Joint Seminar of C-FES and Environmental Biology and Chemistry

cosponsored by "4000 m Project for Toyama Environmental Sciences"
University of Toyama

1st June 2010

16:30 – 18:00, A425 Room, 4th Floor, Faculty of Science

"Isotopic Science for management of Air and Water"

1. The benefit of the use of Pb and Sr isotopes to help improve air quality in Beijing
2. How isotopic monitoring can improve management of nitrate pollution in water

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Abstract

1. High concentrations of fine particles are found in the air of big cities, which can be up to 300 $\mu g.m^{-3}$ for PM_{10} particles (<10 μm 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 1997, but even if a slight decrease in its atmospheric concentrations has been observed, the levels could be up to 0.3-0.4 $\mu g.m^{-3}$. 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.

2. Today, the environmental management of surface/groundwater quality with respect to nitrate contamination is almost exclusively based on monitoring nitrate (NO_3) concentration levels in a selection of sites and samples through time. However, there is now ample evidence that this concentration approach does not allow to establish unambiguously the different sources and their respective contributions to nitrate pollution. It is also observed that increasing the density of data points by increasing the number of environmental monitoring stations and/or the number of samples (reducing periodicity between sampling) does not help much and generates extremely high additional costs. A direct consequence of this is that it is often difficult to design and verify the effect of environmental management measures and plans implemented to control nitrate contamination in a given area.

The results of recent research work showed that the limitations of the concentration monitoring approach can be overcome by using an isotopic approach. This approach is based on measuring natural isotopes of the nitrate molecule ($d^{15}N$ and $d^{18}O$) and associated dissolved species ($d^{11}B$) present in both pollution sources and water. Although the application of the isotopic tracing approach to nitrate pollution issues is recent, it has proven to be very effective at precisely discriminating the different vectors of nitrate in water (i.e. urban and agricultural sources), identifying these sources of pollution and quantifying their respective contributions to a contaminated water body.

The objective of the ISONITRATE project was to demonstrate to policy-makers and -implementers that a water quality monitoring network, operated over several years and integrating isotopic data (that inherently have a far greater information content than chemical data alone) is feasible technologically and economically cost-gaining, and leads to more effective planning of environmental management measures specifically targeted against nitrate pollution in water bodies.

The demonstration project was carried out by characterising the isotopic composition of all identified potential nitrate sources, and by collecting and analysing (chemically and isotopically) water samples from boreholes and rivers over a period of 15 months, on four distinct locations representing the different hydrogeological contexts encountered by most authorities in charge of providing potable water:

a) Natural nitrification of the soil: sampling sites representing the local background NO_3 levels in water (i.e. samples with higher NO_3 are considered polluted). The measured low NO_3 concentrations need not to result from attenuation by natural denitrification, but clearly from natural nitrification.
b) Natural denitrification: sampling sites along a gradient of natural denitrification, all groundwater.
c) Simple case: sampling sites located in a zone where only one pollution source controls the NO_3 budget in water.
d) Complex case: sampling sites where NO_3 in water results from the combination of distinct sources with various contributions along the hydrological cycle.

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２０１０年６月１日火曜日

大気と水環境保全のための同位体科学

David Widory 博士

フランス地質調査所（BRGM）安定同位体研究室長

Widory 博士は，今から約 10 年前，富山大学理学部生物圏環境科学科に JSPS ポスドク研究員として在籍した経歴をもつ地球化学の研究者です。現在は，フランス地質調査所に所属し，安定同位体を用いて大気汚染や地下水汚染に関する研究をされています。2007 年，2008 年に引き続き，学会参加のため来日される折を利用し，富山大学にて最近の研究を紹介して頂けることになりました。複数の同位体を用いて，中国北京における大気浮遊粒子状物質の起源を探る研究と，欧州における水環境中の窒素汚染についての研究について発表して頂きます。ご関心のある教員，大学院生，学部生のご参加をお待ちしております。お気軽にお越し下さい。

日時：６月１日(火)午後 4 時 30 分～6 時 00 分
場所：理学部４階 A425

（問い合わせ：極東地域研究センター・和田直也（内線 6678））