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Differences in physical properties, mineralogy and geochemistry of weathering crust and host rock: a case study of the porous limestone of Parliament and Citadella in Budapest (Hungary)

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Ashlars of the Parliament and Citadella were studied to assess the processes of atmospheric pollution related decay of porous limestones. Different types of weathering crusts cover most parts of the buildings. White (thin and thick laminar) and black crusts (laminar and framboidal) are the most frequent decay features. The detachment of the crusts is characterised by contour scaling, multiple flaking or blistering and may lead to accelerated decay of the substrate; i.e. crust removal is followed by granular disintegration. Alternatively, secondary crust formation may temporarily stabilise the stone surface, prevailingly within the first few centimetres. Detailed mapping of deterioration features enabled us to quantify the percentage of each weathering form.

For a better understanding of the mechanisms of stone decay detailed physical, mineralogical and chemical analyses were performed on site and in the laboratory. Elastic rebound hardness testing (Schmidt hammer), water absorption and micro-drilling resistance tests were applied to analyze the physical changes close to the stone surface at the buildings. Core samples were also taken to laboratory for testing the alteration of the stone at depth. Besides porosity and pore size distribution, the mineralogy of crusts and host rocks were also analyzed.

In order to constrain the influence of temperature variations on the detachment of different types of crust temperature measurements were carried out. The white crusts do show remarkably lower temperatures than black crusts. Annual and diurnal temperature variations are also supposed to be important for the crust detachment.

Schmidt hammer rebound values are sensitive to stone degradation. Damaged stones range between 15-20, intact stones give higher values. The micro-drilling resistance measurements clearly document the existence of crusts and cemented zone at the stone surface and the degradation of the material below. A porosity and pore size distribution also reflects this trend: there is a zone of decreased porosity near to the exposed surface while an increase in porosity is observed below the crust.

On ashlars where the crust has been recently detached the exposed host rock show a limited drilling resistance at its surface with a gradual increase in drilling resistance at greater depth. Our tests have shown that a direct assessment of the weathering status via Karsten tube measurements is not unequivocally possible. Once a crust starts to get separated from the host rock, water can seep off rapidly in the weakened zone behind the crust masking the host rock properties.