fine particle aerosol sampling
# NEWSLETTER

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**aerosol** *n.* a colloidal dispersion of solid or liquid particles in a gas (air).

# Fine Particle Characterisation and Source Apportionment

In our January 2006 ASP Newsletter No 34 we started looking at fine particle characterisation and source apportionment using the techniques of Ion Beam Analysis (IBA) at ANSTO coupled with the relatively new approach of Positive Matrix Factorisation (PMF) for determining fine particle source fingerprints and their contributions to the total PM2.5 mass measurements. In this Newsletter we continue this approach with new long term data from the Mascot site in Sydney, Australia. This site, with the help of Botany City Council, has now been measuring $PM_{2.5}$ pollution since 1992.

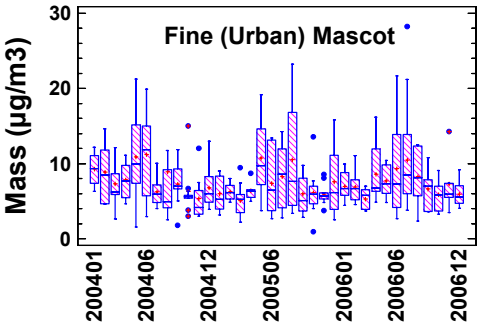



**Fig. 1** Average monthly $PM_{2.5}$ mass concentrations at Mascot, Sydney

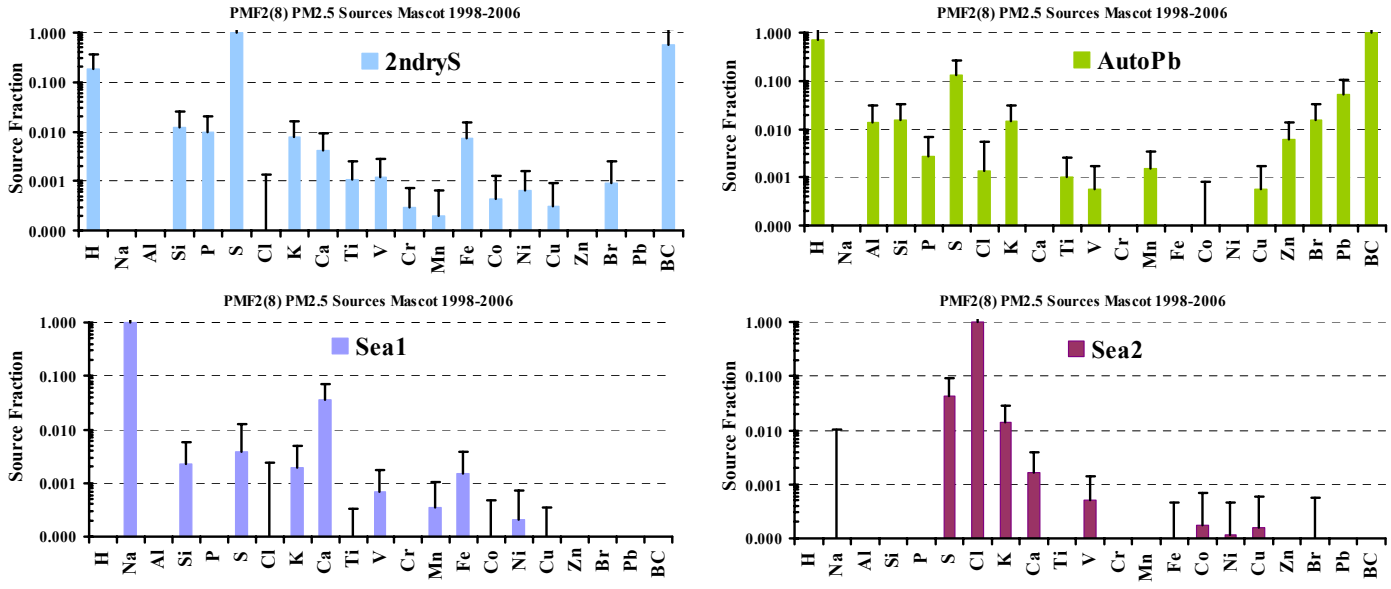
| $PM_{2.5}$ Species | Mascot 2004-06 (µg/m$^3$) |
|---|---|
| Mass | 7.6±4(33) |
| Sulfate | 1.7±1.2(8.0) |
| Soil | 0.48±0.43(2.6) |
| BC | 1.5±1.1(6.9) |
| Sea salt | 1.2±1.3(9.0) |
| Potassium | 0.056±0.05(0.32) |
| Iron | 0.081±0.08(0.61) |
| Zinc | 0.015±0.02(0.15) |
| Lead | 0.015±0.026(0.17) |

**Table 1.** Average $PM_{2.5}$ composition for January 2004 to December 2006 at Mascot. Max values in ( )

**Fig. 1** shows a box and whisker plot for the monthly fine particle mass measured at Mascot site during 2004-2006. **Table 1** is the average $PM_{2.5}$ composition at the Mascot site. The large standard deviations of the results reflect the large daily and seasonal variations. Black carbon (BC) and sulfate are usually associated with combustion products and generally dominate the fine aerosol. Sulfate is associated with industry, coal burning and lead historically with petrol combustion by motor vehicles, although Pb was removed from petrol in NSW in January 2001. IBA analysis, at ANSTO, can now be used to characterise and source fine particle pollution in detail through determination of source fingerprints and their contributions to the measured $PM_{2.5}$ fine mass. We now use the novel receptor-modelling statistical technique of PMF to achieve this. The advantage of PMF is that both the source fingerprints as well as their relative contributions, on a daily basis, can be estimated simultaneously from the same extensive data set covering many years.

**Fig. 2** shows some typical source fingerprints obtained for the Mascot site using these new PMF techniques.

## PMF Average $PM_{2.5}$ Source Fingerprints for the Mascot Site 1998-2006



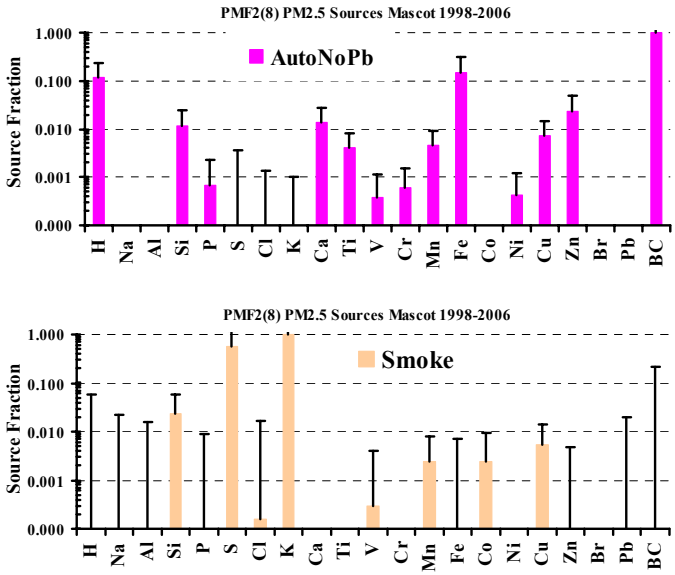



**Fig. 2.** PMF average source fingerprints obtained using PMF analysis on all Mascot $PM_{2.5}$ data from 1998-06.

The percentage monthly contrbutions for a combination of 5 of these sources for the sampling period from January 2004 to June 2006 are shown in **Fig. 3** below. All sources except Soil have significant seasonal variations. Smoke and Autos are higher in the winter as expected. Smoke can contribute as much as 25% to $PM_{2.5}$ levels during winter. Secondary sulfate and Sea spray are higher in the summer when there is significantly more sunlight and the NE sea breezes predominate in the Sydney region. The average source contributions obtained by this PMF analysis for the Mascot site are given in **Table 2** for the 2004-06 period.

## $PM_{2.5}$ Percentage Source Contributions at Mascot Site 2004-05

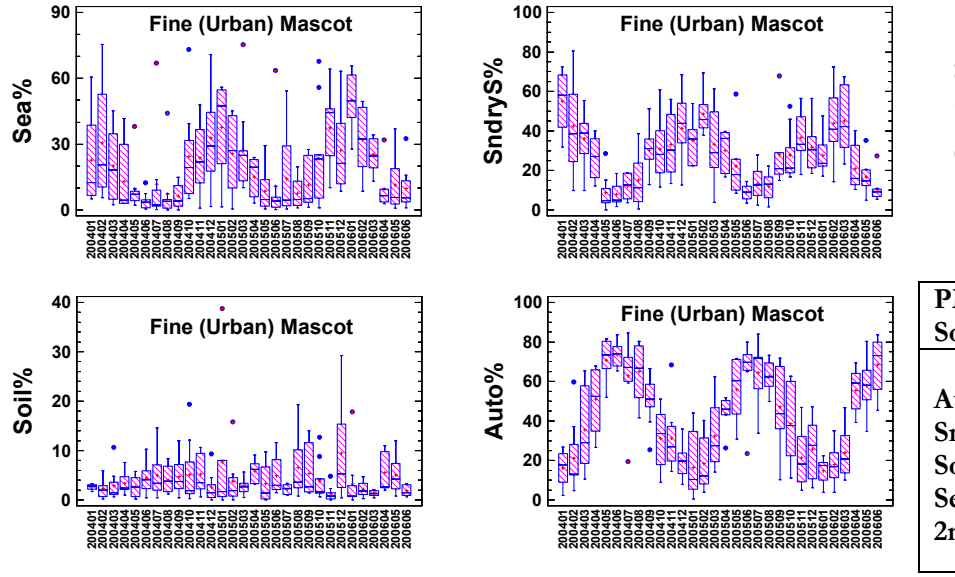



**Fig. 3.** Average monthly percentage source contributions for January 2004 to June 2006 at the urban site of Mascot for $PM_{2.5}$ particles using PMF analyses.

| $PM_{2.5}$ Sources | Mascot Av.(%) 2004-06 |
|---|---|
| Auto | 42±24%(85%) |
| Smoke | 6.6±4%(25%) |
| Soil | 4±5%(39) |
| Seaspray | 20±20%(75%) |
| 2ndry Sulfate | 27±18%(81%) |

**Table 2**. Average percentage source contributions for $PM_{2.5}$ for the Mascot site for 2004-06. Max values in ( )

This Newsletter demonstrates that given enough high quality fine particle data, covering a sufficient timeframe we now have the ability, at ANSTO, to provide quantitative $PM_{2.5}$ characterisation and source contribution estimates from the total measured fine mass. If you need more information please contact us through any of the contact addresses below.

**Short Term US EPA NAAQS Standards for Airborne Particulate Matter**

| Index (NAAQS) | TSP (µg/m³) | $PM_{10}$ (µg/m³) | $PM_{2.5}$ (µg/m³) | Air Quality |
|---|---|---|---|---|
| 0 to 50 | 0 - 75 | 0 - 50 | 0 - 15 | Good |
| 51 to 100 | 76 - 260 | 51 - 150 | 16 - 65 | Moderate |
| 101 to 200 | 261 - 375 | 151 - 350 | 66 - 150 | Unhealthy |
| 201 to 300 | 376 - 625 | 351 - 420 | 151 - 250 | V/Unhealthy |
| > 300 | > 626 | > 421 | > 251 | Hazardous |

Source : US EPA July 1997 Documents.


**Want more information on how ANSTO can help you with your Fine Particle air sampling and characterisation?**

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**Australian NEPM for $PM_{2.5}$**

8 µg/m³ annual and 25 µg/m³ 24-hr average

**Further information can be obtained from our WEB site or by contacting David Cohen at the addresses given in the header or ad in this ASP Newsletter.**