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The influence of biofouling on water transport inside porous stones

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During the 21st Century, climate change and improving air quality will alter biological communities and their influence on building stones. While air pollution used to be a principal factor of stone deterioration, it is diminishing in many parts of the world. These environmental changes affect the aesthetics of building stones, and fewer black gypsum crusts will form, while more biological-induced discolorations could occur. Within the British Isles, it resulted in the “greening” of monuments after increased algal growth. Besides aesthetical damage, the formation of biofilms could affect water transport and retention. Changes in the water-stone relationship should be studied in detail because moisture is the most significant facilitator of stone alteration, leading to physical, chemical and further biological weathering.

This topic was intensely studied on soils. However, knowledge of the effect of biofilms on water transport and retention of stones is limited. For this reason, three porous natural building stones: Ernzen, Euville and Savonnières, were biofouled at the outer surface with the cyanobacteria *Phormidium autumnale*. The colonization was estimated by spectrophotometry, and their relationship with the stones was studied by Scanning Electron Microscopy (SEM), Environmental SEM (ESEM) and optical microscopy on thin sections. Based on the European standards, the water transport properties were determined of biofouled and untreated samples.

Microscopy showed that the biofilms covered the surface while they spanned over and closed numerous pores. They had a measurable effect on water transport and retention and reduced the rate of capillary water absorption and drying in combination with higher moisture content after (vapor) sorption. Moreover, the biofilms changed the surface wettability and induced near hydrophobic conditions in a dry state while no effect was measured on the water vapor diffusion and air permeability. These changes can alter the material properties and other processes like salt weathering and freeze-thaw damage. As swelling and shrinkage were observed by ESEM, the properties and physical effects of biofilms are expected to change with fluctuating relative humidity.