Research Institute of the Nerja Cave has been in charge of the research, preservation and dissemination of the heritage of the cave. An interdisciplinary research project has been carried with numerous external researchers, aiming to provide the Nerja Cave Foundation with the mechanisms, tools and information necessary for the development of a rational management plan based

on research, conservation and dissemination of this Asset of Cultural Interest (V.V.A.A. 2015). The research carried out, which we present in this paper, is integrated in the design of a conservation model of the underground cultural heritage that could be applied in other similar caves. The proposed model is based on the premise *to know how to preserve*.

## 2 RESEARCH

A study on biodeterioration has been developed focused, for the moment, on phototrophic biofilms. We have investigated these biofilms by studying their development and relationship with the environmental factors. The results have allowed us to identify the cyanobacteria *Chroococcidiopsis* sp. together with rhodophyta *Cyanidium* sp., both considered extremophiles, as the most abundant phototrophic organisms in the cave (Rosal del *et al.*, 2014). Moreover, these biofilms have been related to physical and chemical damage of the substrate, such as discoloration, dissolution and rupture, amongst others (Fig. 1). These and other alterations of the rock substrate have been analyzed, *in situ*, using laser induced plasma spectroscopy technology (LIBS). This data has been the basis for the design of corrective measures, including an experimental lighting system that will be tested through taxonomic and ecophysiological studies, aimed to control the re-