

Biocolonizer species are putting the conservation of the granite at Machu Picchu at risk

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There is a wide variety of biocolonizer species that are putting the conservation of the granite at Machu Picchu at risk. Credit: Héctor Morillas / UPV/EHU

The UPV/EHU's IBeA research group has used a non-destructive methodology to determine the role of specific algae, lichens, mosses and cyanobacteria that may be causing exfoliation and delamination processes that are degrading the Sacred Rock of Machu Picchu, one of the most important symbols in the Peruvian archaeological city.

The Sacred Rock is one of the most important monuments at the Inca sanctuary Machu Picchu, located in the Cusco region in Peru. It is a granitic rock that the Inca culture used for religious worship, regarded as the gateway between Earth and heaven. Owing to the location and climate conditions of the site, many rocks in the archaeological city are affected by biocolonization. And at the Sacred Rock in particular, it is possible to see various [exfoliation](#) processes occurring.

"In other words, there are small losses of material that are causing small areas of the rock to flake," explained UPV/EHU Ph.D. lecturer Héctor Morillas. He is conducting research relating to Machu Picchu in collaboration with the IBeA research group of the Department of Analytical Chemistry and with the Department of Plant Biology and Ecology at the UPV/EHU's Faculty of Science and Technology.

By applying a non-destructive, multi-analytical methodology, the researchers have determined the role played by the species of lichens, algae, mosses and cyanobacteria colonizing the Sacred Rock with respect to the conservation problems it is displaying.

Morillas said, "Once these species penetrate the material through some kind of minor deterioration that has been forming, they attach themselves to the material itself so that they can feed off the minerals of the rock, gradually degrading it. As time passes, these micro-organisms can cause minor delamination that could result in the progressive loss of this rock."

Monitoring biogenic pigments to determine depth

The researchers determined the family to which each of the species of micro-organisms found in numerous micro-samples of the rock belongs, as well as which biogenic pigments are excreted by each of them. "We carried out in-depth profiling to predict how far these micro-organisms may have penetrated," said Morillas. "There is a wide variety of biocolonizer species in the Sacred Rock, most of which have penetrated through the porous substrate, and which could be one of the factors responsible for the stress being endured by this [rock](#)."

This research is just one of the studies being conducted by the scientists at this location. The diagnosis of the conservation state of various buildings, such as temples, houses or meditation areas in the archaeological city, has also begun; at the same time, the building material used throughout Machu Picchu has been analysed.

"We are also studying possible alterations in the granitic material owing to possible incorrect restoration carried out in the past in certain places at Machu Picchu," said Morillas. The researcher has also conducted an ecotoxicity study of the city itself and all the surrounding area of the Archaeological Park. "We have analysed the soil, air and rainwater for potential contaminants."

Additionally, Morillas analysed [rock paintings](#) located in the park and has been able to specify the [materials](#) used to produce them. "These paintings are believed to date back much earlier than the pre-Hispanic era," said Morillas. "Thanks to all this, we are drawing up the basis of a project with various universities and institutions in other countries to study the conservation of emblematic UNESCO locations."

More information: Héctor Morillas et al, Evaluation of the role of biocolonizations in the conservation state of Machu Picchu (Peru): The

Sacred Rock, *Science of The Total Environment* (2018). [DOI: 10.1016/j.scitotenv.2018.11.299](https://doi.org/10.1016/j.scitotenv.2018.11.299)

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