Pb elemental concentrations and isotopic compositions in environmental survey: Is lichen transplantation efficient?

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Lichens are known to be sensitive to various pollutants and are considered a good biological indicator of the air quality. Lichens are epiphytic, which means that their influx is exclusively atmospheric (precipitation, fog, mist, particles, gas...), so they integrate the atmospheric fallout signal and generally contain much higher concentrations of trace metals than, *e.g.*, rain. Another advantage of lichens is their ubiquity and the ease of sampling. However, lichens are not found everywhere. To compensate for the absence of lichens in certain areas, transplantation techniques have been developed and are now commonly used. These techniques consist in an importation of lichens from one area to another one, in which they are originally absent.

In this work, lichens (*Hypogymnia physodes*) have been transplanted from one reference site to 5 different sites including the reference site itself and 2 peri-urban sites. The other 2 sites have been chosen for their proximity to a highway and the proximity to an industrial site. The impact of two different system set-ups (one covered and one non-covered) has been tested. The main difference between the two set-ups is protection from the rain for the covered set-up. Samples have been collected 14, 34 and 68 days after transplantation. Pb concentrations and Pb isotopic compositions already accumulated in thallus have been measured by ICP – mass spectrometry.

A systematic difference between the two set-ups (covered and non-covered) is found for Pb concentrations. Lichens coming from the non-covered set-ups provide higher Pb concentrations. Lead concentrations in covered set-ups have been found lower than or equal to the original concentration, whereas the Pb concentration in lichens from the non-covered set-ups is higher for all the sites after 68 days.

Pb isotopic compositions also show a systematic difference between the two set-ups, with the Pb isotopic composition of lichens from the non-covered set-up being more radiogenic. Pb isotopic compositions of lichens coming from the covered set-ups remain in the same range, whereas substantial changes in the Pb isotopic composition are recorded for lichens coming from the non-covered set-up, even after only 34 days of transplantation in some cases. Nevertheless, interpretation of the Pb isotopic composition variation is not straightforward.

Nano-spinel synthesis using Fe(III)-reducing bacteria

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Geobacter sulfurreducens is a bacterium capable of reducing amorphous iron(III) oxide through electron transfer coupled to organic matter oxidation, converting the iron to nano-sized magnetic particles of magnetite (Fe_3O_4), with a size of approx. 20 nm [1] (Fig. 1).

Nano-spinels of the general chemical formula $M_xFe_{3-x}O_4$, where *M* is a transition metal cation other than Fe, such as Co, Ni or Mn, have been produced using the capability of *G. sulfurreducens* to form nanomagnets[2]. These materials have different electrical, magnetic, and structural properties, from coarse grained materials making them ideal for use in technical devices. Characterization of these nanoparticles has been carried out using the synchrotron radiation spectroscopies XMCD (x-ray magnetic circular dichroism) and EXAFS in addition to SQUID magnetometry and TEM.

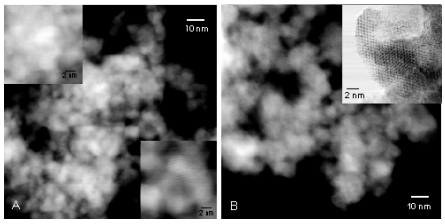

Figure 1. SuperSTEM images of (A) Co-biospinel, (B) Ni-biospinel.

The extraordinary capability of bacteria to produce nano-magnets has not yet been exploited by industry and such processes have enormous commercial potential. In addition, the ability of the bacteria to precipitate magnetite from Fe(III) oxides could be used as a bioremediation strategy to clean up environments contaminated by Fe(III)-oxides, such as acid mine drainage (AMD) sites, inexpensively and effectively.

References

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