

STONE WEATHERING INDUCED BY AIR POLLUTION: THE INVESTIGATIONS OF THE DEVELOPED BLACK SURFACES AND THE SUBSTRATES

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The development of black crusts on natural stones of historic buildings is mainly related to the surrounding polluted atmosphere. The blackening of surfaces is caused, in fact, by the accumulation of air pollutants produced by human activity, especially carbon particles originating from combustion processes including fossil fuel and biomass burning combustion. Since the surfaces of historic buildings and their artistic and architectural elements are the areas where air pollutants (gases and particles) are deposited, accumulate and interact with the stone substrate, the chemical composition of crusts will reflect the change over time of the pollution sources. Investigations of the geochemical composition of damage layers present on the monuments can be the basis for planning suitable strategies for the protection and conservation of the built cultural heritage. Cairo (Egypt), Venice (Italy), Madrid (Spain), and Budapest (Hungary) are four cities with numerous cultural heritage buildings; moreover, they suffer high level of air pollution. Samples of black crusts and limestone host rocks taken from different heritage buildings and archaeological sites were investigated by using traditional techniques such as, polarizing optical microscope for petrographic characterization of the study samples, scanning electron microscopy coupled with energy-dispersive X-ray spectrometry (SEM-EDS) for studying the morphology of the black crust and its relation with the host material, and infrared spectroscopic techniques (FT-IR) for mineralogical analysis. An innovative technique, laser ablation inductively coupled mass spectrometry (LA-ICP-MS), was used to determine the concentration of trace elements which usually accumulates on the black crust. Furthermore, a new

methodology based on CHN (Carbon, Hydrogen, Nitrogen) and TGA (Thermo-gravimetric) analysis was developed for the quantification of the two main constituents of the carbonaceous fraction present in the black crusts, i.e. OC (organic carbon) and EC (elemental carbon).