Probing $PM_{2.5}$ Sources with Laser Ablation: A case Study of Traffic Emissions in Dublin City, Ireland

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Particulate matter is one of the most problematic air pollutants globally, and recently the associations between exposure to ambient particulate matter ($PM_{2.5}$) and adverse health outcomes have been more firmly established. Exposure to unhealthy concentrations of $PM_{2.5}$ has been connected to increased respiratory and cardiovascular illness. Diesel vehicles in particular are known for their significant contribution to overall emissions of $PM_{2.5}$ in the atmosphere, and therefore constitute a significant threat to public health and the environment. In urban areas, determination of the proportion of total $PM_{2.5}$ attributable to diesel vehicle emissions requires source apportionment techniques, which rely on elemental abundances of several cations and anions. The data are typically obtained using several techniques, such as ion chromatography, XRF, ICP-OES, PIXE or ICP-MS.

Here we present a large set of data obtained with a single analytical technique; laser ablation inductively coupled mass spectrometry (LA-ICP-MS). We collect parallel samples onto quartz and teflon filters and obtain quantitative elemental data for C, Na, Mg, Al, Si, P, S, Cl, K, Ca, V, Cr, Mn, Fe, Ni, Cu, Zn, Ge, As, Se, Br, Rb, Sr, Mo, Ag, Cd, In, Sn, Sb, Te, Ba, Hg, Tl, Pb, and Bi, by running large beam diameter line scans on the teflon filter, using C as the internal standard.

With this rapid technique, it is possible to analyse nearly all of the toxic metals, and to obtain targeted chemical fingerprints of the major sources of $PM_{2.5}$. These include a wide variety of vehicular exhaust emissions, solid fuels including wood, peat and coal, sea-spray, mineral dust and road dust, with a particular focus on emissions from diesel vehicles of a variety of European emissions standards. The low detetcion limits of LA-ICP-MS allows us to distinguish between emissions from combustion of solid fules and diesel, which are difficult to separate with data from conventional techniques. Using the end-member fingerprints, we are quantifying the impact of diesel vehicles in Ireland on the exposure of the population to $PM_{2.5}$, through field measurement of ambient $PM_{2.5}$.