

The origin of atmospheric lead in urban air of three European cities: Lead isotope approach

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Abstract

Atmospheric lead pollution has adverse health effects on humans. Identification and characterization of Pb pollution sources are crucial for better understanding and evaluation of risks associated with air pollution. We have analyzed concentrations of trace elements (Pb, Zn, Cu, Ni, Cr, Cd, Sb, As, and Zn) and Pb isotopic composition of aerosols in fine particulate matter (PM_{2.5}) in three industrial cities (Hradec Králové, Olomouc and Brno), located in the Czech Republic. Sampling was performed in 12 hours intervals in winter and summer. Trace element and PM_{2.5} concentrations were higher in winter in all studied cities, on average by 47 %. Across the sites, ²⁰⁶Pb/²⁰⁷Pb ratios ranged from 1.142 to 1.178 in summer and from 1.143 to 1.173 in winter. The mean ²⁰⁶Pb/²⁰⁷Pb ratios were statistically indistinguishable in all three studied cities (1.165 in Hradec Králové, 1.163 in Olomouc, and 1.160 in Brno). In the ²⁰⁶Pb/²⁰⁷Pb vs. ²⁰⁸Pb/²⁰⁷Pb graph, isotopic composition of aerosols sampled in summer lay on a straight line, whereas isotopic composition of samples collected in winter was shifted toward higher ²⁰⁸Pb/²⁰⁷Pb values. Increased winter PM and sulfate concentrations points to primary role of coal processing/combustion in Polish and Czech coal-fired power plants and household heating as winter season requires higher electricity production. However, our data showed that coal combustion was not the only Pb pollution source. Lead isotopic composition in aerosol

samples exhibited values that closely corresponded to Pb isotopic composition of Variscan ores. Pb recycling and waste incineration could explain these values and could also explain the shift in $^{208}\text{Pb}/^{207}\text{Pb}$ ratio of $\text{PM}_{2.5}$ to higher values. Such explanation, however, is questionable, because these industrial pollution sources do not exhibit seasonality. Since, we also observed lower $^{206}\text{Pb}/^{207}\text{Pb}$ isotope composition of urban air, we suggest that these samples could contain traffic-related Pb. It either originated from remobilized alkyl-Pb that was used as gasoline anti-knock additive (banned in 2000) or from currently sold unleaded gasoline and diesel (EU limits Pb content less than 5 mg Pb L⁻¹ for currently sold fuel).

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