Air pollution impact on stones in urban environment: a multidisciplinary approach

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Air pollution is the major responsible for the formation of damage layers on stone monuments and historic buildings in urban areas (Bonazza and Sabbioni, 2016). Among widely used building materials, marble and limestone were selected in previous studies on pollution impact, thanks to their chemical homogeneity (mainly composed by calcium carbonate) and low porosity. The effects of pollution have been heretofore assessed by analyzing samples collected from historic buildings or performing tests in simulation chamber and/or in field but gaps still remain in measuring deposition fluxes on materials and developing proper tools for long-term management of cultural heritage. Moreover, the possible effects on built heritage of the current atmosphere poorer than in the past of SO_2 but richer of NO_x and organic compounds (mainly released by vehicular traffic) should be considered.

Field exposure tests with model samples are currently under execution in Italian cities characterized by different environmental conditions as a non invasive methodological approach for studying the impact of urban pollution on carbonate stones. The methodological approach selected for this investigation as well as first available results are here discussed. Marble (Carrara Marble) and limestone (Red Verona Marble) were selected as model samples as they were widely used as construction and ornamental elements in historic Italian architecture. They will be exposed at least for 2 years in Bologna, Ferrara, and Florence. Preference for samples exposure were given to sites located outdoor, partially sheltered from the rain wash-out, in areas strongly affected by pollution due to vehicular traffic. Galvanized metallic racks was prepared to host samples with different exposure orientations: horizontal, oblique (tilted with 45° slope) and vertical, in order to identify how positioning may reflect on deposition and removal of pollutants. The exposed samples will undergo mineralogical, petrographic and geochemical analyses (Optical Microscopy, Scanning Electron Microscopy coupled with Energy Dispersive X-ray Analysis, Inductively Coupled Plasma Mass Spectrometry, Ion Chromatography analysis and Thermal-chemical methodology using a CHNSO combustion analyzer (Ghedini et al., 2006)) at predefined time intervals to characterise the products derived from pollutants-stone interaction in terms of typology, origin and impact on stone. Moreover, the integration with colorimetric analysis will allow to identify a connection between the deposited soluble and carbon fractions and changes of colorimetric parameters, for setting up damage functions. Simultaneously passive sampling of aerosol has been designed by the exposure of filters while seasonal environmental monitoring campaigns of particulate matter will allow to compare the quantity of soluble ions and carbon fractions present into atmosphere with that actually accumulated on samples surface. Additionally, monitoring campaigns of bioaerosol has been planned in Bologna in order to quantify the microbial load (fungi and bacteria) in air. Data of environmental monitoring campaigns as well as results of analyses carried out after the first year of exposure will be also reported.

References

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