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Analysing pollutants deposition on carbonate stones exposed in different Italian urban sites

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Air pollution constantly threatens the conservation of stone used in historic built heritage of urban areas. Previous studies on pollution impact focused mainly on marble and limestone, due to their low porosity and chemical homogeneity, by analysing samples collected from historic buildings or performing tests in simulation chamber and/or in field. However, gaps still exist in measuring deposition fluxes on materials and developing proper solutions for long-term management of cultural heritage. Furthermore, the possible repercussions on built heritage of the current atmosphere, poorer than in the past of SO_2 but richer of NO_x and organic compounds, merit consideration.
Two years-long field exposure tests with model samples are currently under execution in Italian cities (Bologna, Ferrara, Florence) characterized by different environmental conditions as a non-invasive methodological approach for studying the impact of urban pollution on carbonate stones. The selected methodological approach as well as first available results on exposed samples after the first year of exposure will be 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. Galvanized metallic racks were prepared to host samples with different exposure orientations (i.e. horizontal, oblique and vertical) in order to identify how positioning may reflect on deposition and removal of pollutants. Stone samples were exposed outdoor, partially sheltered from the rain wash-out, in areas strongly affected by pollution due to vehicular traffic. At predefined time intervals, the exposed soiled specimens 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)) to characterise the damage products (typology, origin) due to the impact on stones by gaseous pollutants and carbon/soluble fractions of aerosol. Moreover, a connection between the deposited soluble and carbon fractions and changes of colorimetric parameters will be assessed for setting up damage functions, by performing colorimetric analysis. 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 soluble ions and carbon fractions present into atmosphere with that actually accumulated on samples surface.

References

Ghedini N., Sabbioni C., Bonazza A. and Gobbi G., Chemical-Thermal quantitative methodology for carbon speciation in damage layers on building surfaces, Environmental Science and Technology, 40 (2006), 939-944.