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Improving air quality in Beijing by isotopically tracking the atmospheric sources of lead in aerosol

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High concentrations of fine particles are found in the air of big cities, which can be up to 300 micro g.m-3 for PM10 particles (<10 microns in diameter). As fine atmospheric particles have a damaging effect on public health, they have recently become a cause of major concern. Lead-isotope ratios have proved to be reliable tracers of lead origin in the atmosphere, including urban air.

The city of Beijing in general, and particularly in prospect of the 2008 Olympics, is conscious of the need of improvement of the air quality. Leaded gasoline in the city has been phased-out since 1 997, but even if a slight decrease in its atmospheric concentrations has been observed, the levels could be up to 0.3-0.4 micro g.m-3. Industrial emissions, particularly non-ferrous industry as well as coal-combustion are the usual suspects, but so far the classical chemical methods showed their limitations in determining the respective sources contributions.

It is with this aim that used the lead isotope systematic to decipher its origin in the atmosphere of Beijing. The study followed two steps: A) Characterisation of all the potential pollution sources: typical Chinese soils (representing a natural end-member), coal combustion fly ashes, smelters and lead refining plants. B) Sampling in the ambient air and their isotopic analysis to both identify the main source of pollution and determine their respective contributions.

Results show that all the studied pollution sources are significantly discriminated by their lead isotope ratios, confirming that this is a reliable tool that can be used as a direct tracer of pollution processes.

Ambient air samples, both TSP and fine fraction, taken from three different locations within and around the capital city (Chegongzhuang, Liangxiang and Changping), show that the atmospheric lead budget is mainly controlled by a ternary mixing relationship, indicating that:

- Emissions from lead refining plants are the major vector of lead in the air, whatever the size of the particles is (TSP or fine fraction).
- In terms of contribution, coal combustion represents the second source within the TSP fraction.
- Emissions from the smelter are isotopically detectable under specific weather conditions, both in the TSP and fine fractions.
- In the TSP fraction, only one sample during the sampling period (12 months) did show contribution from outside the city (=natural lead).

The outcomes of this study should definitely help local authorities define an improved air quality management plan, in the expectation of lowering lead levels in the atmosphere of Beijing.

Keywords: isotope, aerosol, lead, strontium, pollution