Comparison of Elemental Concentrations in the Atmosphere in Bratislava with other Slovakian and Czech Sites

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Objective

The main objective of this study is to determine the concentrations of several elements, mainly heavy metals, in the atmospheric aerosol particles in five different locations. Two sampling sites are located in Bratislava (Líščie údolie and SLOVNAFT). Other two are in polluted areas of Slovakia (Prievidza, Veľká Ida) and the last one is in Czech Republic (Tušimice).

Bratislava is a city with the chemical industry, technical glasswork, building industry, incineration plant, and car industry. Neither a ferrous or non-ferrous smelter, nor a power plant is in the vicinity.

The refinery and petrochemical company **SLOVNAFT** is one of the biggest in the Central Europe. Annually it processes approximately 5 millions tones of crude oil supplied mainly from Russian Federation, which is transported to Bratislava by means of the pipeline system DRUŽBA.

Close to the city **Prievidza** is the mine Nováky with annual coal production of 1900 thousands tons. Coal is predominantly burned (85%) in thermal power plant Nováky with 518 MW of power capacity. Also chemical industry is located in the town Nováky.

Near the town **Veľká Ida** is the largest ferrous metallurgy complex in Slovakia, U.S. Steel Košice.

The Czech sampling site **Tušimice** is affected by operation of the surface coal mines. In the year 1998 the thermal power plant Tušimice I was terminated. The power plant Tušimice II is working with power capacity of 4x200 MW.

Table 1. Contents of elements [ng·m^{-3}] in atmosphere

Location	Liščie údolie	Slovnaft	Velká Ida	Prievidza	Tušimice
Na	104				
Al	189	184			
Cl	49				
K	195				
Ca	179				
Sc	0,032				4,6
Ti	7,8				
V	0,83				
Cr	1,1	2,8	1,1	1,2	150
Mn	4,9				13
Fe	252		643	435	
Co		0,3	0,42	0,19	1,37
Ni	0,45	5,1	1,6*	1,0*	4,4
Cu	8,0	41	18	21	9,0
Zn	28		1294	1515	26122
Ga	0,02				
As	0,3		1,7*	7,9*	1,5
Se	0,42			0,18	
Sr		3,1			480
Br	3,5				2,5
Cd	0,11	2,2	1,1*	0,4*	7,1
In	0,001		0,045	0,042	
Sb	1,0		1,37	5,5	2,4
I	0,66			0,44	
Cs	0,045		0,028	0,032	1,9
Sm	0,012		0,84	0,89	0,5
Eu			1,9	0,84	
Dy	0,01				
Tm	0,1			0,016	
Hf			0,018	0,022	
Ta			0,13	0,08	
W	0,22				
Hg	0,064		<4,2	<4,2	
Pb	22	42	90	29	45
Th	0,042				1,4
U	0,012				0,2

Results

Wide range of elements was determined by the instrumental neutron activation analysis (INAA) at IBR-2 reactor in Dubna in total airborne particulate matter. Another six elements (Cr, Ni, Cu, Zn, Cd, Pb) were determined using atomic absorption spectrometry (AAS). The results of present study are presented in Table 1. The concentrations of almost all elements are lower in Bratislava compared to other localities. The low atmospheric pollution in Bratislava may be caused by a small number of pollution sources, and in particular by the high number of windy days per year, typical for this location. This statement is supported by the negative correlation found between the wind velocity and the elemental concentrations in our samples [1].

Figure 1 shows decreasing trend of air pollution by heavy metals in Bratislava since the year 1981. The emissions of Pb have decreased reflecting the shift from leaded to unleaded gasoline. Generally, the reason of this trend is the decline of industry production in Slovakia after 1989, since the fuel burning processes in thermal power plants and industrial activities are a major source of atmospheric pollution with heavy metals. The emissions of pollutants were reduced via application of stricter requirements in the legislation, desulphurization of power plants, and introducing of more sophisticated technologies in smelters, too [2].

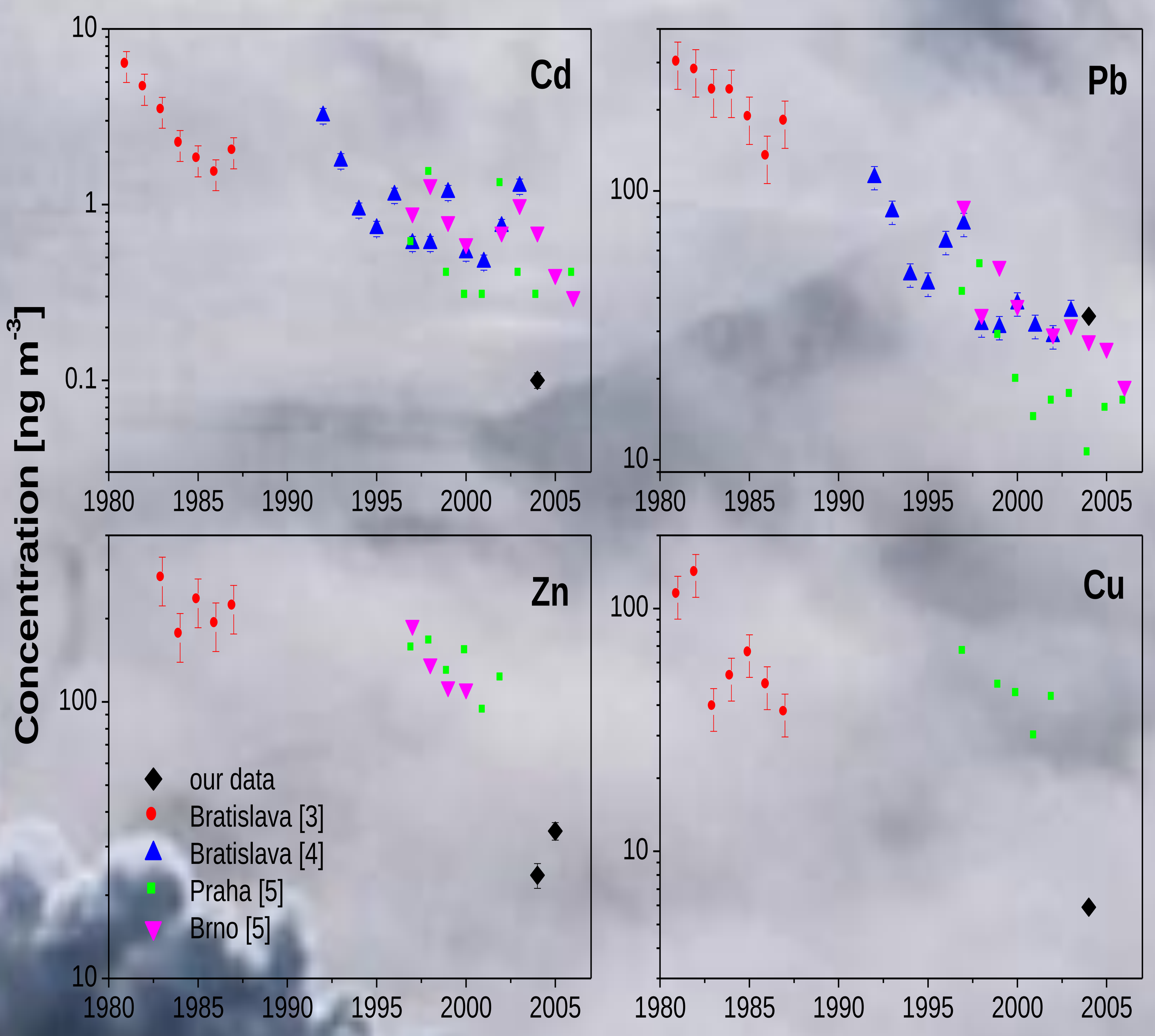

Figure 1. Temporal variation of atmospheric concentrations of Cd, Pb, Zn, and Cu in Bratislava since the year 1981.

The comparison of two sampling sites, Tušimice and Prievidza, is very interesting since both are affected by the mining activities and combustion of coal in the power plant. The site Tušimice is the most heavily polluted area in this study. Mining operations in the surface coal mines raise atmospheric concentrations of crustal elements, lanthanides and actinides. In Prievidza coal is mined from the underground, therefore concentrations of pollutants are lower compared to the Tušimice data, but still are higher than in Bratislava. Of high importance are the data of As concentrations in Prievidza, since the coal processed in Nováky power plant is characteristic with very high concentration of this element. In comparison to the other areas the atmospheric concentration of As in Prievidza is the highest that reflects coal combustion impact.

Atmospheric concentrations of Pb are similar in all investigated areas only at the site Veľká Ida it is approximately three-times higher. Elevated concentration of Pb could be attributed to impact of the neighbouring ferrous smelter. This observation suggests the sources of Pb to be different from the traffic emissions.

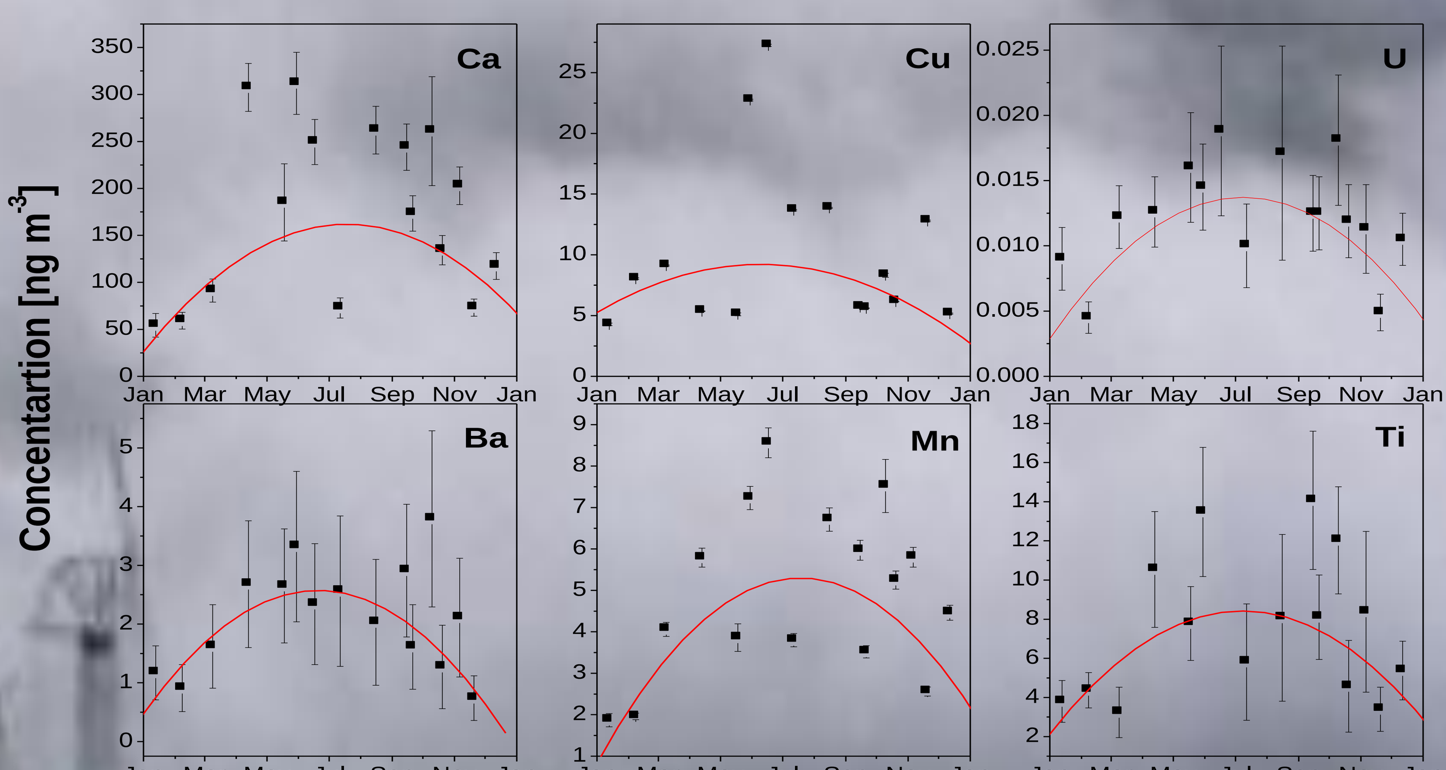

Figure 2. Seasonal variations of concentrations of some elements in atmospheric aerosol in Bratislava during the year 2004.

Sampling site Líščie údolie was investigated more in detail. Sixteen aerosol filter samples were collected in 2004 and the elemental composition was determined in order to evaluate seasonal variations. For some elements elevated concentrations were observed for the summer season (Figure 2). Most of these elements are soil derived (Ca, Ti, Mn, Ba, U), although they may also be emitted as fly-ash from the combustion of coal, or as dust from other mineral related activities. The rise of concentrations might be caused by intensive vertical mixing within the troposphere typical for hot season, and consequently results in stronger resuspension of soil dust from the Earth's surface [6].

References

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