Biogeochemical pathways of critical environmental contaminants (PTTE, POPs) in the rhizospheric soil-plant system

*Hideyuki Inui[1], Vladimir Beskoski[2], Mikael Motelica-Heino[3]

1. Kobe University, 2. University of Belgrade, 3. University of Orléans

Plants have a significant role in the biogeochemical cycling in continental ecosystems namely in the transformation and chemical export of anthropogenic chemicals in the critical zone environments. In particular the rhizosphere soil, which is the few millimeters of soil covering the roots of plants and influenced by their biological activity, is a dynamic system characterized by feedback interactions between soils characteristics, roots processes and dynamics of the associated microbial communities. It is a geochemical micro-environment influenced by plants physiology (roots exudation of compounds such as organic acids etc., respiration, …), microorganism activity (mineralization of organic matter…) and soil characteristics (SOM, pH, texture, WHC, CEC etc). These dynamic small-scale biogeosystems are characterized by feedback interactions between soil characteristics, plant roots and dynamics of the associated microbial communities and play an essential role in the transformation of natural organic matter, nutrients and trace elements. They may also locally influence the ecodynamic of critical environmental contaminants such as potentially toxic trace elements (PTTE) and/or persistent organic contaminants (POPs), either directly (precipitation, complexation, adsorption, degradation, plant uptake) and indirectly (effects of the rhizosphere on pH and redox potential, dissolution of minerals…) in contaminated soils.
The study of rhizosphere-related processes on mobility, availability and toxicity of PTTE and POPs in rhizospheric soils, based, in particular, on the role of the root-mycorrhizae-bacteria associations in their transformation of, is thus a major challenge to understand the ecodynamics of these contaminants in natural or anthropogenic continental biogeosystems. Identifying these feedbacks, positive or negative, for the study of physical-chemical processes, biological and microbial requires to be done at different spatial scales, micro (eg. soil pore –organo/mineral aggregates–microorganism interface), local (biological community or soil unit) to regional (ecosystem in its watershed). This objective will be reached through characterization of rhizosphere microflora, identifying the role of roots exudates, evidencing the influence of these biogeochemical factors on the speciation, transformation, mobility and phytoavailability of PTTE and POPs in rhizospheric soil.
Generic issues to be addressed are:
1) What and how do the structure and dynamics of microbial soil populations control zoning of critical environmental contaminants?
2) Can the foreseen spatio-temporal changes in microbial communities and distribution of these contaminants at a small spatial scale solve their contributions in terms of source and sink on large biogeochemical cycles?
3) What is the role of the rhizosphere on their transformation, mobility and transfer?
4) How can local sources and sinks be upscaled at the watershed and global transfer level?
The specificity of our work is to bring together a diversity of approaches at different spatial scales and in different conditions (laboratory, mesocosm, land) with a holistic integration of components (mineral and organic fractions of soil) and different biological factors (micro-organisms, plants). Results illustrating root-bacteria associations in the mobility, availability and toxicity will be discussed to understand their ecodynamics in soils, study the contribution of rhizospheric microbial communities their (im)mobilization processes, elucidate their transfer from soil to vegetation compartments and more global pathways in the critical zone. Far from being isolated, the different compartments of the critical zone interact according to

and on very variable spatial and time scales still largely unknown.

Keywords: Persistent organic pollutants, Potentially toxic trace elements

