Elemental composition of fine particles: exposure in the general population and influence from different sources

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I Molnár, P., Janhäll, S., and Hallquist, M., **2002**. Roadside measurements of fine and ultrafine particles at a major road north of Gothenburg. *Atmospheric Environment 36(25) 4115–4123*.

II Molnár, P., Gustafson, P., Johannesson, S., Boman, J., Barregard, L., and Sällsten, G., **2005**. Domestic wood burning and $PM_{2.5}$ trace elements: personal exposures, indoor and outdoor levels. *Atmospheric Environment 39(14) 2643–2653*.

III Molnár, P., Johannesson, S., Boman, J., Barregård, L., and Sällsten, G., **2006**. Personal exposures and indoor, residential outdoor, and urban background levels of fine particle trace elements in the general population. *Journal of Environmental Monitoring 8(5) 543–551*.

IV Molnár, P., Bellander, T., Sällsten, G., and Boman, J. Indoor and outdoor concentrations of $PM_{2.5}$ trace elements at homes, preschools and schools in Stockholm, Sweden. *Journal of Environmental Monitoring Accepted*.

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ABSTRACT

The general population is exposed to particulate air pollution from many different local and regional sources. Examples of local sources are traffic, biomass burning and resuspended dust, while regional sources are dominated by combustion processes from heating, traffic and industries. The overall aim of this thesis was to characterise the personal exposure to trace elements in fine particles, mainly $PM_{2.5}$ and investigate how the exposure is related to indoor and outdoor levels. Particulate matter was collected on filters and analysed for elemental content by X-ray fluorescence (XRF) spectroscopy.

In the general population in Göteborg, personal exposures to Cl, Ca, Ti and Fe were significantly higher compared with indoor, residential outdoor and urban background levels. Significant correlations were also found between urban background PM mass and personal exposure to elements related to both combustion (S, V and Pb) and resuspended dust (Ti, Fe and Zn), indicating that both sources could be relevant for health effects from urban background PM. In a community where wood burning for domestic heating is common, significantly (66–80%) higher personal exposures and indoor levels were found for K, Ca and Zn compared with a reference group living in the same area, indicating that these elements could be good markers for wood smoke. In a study in Stockholm concerning children's environments (home, school and preschool), higher indoor than outdoor levels of Ti were found, while long-range-transported (LRT) elements (S, Ni, Br and Pb) were higher outdoors. A community located 25 km from the city centre had significantly lower outdoor levels of crustal and traffic-related elements compared with both the city centre and a suburban area. The levels of Fe and Cu were four times higher in the central communities. Outdoors, Cu levels were found to correlate well with the traffic marker NO_2, making it a possible elemental marker for traffic-related aerosols in health studies. Roadside measurements of fine and ultrafine (<100 nm) particles were performed along a major approach road to Göteborg and the levels of ultrafine particles were influenced not only by traffic intensity, but also, by wind speed and direction, as well as boundary layer height. No correlation was found between $PM_{2.5}$ and ultrafine particles or traffic, but there was a correlation between $PM_{2.5}$ and particles sized 100–368 nm. In all environments studied, the origin of LRT air masses had a strong effect on exposure and levels of PM elements.

In conclusion, this thesis demonstrates that elemental analysis is a useful method for better characterising human exposure to fine particles. For several elements, the personal exposure is often higher than corresponding indoor levels. The origin of LRT elements affected not only outdoor levels, but also, the personal exposure and indoor levels, and should be taken into account in time series studies of air pollution and health.

Key words: particulate matter, $PM_{2.5}$, PM_1, ultrafine particles, trace elements, personal exposure, indoor levels, X-ray fluorescence (XRF), air mass back trajectories, long-range transport, domestic wood burning

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