HEAVY METALS IN URBAN DUST – ANTHROPOGENIC VERSUS NATURAL SOURCES

Neele van Laaten, **M. Pirrung, D. Merten**

Friedrich Schiller University, Institute for Geosciences, Jena, Germany
Neele.van-laaten@uni-jena.de

Keywords: Particulate Matter (PM), heavy metals, sources, statistical evaluation

Introduction

Dust (particulate matter, PM) in the atmosphere has been found to be a crucial environmental and health problem in urban areas (Furusjö et al., 2007). Due to anthropogenic processes like traffic, industry, agriculture and the generation of heat and power, people are exposed to increased amounts of PM containing numerous heavy metals (Fang et al., 2005; Guéguen et al., 2012; Johansson et al., 2009). Since fine particles can enter the lungs, respiratory and cardiovascular diseases, cancer and premature mortality are associated with the long-term exposition to PM (Zhu et al., 2015). Besides, dust also affects both the atmosphere (influencing cloud physics and the radiative balance) and natural ecosystems (e. g. by dry deposition on leaves) (Enamorado-Báez et al., 2015; Ragosta et al., 2008).

Although the contents of some heavy metals have been determined in dust from several cities, to our knowledge there exist relatively few publications that deal with the identification and quantification of different sources (Hieu et al., 2010; Ragosta et al., 2008). Besides, there are only few studies that include lanthanoid elements and their (normalized) patterns, that are different for natural and anthropogenic sources (Kulkarni et al., 2006; Moreno et al., 2008). Therefore, the aim of this study is to determine the content of numerous heavy metals (including lanthanoid elements) in dust samples from eastern Germany and to quantify the different sources. This includes the differentiation between anthropogenic sources and natural ones like the erosion of soil, pollen or Saharan dust. Since PM from every source has a specific metal composition, multivariate statistical tools like correlation analysis or factor analysis can be used for the identification and quantification (Furusjö et al., 2007; Hieu et al., 2010).

Methods

Air filters from several public buildings and spiderwebs from handrails of bridges have been collected in the city of Jena (Germany). After separating them from coarse objects (e. g. insects, hair) and drying them the samples have been digested using either aqua regia or HNO_3/H_2O_2. Contents of heavy metals were determined using ICP-OES and ICP-MS. For the evaluation, both basic and multivariate statistical methods were applied, using the heavy metal contents in local loess samples as geogenic background values.

Proceedings of the 18th International Conference on Heavy Metals in the Environment, 12 to 15 September 2016, Ghent, Belgium

Results

A method was developed to determine the content of heavy metals in different dust samples and the comparable contents in loess samples. With this, it could be shown that the patterns of lanthanoid elements (normalized to Post-Archean Australian Shale) are different for urban dust and local loess samples, the latter of which can be seen as dust from natural sources. This shows that there is an anthropogenic influence on the urban atmosphere, changing both the natural composition and the amount of dust. Also for other heavy metals an increased content in PM samples could be determined that is due to diverse sources (e. g. traffic), emitting heavy metals in different mixtures. Statistical methods could be used to show the correlation between certain of these elements.

Conclusion

Urban dust is a composition of PM from different natural and anthropogenic sources. In a both practical and statistical approach, the contents of numerous heavy metals in PM samples can be used to show differences between urban and natural dust on the one hand and commonalities and differences between different sources on the other hand.

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