Hourly elemental composition and source identification of fine and coarse particulate matter in the high polluted industrial area of Taranto (Italy)

F. Lucarelli[1], G. Calzolai[1], M. Chiari[1] and S.Nava[1]

[1]Department of Physics and Astronomy, University of Florence and National Institute of Nuclear Physics (INFN), Sesto Fiorentino (Florence), 50019, Italy

Keywords: PIXE, hourly composition, source apportionment, steel plant
Presenting author email: lucarelli@fi.infn.it

Taranto, an ancient Italian town lying on the Ionic Sea coast, is nowadays one of the most industrialized towns in the South of Italy. An industrial area, that includes the biggest steel plant of Europe, one of the biggest Italian refinery, a power plant and a big cement industry, is located in the northern suburbs of the town. During the last year pollution problems of this area have come under the spotlight and have become a very compelling issue for the policy makers.

In the frame of an extensive environmental investigation, promoted by the Italian Health Ministry, the ISPESL (Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro) and the CNR (Consiglio Nazionale della Ricerca), aerosol samples were collected with high time resolution and analysed by PIXE. The project included two sampling campaigns (February–March and June 2004), in two different sites: Tamburi (site A in the following), an urban district in Taranto adjacent to the industrial area, and Statte (site B), a small town located 7 km N-NW of Taranto. Site A is a dense populated quarter subject to a heavy pollution flux; site B is located along the direction of prevalent winds from the industrial area.

The fine (< 2.5 μm) and coarse (2.5-10 μm) fractions of particulate matter were simultaneously collected in the two sampling sites by means of two ‘‘streaker’’ samplers (PIXE International Corporation). PIXE analyses were performed with a 3 MeV proton beam from the 3 MV Tandetron accelerator of the INFN-LABEC laboratory (Calzolai et al., 2006). These analyses allowed the assessment of the concentrations of several elements (Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Br, Sr and Pb), including important industrial tracers, with hourly time resolution.

Although the vast majority of results in literature are limited to time resolution of the input samples of typically 12 or 24 h, most particulate emissions as well as their atmospheric transport and dilution processes change within a few hours and daily samples are not capable of tracking these rapid changes. Furthermore, source apportionment receptor models need a series of samples containing material from the same set of sources in differing proportions and increasing the time resolution of the measurements typically provides samples that have greater between-sample variability in the source contributions than samples integrated over longer time periods.

In this study the high time resolution of the adopted approach allowed us to follow in detail changes in the aerosol elemental composition due to both the time evolution of the industrial emissions and the time changes in meteorological conditions and thus transport pathways. Moreover, the location of the sampling sites, along the prevalent wind direction and in opposite position with respect to the industrial site, allowed us to follow the impact of the industrial plume as a function of wind direction.

The most significant feature of this data set is the presence of very high hourly concentrations of Fe (up to 15 μg/m^3 in the fine fraction and 12 μg/m^3 in the coarse one) and Mn (up to 170 ng/m^3 and 115 ng/m^3 in the fine and coarse fractions, respectively), which are typical tracers of steel smelter emissions. Their time trends are high correlated and show sharp peaks, typical of industrial emissions, which are in opposite phase in the two sampling sites (Fig. 1).

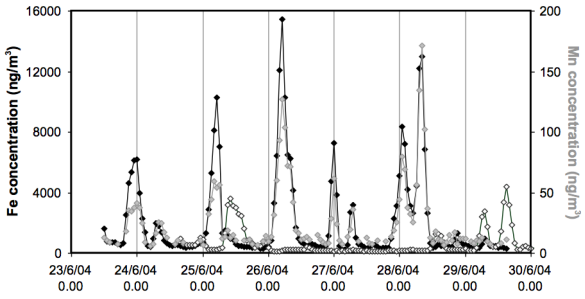

Figure 1. Hourly time trends of fine Fe (black) and fine Mn (white) in site A, and fine Fe (grey) in site B.

Positive Matrix Factorisation (PMF) has been applied to the data to assess the main aerosol sources, and in particular the impact of industrial emissions. Results of these analyses will be shown.

Calzolai, G., Chiari, M., Garcia-Orellana, I., Lucarelli, F., Migliori, A., Nava S., Taccetti, F. (2006), Nucl. Instr. and Meth. B 249, 584-587.