Source assessment of atmospheric lead measured at Ny-Ålesund, Svalbard

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The lead isotopic composition of aerosols reaching the polar regions potentially contains valuable information on the source and long-range transport of atmospheric particulate and associated contaminants, which will complement that from meteorological and elemental composition studies.

In the frame of the Italian polar research programmes, size-segregated (PM_{10}) aerosol samples of atmospheric aerosols have been systematically collected at Ny-Ålesund (Svalbard Islands, Norwegian Arctic) in 2010-2014 and analysed for elemental composition and stable lead isotope ratios ($^{206}Pb/^{207}Pb$, $^{208}Pb/^{207}Pb$), along with other chemical tracers, such as aluminium (crustal marker) and non-sea-salt sulphates (anthropic and marine biogenic marker).

It was found that most of lead reaching Ny-Ålesund is anthropogenic, with a marked seasonality of both the concentration and isotopic signature. For example, lead concentration in summer 2012 decreased by 40% (p=0.01) compared to spring, whereas $^{208}Pb/^{206}Pb$ moved from 2.107±0.004 to 2.090±0.009 (p=6.0×10^{-6}). The same trend was found for the non-sea-salt sulphates, mainly from anthropic sources.

By comparing the measured isotopic ratios to literature data (Figure 1), the atmospheric lead reaching the Arctic during spring could be related to inputs from eastern Eurasia, whereas North America was the major source of atmospheric lead during the summer.

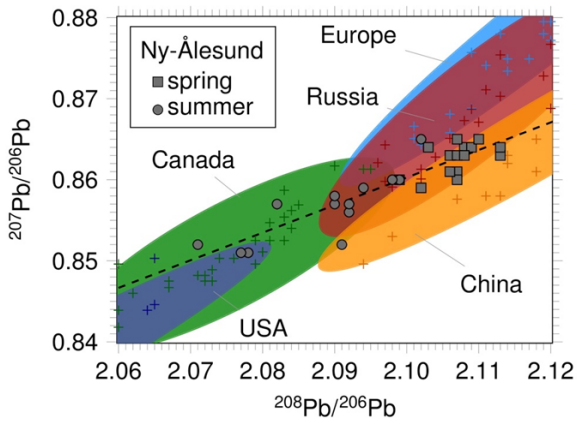

Figure 1. Three-isotopes plots. Ellipses represent the joint-distribution (90% confidence level) of literature data (Bollhöfer and Rosman, 2001a, 2001b, 2002; Carignan et al., 2002; Mukai et al., 2001a, 2001b).

This change was likely due to the quick, recurring transition from spring to summer in the Arctic atmospheric circulation, leading to a shift in the pattern of the source regions of the aerosol. The source assessment was confirmed by the back-trajectory analysis of air masses (Table 1).

Table 1. Results of cluster analysis of monthly back-trajectories (BTs). Values are the percentage of BTs represented by the cluster.

Cluster	Apr	May	Jun	Jul	Aug
Northern Europe	0	12	0	0	0
Eurasia	33	15	5	0	0
Northern America	4	0	18	0	21
Greenland, Iceland	0	8	15	29	17
Local	63	65	62	71	62

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