

Levels and Speciation of Platinum in Size-Fractionated Atmospheric Aerosol in Urban and Rural Sites across Europe

Martin Shafer (1), Dagmara Antkiewicz (2), Joel Overdier (2), and James Schauer (1)

(1) University of Wisconsin-Madison, Madison, United States (mmshafer@wisc.edu), (2) Wisconsin State Laboratory of Hygiene, Madison, United States

In this study we characterized the levels and speciation of platinum in a unique set of size-resolved atmospheric aerosol (PM) samples obtained from urban environments across Europe. From April-July 2012 we collected PM from roadside canyon, roadside motorway, and background urban sites in each of six European cities (Amsterdam, Frankfurt, London, Milan, Stockholm, and Thessaloniki). A Hi-Vol sampler was used to collect PM in three size classes (>PM₇, PM₇-PM₃, PM₃) and characterized for total platinum, soluble platinum (in a suite of physiologically relevant fluids – lung fluid (ALF), Gambles saline, 0.07M HCl, and MQ) and speciated forms (colloidal and anionic) within the soluble fractions. In addition we measured 50 other elements by SF-ICPMS, soluble ions by IC, and soluble organic carbon in the PM. Order-of-magnitude differences in air concentrations of total platinum were observed between urban sites, ranging from 4 to over 45 pg/m³; with a median level of 6 pg/m³. When platinum concentrations are normalized to PM mass the cross Europe and site-to-site variability was substantially reduced - a 3-fold variation from 200 to 600 ng/g was observed. Roadside canyon sites in London, Stockholm and Thessaloniki exhibited the highest concentrations; however levels at urban background sites were remarkably similar across the cities. Relatively consistent and low concentrations (1 to 2 pg/m³) of total platinum were observed at rural background sites across Europe. The contribution of coarse particles (>7 micron and 7-3 micron) to air concentrations of total platinum was very significant (>35% at nearly all sites). Soluble platinum fractions ranged from 2 to 6% (MQ to HCl) in rural background sites to 5 to 20% (MQ to HCl) in roadway canyon sites in London and Thessaloniki; with the extractable platinum fractions a strong function of pH. With the exception of urban canyon sites in London and Thessaloniki, soluble platinum concentrations in the fine aerosol (PM₃) were all below 1 pg/m³. Rural background concentrations were especially low (<0.03 pg/m³ in MQ and 0.1 pg/m³ in the other solvents). Urban background concentrations are consistent across sites, averaging 0.1 pg/m³ in MQ, 0.2 pg/m³ in Gambles Solution, and 0.4 pg/m³ in ALF and HCl. The colloidal fraction (i.e. between 10kD and 200nm) was significant (10-50%) in many PM₃ and PM >7 sample extracts. The lowest anionic fractions (<0.5%) were measured in MQ extracts of Northern Europe rural and urban background sites. The highest anionic fractions (10-12%) were measured in ALF extracts of London, Stockholm, and Thessaloniki roadside canyon sites. Anionic platinum concentrations averaged 0.02 pg/m³ at rural background sites and 0.06 pg/m³ in roadside and canyon sites in MQ extracts. Anionic concentrations of platinum in Gambles and ALF extracts ranged from 0.1 pg/m³ in rural background sites to 0.4 pg/m³ in roadside and canyon sites. Much greater levels were measured in London and Thessaloniki urban canyon sites (1 – 2.5 pg/m³).