

## Total-reflection X-ray fluorescence analysis of airborne particulate matter samples

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Airborne particulate matter (PM<sub>10</sub>) means particles present in the surrounding air with aerodynamic diameters smaller than 10 µm. These particles can further be divided into a "coarse" fraction (between 2.5 and 10 µm) and a "fine" fraction (PM<sub>2.5</sub>, below 2.5 µm). The coarse fraction typically consists of crustal elements such as K, Ca and Fe, which originate from erosion or mechanical abrasion processes. Furthermore, Cu and Zn are indicators for road traffic, originating from brake abrasion and tire wear. Particles of the fine fraction are mainly of anthropogenic nature and result from combustion processes. Compounds containing S, V, Ni and Pb are typically emitted during combustion of heavy oil and by road traffic, whereas K serves as an indicator for biomass burning. [1] PM<sub>2.5</sub> particles are of particular importance for human health, as they can enter the human lungs and significantly contribute to acute or chronic cardiovascular and respiratory diseases. [2]

This contribution will present the results of two outdoor sampling campaigns from July 2016 and January 2017. Samples were taken hourly during on 9 and 10 days respectively with typically 5 to 6 samplings per day. Samplings were carried out using a three-stage Dekati cascade impactor (Dekati, Finland; > 10 µm, 2.5 to 10 µm and 1 to 2.5 µm) and a four stage Sioutas Personal Cascade Impactor (SKC inc., U.S.A.; > 2.5 µm, 1 to 2.5 µm, 500 nm to 1 µm and 250 to 500 nm), with which also sub-µm particles can be collected and analyzed. As sampling substrates 30 mm quartz reflectors were used for the Dekati impactor and 1" Si wafers for the Sioutas impactor. Particles with an aerodynamic diameter smaller than the cut-off diameter of the smallest stage were collected in a backup filter suitable for EDXRF analysis. The elements S, Cl, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Br, Rb, Sr and Pb were detected and quantitatively analyzed. Seasonal changes could be found: The July campaign was dominated by crustal elements, whereas considerable masses of S (combustion, heating) and Cl (de-icing salt) could be found in the January campaign. Detection limits ranging from a few 10 pg/m<sup>3</sup> to several 100 pg/m<sup>3</sup> were achieved, depending on the element and the analyzed size fraction.

For TXRF analysis two spectrometers were used. The TXRF spectrometer Atomika 8030C (Atomika, Germany; now Cameca) is equipped with a 2500 W Mo/W mixed alloy anode tube (PANalytical, The Netherlands) and an 80 mm<sup>2</sup> LN<sub>2</sub> cooled Si(Li) detector (Oxford Instruments, U.K.). The second device is a lab-built tabletop TXRF spectrometer based on the WOBISTRAX design [3], with a 35 W Rh anode low power tube (IfG, Germany), and a silicon drift detector (SDD) with an active area of 80 mm<sup>2</sup> (KETEK; Germany).

[1] A. Wagner, J. Boman, M. Gatari, *Spectrochim. Acta B*, 63, **2008**, 1426-1431.

[2] C.I. Davidson, R.F. Phalen, P.A. Solomon, *Aerosol Sci. Technol.*, 39(8), **2005**, 737-749.

[3] C. Streli et al., *Spectrochim. Acta B*, 59, **2004**, 1199-1203.