Standard Project

Experimental Report template

Proposal title: Relationship between Zn speciation and isotopic fractionation in a soil-plant system		**Proposal number:** 20110858
Beamline: FAME	**Date(s) of experiment:** from: 27 june to 2 july 2012	**Date of report:** Feb 2013
Shifts: 15	**Local contact(s): denis Testemale**	*Date of submission:*

Objective & expected results (less than 10 lines):

Higher plants play a key role for the stabilization of metals in contaminated environments. This project was focused on the fate of Zn in an infiltration basin receiving metal-contaminated rainwater and colonized by aquatic plants. It combined isotopic geochemistry, chemical extractions and EXAFS spectroscopy. Isotopic measurements showed enrichment in heavy isotopes in the roots and in light isotopes in the aerial parts of plants relative to the substrate. Moreover, the litter did not show any fractionation pattern relative to the sediment. Various processes may explain these fractionation patterns, such as the sorption on Fe oxyhydroxides forming the root plaque, the transport of Zn inside cells by transmembrane transporters, and the release of Zn accumulated in plants during biodegradation and transfer in underlying horizons. To test these hypotheses and better understand the dynamics of Zn in this soil-plant system, an EXAFS study of Zn speciation in the various soil and plant compartments coupled with chemical extractions was used.

Results and the conclusions of the study (main part):

Zn K-edge EXAFS spectra for the suspended matter sampled in the inlet of the infiltration basin, bulk sediment and size fractions, and sediment after DTPA chemical extraction, and plant litter at various stages of degradation were recorded. For the living plant, spectra for the roots before and after extraction with HCl, rhizome, stem and leaves of phalaris and typha were recorded. We already have an extensive database of Zn EXAFS reference spectra.
Sediment samples were recorded at ambiant temperature whereas plant samples were recorded at 10K using the He cryostat. Some samples were recorded at both temperatures, and we noticed no difference in amplitude or spectral feature. Thus, all spectra can be compared directly.

Figure 1 compares the spectra for plant litter and suspended matter sampled in the inlet of the infiltration basin (the two major sources of Zn for the substrate), and the sediment (fine fraction, bulk and resudie after DTPA extraction). Treatment by LCFs is under way, but we can already see that Zn speciation is drastically modified from the inputs to the sediment: Zn present as organic complexes and weakly sorbed phases is transfered to phyllisilicate phases, a chemical form which is also observed in soils.

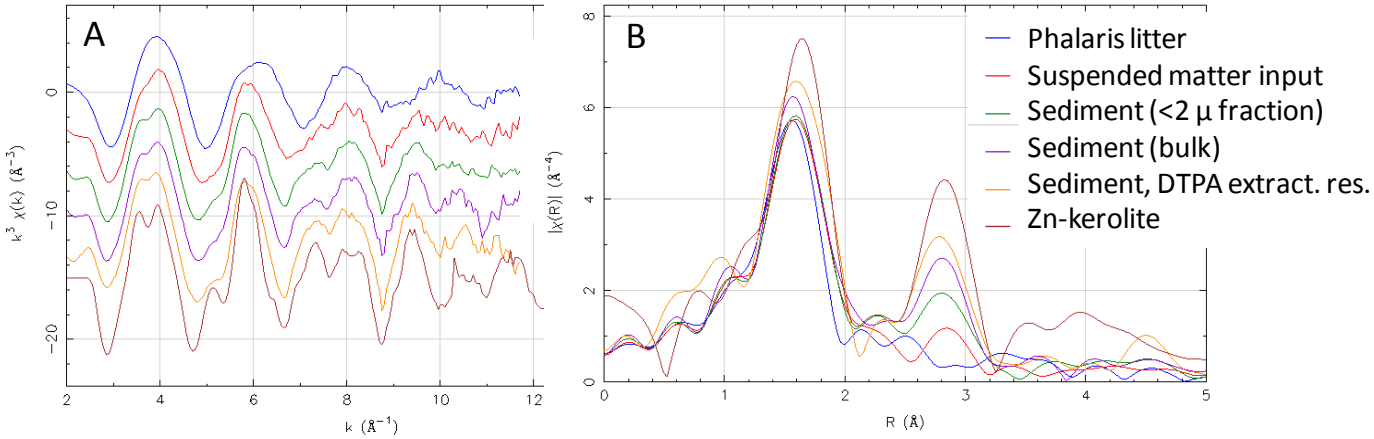

Figure 1: Zn k-edge EXAFS spectra and TFs for the litter and sediment.

Figure 2 shows the spectra recorded on the various parts of Phalaris plant. The leaving organs (roots, rhizome, stem and leaves) show relatively comparabe EXAFS spectra. They indicate an association of Zn with organic acids, with Zn in octahedral coordination. A similar result is obtained for the root after HCl extraction, whwich suggests that Zn is not present as external precipitates.
Phalaris litter presents a different spectrum, with Zn in tetrahedral coordination, corresponding to high afifnity Zn sites of organic matter. The same signature was obtained for dead leaves and litter at various stages of degradation.

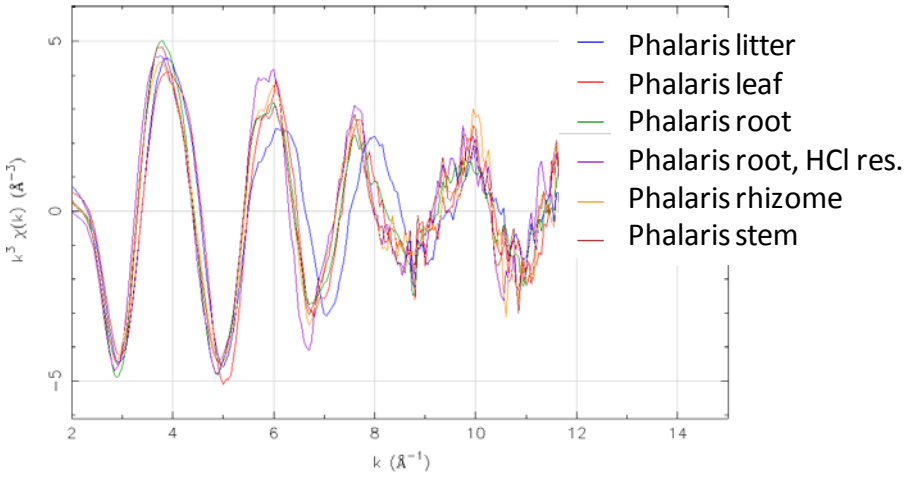

Figure 2: Zn k-edge EXAFS spectra for the various compartments of Phalaris

Thus, Zn undergoes different changes in chemical speciation form the sediment to the plant and then back to the sediment, with an intermediate which is the litter.
Further isotopic analyses are under way to determine whether Zn associated to the phyllosilicates, which is considered as a stable phase, may be re mobilized by the plant.

Justification and comments about the use of beam time (5 lines max.):

We recorded 3 to 10 spectra on each sample, depending on its Zn content and global composition.
The experiment went smootlhy, with no beam lost.

Publication(s):
Dynamics of Zn in a soil-plant system: Combined isotopic and spectroscopic approach, M. Queyron, A.M. Aucour, J.P. Bedell, V. Magnin and G. Sarret, ICOBTE Conference, Athens, June 2013 (Conf. Comm.)