

# Source apportionment of PM<sub>2.5</sub> at Abu Dhabi sites

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Keywords: PM<sub>2.5</sub>, source apportionment, PMF, Abu Dhabi.

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Particulate matter (PM) is one of the most concerning pollutants in the United Arab Emirates. Air quality monitoring showed that concentrations of particulate matter are high in Abu Dhabi and frequently exceed international air quality limit and guideline values for the protection of human health. A considerable fraction expectedly originates from the natural background. Nearly 80% of Abu Dhabi consists of sandy desert and the north and west is composed of an extensive area of evaporite deposits (AGEDI, 2012; Glennie, 2001). Local industrial sources and traffic as well as long-range transported aerosol are also expected to contribute to the particle mass observed.

To our knowledge, no source apportionment study has been carried out in the area so far. For an efficient abatement strategy, a clear identification of the sources and their contributions to PM mass is needed.

The objective of this study is to identify and quantify the major sources to fine particle mass at two sites in the Emirate of Abu Dhabi. Positive Matrix Factorisation (PMF), a widely recognised receptor modelling method, was applied on chemically speciated data to find multiple sources of particles in the area and possible differences between the sites.

To achieve this, particle sampling was carried out at two sites in Abu Dhabi. One of the selected sites was a residential urban background site (Khalifa) in the city of Abu Dhabi. The other site was an urban background site (Bida Zayed) in the Western Region of the Emirate of Abu Dhabi. The measurements took place between March and November 2012.

## Method

PM<sub>2.5</sub> was sampled during 24 hours periods on a daily basis with sequential filter samplers using Teflon filters and Quartz fibre filters. 70 sampling days from each of the sites were analysed chemically. In order to determine the concentrations of elements and inorganic

ions, Teflon filters were analysed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and ion chromatography (IC; Table 1), respectively. Quartz fibre filters were analysed applying Thermal Optical Analysis (TOA; Table 1).

The speciated PM<sub>2.5</sub> data from both sites were analysed through EPA PMF3 to identify the PM sources.

## Results and Conclusions

The median concentrations of individual compounds were very similar at both sites. Only for carbonate, a clear difference could be observed, showing higher concentration at Bida Zayed compared to Khalifa, pointing to different geological contributions.

An additional step was introduced into TOA in order to take into account carbonates, which are a non-negligible fraction of mineral dust in the area.

The study shows that secondary aerosol is a major contribution at both sites. The common source factors that were found at both sites were

- mineral dust, characterised by high loading of Ti, Fe, Al, Li, Mg, Y, Th etc
- traffic, characterised by non-exhaust markers (Zn, Cu, Sb, Mo) and carbonaceous fractions
- secondary aerosol, characterised by sulphate and ammonium and combustion signatures.

An industrial source factor was identified at both sites, although with different signatures, which can be interpreted as influence of different industries.

A sea salt factor was only identified at Khalifa. This site is located on the island housing the city of Abu Dhabi, whereas Bida Zayed is located about 50 km from the coast, explaining why a sea salt factor was not resolved.

The geology of the surface of Abu Dhabi is quite heterogeneous. An additional source factor, characterising natural contribution was only found at Bida Zayed and pointing to evaporite deposits. This is likely explained by the higher occurrence of sabkhas in the Western Region.

This work was financed by the Environment Agency Abu Dhabi (EAD), United Arab Emirates.

Glennie, K.W. (2001) *Evolution of the Emirates Land Surface: an Introduction in United Arab Emirates: A new perspective*, Trident Press.

AGEDI Abu Dhabi Global Environmental Data Initiative (2012) <http://www.agedi.ae/Pages/index.aspx>.

Table 1. Analytical methods and analysed species.

Elements (ICP-MS)
Li, Be, Mg, Al, Si, K, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Br, Rb, Sr, Y, Mo, Cd, Sn, Sb, Cs, Ba, Tl, Pb, Bi, Th, U
Inorganic ions (IC)
SO <sub>4</sub> <sup>2-</sup> , NH <sub>4</sub> <sup>+</sup> , NO <sub>3</sub> <sup>-</sup> , Na <sup>+</sup> , Cl <sup>-</sup> , Mg <sup>2+</sup> , Ca <sup>2+</sup> , K <sup>+</sup>
Carbonaceous fractions (TOA)
OC1, OC2, OC3, OC4, PyrOC, EC1, EC2, EC3, Carbonate