

# Evaluation of the role of biocolonizations in the conservation state of Machu Picchu (Peru): The Sacred Rock

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## Abstract

Machu Picchu Inca sanctuary (Cusco Region, Peru) was constructed on a granitic plateau, better known as Vilcabamba batholith. One of the most important carved granitic rocks from this archaeological site is the Sacred Rock, used by Inca citizens for religious rituals. Due to the location and climatic conditions, different rocks from this archaeological site are affected by biocolonizations. Concretely, the Sacred Rock shows flaking and delamination problems. In this work, a non-destructive multi analytical methodology has been applied to determine the possible role of the biodeteriogens, forming the biological patina on the Sacred Rock, in the previously mentioned conservation problems. Before characterizing the biological patina, a mineralogical characterization of the granitic substrate was conducted using X-ray Diffraction, Raman microscopy (RM) and micro energy dispersive X-ray fluorescence spectrometry. For the identification of the main biodeteriogens in the biofilm, Phase Contrast Microscopy was used. RM also allowed to determine the distribution (imaging) and the penetration (depth profiling) of the biogenic pigments present in the biopatina. Thanks to this study, it was possible to asses that some colonizers are growing on inner areas of the rock, reinforcing their possible assistance in the delamination. Moreover, the in-depth distribution of a wide variety of carotenoids in the patinas allowed to approach the penetration ability of the main biodeteriogens and the diffusion of these biogenic pigments to the inner areas of the rocky substrate.

Keywords:

Machu Picchu, Sacred Rock, Biodeteriogens, Raman microscopy, Phase Contrast Microscopy, Depth profiling