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Submicroscopical and microanalytical characterization of airborne fine particles (PM_{10}) collected by automatic device and entrapped by biomonitors in Mediterranean urban environment

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The decision taken by the European commission to revise the standard for airborne particulate matter (PM) has led to a renewed interest in the characterization of PM in the different regions of Europe (Putaud et al., 2004) and also to a better understanding of PM pollution problems.

PM levels and composition strongly reflect ambient (geographical and climatic) conditions and type of monitoring site (from rural to urban) (Querol et al., 2004). In particular, in Mediterranean urban areas affected by processes of natural dust resuspension, desert dust transport or low-rainfall rates, mineral dust may exert a considerable influence on PM load and nature in addition to the local emissions (e.g. vehicular traffic). Moreover, at coastal sites sea-spray may also significantly contribute to PM compositional changes.

We present here a summary of the results obtained from biomonitoring studies carried out in Naples urban area, focusing on the characterization of PM collected by automatic device (PM_{10}) and entrapped by moss and lichen exposed in bags (Adamo et al., 2003, 2004).

Major and trace element concentrations in both PM_{10} collected by automatic device and biomonitors were measured by acid digestion in teflon vessels followed by analyses of mineralised solutions with a combination of analytical techniques (FAAS,

GFAAS, ICP-AES,). X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM and ESEM) equipped with microprobe (EDS) were the instrumental techniques applied to obtain information on the morphological, mineralogical and chemical nature of PM.

PM_{10} levels in Naples urban area were highly variable, but generally above the threshold values fixed by the directive 1999/30/EC. Accumulation of fine particles in filters increased significantly in windy conditions, while their concentrations were inversely related to those of main gaseous pollutants (SO_2, NO_2, CO). The concentration of major and trace elements in PM_{10} samples was affected by airborne soil dust particles, according with the statistically significant relationships between concentrations of elements Al, Ca, Cr, Cu, Fe, K, Mg, Mn and V. Very significant relationships were observed between Ni and V, assumed to be representative of oil combustion processes, and between Na and Mg, indicative of marine aerosols. Lead and Hg did not correlate significantly with any other element, suggesting for them an anthropogenic origin and different mechanisms of atmospheric transport and deposition, with respect to the other metals. On the base of the Enrichment Factor (EF) of trace metals in PM_{10} samples with respect to average concentrations in Italian surface soils, Cd and Pb resulted by far the most important metallic pollutants released by anthropogenic sources, followed by Hg, Cu, Ni, Zn and V.

SEM, ESEM and EDS observations showed the recurrent occurrence of PM on the surface of both biomonitors, particularly in moss samples, indicating the considerable presence of dust in the urban atmosphere which, according to chemical composition, may be due both to anthropogenic and natural sources.

Comparison of moss and lichen chemical composition with PM_{10} samples gave significant positive correlation indicating that in urban environment, surface interception of particulate atmospheric deposition was the most important process in the biomonitors accumulation.

The mineral composition of PM_{10} shows a dominance of calcite and quarts followed by feldspars, smectite, and sea-bearing salts (halite, gypsum, K-Mg-sulphates). For same samples, SEM revealed also a consistent presence of glass fibres and allowed a better characterization of the feldspars. Abundance of S-rich particles, to which trace elements are also associated, was observed both on filters and biomonitors.

References

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