Aerosol sources and influence of special activities in subway environments

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Public transport is used daily by millions of people around the world. Among the different transport modes, rail subway systems are desirable as they are based on electric trains and are energetically efficient. However, air quality in these underground environments is affected by several factors and emission sources and is therefore worse compared to outdoor air quality in terms of particulate matter (PM) concentrations (e.g. Martins *et al*, 2016). Moreover, some maintenance or renewal activities may also add to the already existing aerosol sources in the subway environment. It is therefore necessary to identify the aerosol sources present in this environment and quantify and characterize them to be able to improve the air quality in the subway systems.

A monitoring campaign focused on aerosols was (and is currently) carried out in different platforms in the Barcelona metro system: Sagrera, Palau Reial and Maria Cristina. These platforms were affected by special activities, such as rail renovation (Sagrera) or ballast addition (Palau Reial and Maria Cristina). The renewal of the ballast bed was carried out in normal conditions, i.e. using water to avoid dust resuspension (Palau Reial), and using ballast previously coated with an antiresuspension polymer (Maria Cristina), to study the efficiency of such a measure. Ambient particles with diameter below 2.5 µm ($PM_{2.5}$) were collected daily using a high volume sampler during the metro operating hours. The samples were chemically analysed to determine major and trace elements, inorganic ions, total carbon and organic compounds (the latter only in a selection of the samples). Moreover, the chemical composition of some subway components such as brake pads (different types), rail tracks and cathenary was analysed in order to determine the influence of each of the sources in the ambient PM in the subway environment.

Subway $PM_{2.5}$ was mainly constituted by Fe_2O_3, which contributed more than 40% to the bulk $PM_{2.5}$ mass concentration. The second component in contribution was the carbonaceous aerosol, accounting for about 30% of the $PM_{2.5}$. The influence of the special activities was reflected in the bulk $PM_{2.5}$ concentrations and in the concentrations of some of the species analysed. An example for the ballast addition influence is shown in Figure 1, where an increase in the concentrations of most components is observed. The influence of the works in the trace elements concentration was evident at Sagrera station (Figure 2). Enrichment factors with respect to the base situation of up to 3 were observed.

A deeper analysis of this information will allow the identification and quantification of the different subway sources. This information will provide the tools to establish air quality improvement actions for subway systems.

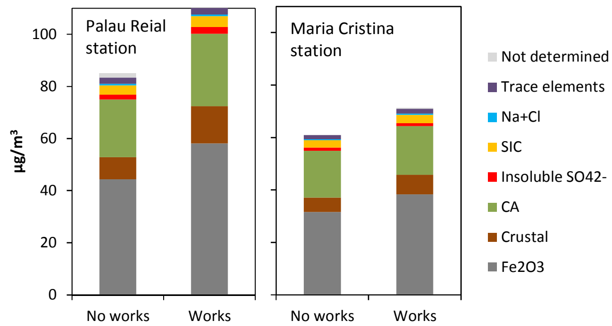

Figure 1. Chemical composition of $PM_{2.5}$ at Palau Reial and Maria Cristina subway stations in Barcelona during days without any special activity (No works) and during days when ballast addition took place (Works).

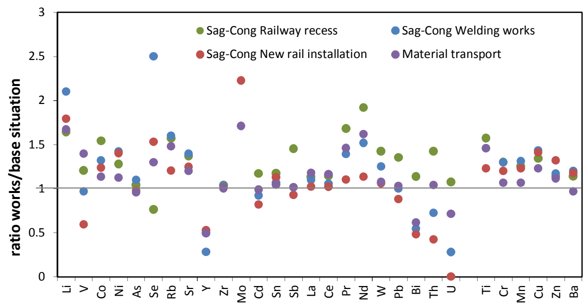

Figure 2. Enrichment factors (concentration during special activities with respect to concentration during the base situation) of different trace elements in $PM_{2.5}$ at Sagrera subway station in Barcelona.

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Martins V., Moreno T., Mendes L., Eleftheriadis K., Diapouli E., Alves C.A., Duarte M., de Miguel E., Capdevila M., Querol X. and Minguillón M.C. (2016) *Environ. Res.* **146**, 35-46.