

Platinum concentrations and chemical speciation in size-resolved urban aerosols

The objective of this study, conducted by the University of Wisconsin (USA), was to determine the concentrations and chemical speciation of platinum in size-resolved atmospheric urban aerosols.

Six European cities were selected for study, representing diverse geographic and climatic urban environments. Within the chosen cities, several sites were selected for sampling, with an aim of representing roadside canyons, roadside motorways and background urban locations in each city. Samplers were also placed at rural locations in Northern, Central, and Southern Europe to characterize the regional background speciation of platinum.

For each of the particulate size fractions – PM3 'fine fraction', PM3-7 'coarse fraction', and PM7 'super coarse fraction' – in addition to measuring the total platinum present, soluble platinum¹, dissolved platinum² and anionic platinum were also measured following extraction with various solvents: high-purity Milli-Q water (MQ), Gambles solution, Artificial Lysosomal Fluid (ALF), and 0.07M HCl.

¹ Soluble platinum was defined as that which passed through a 0.22 μm filter following solvent extraction

² Dissolved platinum was defined as that which passed through a 10 kD ultrafilter following solvent extraction

The results presented here are in picograms of platinum per cubic metre of air (pg m^{-3}). A picogram is a millionth of a millionth of a gram.

Total platinum concentrations

Total platinum concentrations at urban sites ranged from 2.4 pg m^{-3} at an urban background site to over 22 pg m^{-3} in the urban roadside canyons of Stockholm and Thessaloniki, and peaked at over 45 pg m^{-3} in the urban roadside canyon of London. Total platinum concentrations at the rural background sites ranged from 0.9-4.9 pg m^{-3} .

The highest concentrations of platinum per gram of particulate were in PM7. However, PM3 represented approximately 74% of the total particulate mass, on average, and approximately 60%, on average, of the total platinum mass was present in this fraction, with the coarse (PM3-7) and super-coarse (>PM7) fractions contributing about equally to the remainder of the total platinum.

Soluble platinum concentrations

With the exception of urban canyon sites in London and Thessaloniki, soluble platinum concentrations in the fine aerosol (PM3) were all below 1 pg m^{-3} . Rural background

concentrations were especially low (0.05 pg m^{-3} in MQ and $0.15\text{-}0.25 \text{ pg m}^{-3}$ in the other solvents) and consistent. Urban background concentrations were also quite consistent across sites, averaging 0.2 pg m^{-3} in MQ, $0.4\text{-}0.7 \text{ pg m}^{-3}$ in the other solvents. Concentrations in London and Thessaloniki urban canyon sites were over an order of magnitude greater at $1.8\text{-}6.7 \text{ pg m}^{-3}$.

Dissolved platinum concentrations

The same trends observed for soluble platinum in the PM3 fraction were also observed for dissolved platinum, but the dissolved platinum concentrations were in most cases significantly lower: typically in the 0.2 to 0.4 pg m^{-3} range for urban sites, but up to 2.5 pg m^{-3} in London and 3.8 pg m^{-3} in Thessaloniki urban canyon sites with the more aggressive, lower pH solvent extractants.

Anionic platinum concentrations

Anionic dissolved platinum concentrations, which represent an upper boundary of the potential chloroplatinate levels, averaged from 0.02 pg m^{-3} at rural background sites to 0.07 pg m^{-3} in roadside and canyon sites (excluding London and Thessaloniki) in MQ extracts of the PM3. The average concentration for the London and Thessaloniki urban canyon sites was 1.11 pg m^{-3} .

Anionic platinum concentrations in Total Suspended Particles (TSP, i.e. the sum of the PM3, PM3-7 and PM7 size fractions) in MQ extracts averaged 0.03 pg m^{-3} at rural background sites, 0.08 pg m^{-3} at urban background sites, 0.11 pg m^{-3} at roadside and canyon sites (excluding London and Thessaloniki), and 0.96 pg m^{-3} at the London and Thessaloniki urban canyon sites. Corresponding average concentrations in the Gambles extracts were 0.06 , 0.48 , 0.70 and 1.05 pg m^{-3} respectively. Average concentrations using ALF were lower than those for Gambles, apart from the London and Thessaloniki urban canyon sites where the average concentration was 1.99 pg m^{-3} , the highest average concentration of anionic platinum identified in TSP across the various extracts and sampling site categories.

Various aspects of this research programme have been or will be published in the peer-reviewed scientific literature, including:

- Shafer et al (2016) Oxidative Potential of Size-Fractionated Atmospheric Aerosol in Urban and Rural Sites across Europe. *Faraday Discussions*, **189**, 381-405.



- Shafer et al (2024) Particle-size resolved aerosol levels of total and extractable platinum in urban and rural regions of Western Europe. *Atmospheric Environment*, **318**, 120213.