Lorraine University PhD Studentship

Title: Exploring long range electron shuttling between bacteria and iron rich minerals

Graduate School: SIReNa

Laboratory: Laboratoire Interdisciplinaire des Environnements Continentaux (LIEC) UMR 7360 CNRS-UL

Supervisors: Dr Christaian Mustin and Dr Asfaw Zegeye

Start date and duration: October 2019 for 3 years

Closing date for application: June 2019

Overview:

In soils and sediments, iron bearing minerals are commonly encountered associated with organic matter. The formation of these organo-mineral complexes stabilizes the organic matter, limiting its oxidation by bacterial activity. However, in anaerobic conditions, Fe (III) can play the role of electron acceptor and its bio-reduction could lead to the solubilization and the oxidation of the organic matter. Likewise, the organic matter can influence the stability of the mineral either by blocking the active reduction sites or by playing the role of electron shuttle which accelerate the dissolution of the solid phase. In particular, the crystallization or the mineralogical transformations of these iron (III) bearing minerals are inhibited or oriented by the sorption of organic matter on their surface. Consequently, the aerobic / anaerobic oscillations, the deployment of specific microbial activities and the physicochemical properties of organic molecules have an influence on the intensity of iron and carbon redox cycling. All these parameters can modify the composition of these organo-mineral assemblages and, accordingly, their stability and their accumulation in soils and sediments. The impact of complexing or electron transfer processes, between organic matter and iron bearing minerals needs to be addressed in order to understand and get a better insight on the mobility of iron and carbon (*i.e.* mineralization) in the environment. In particular, the long-range iron reduction-oxidation processes (several millimeters or centimeters) and their activation by quinoline like molecules (*e.g.* anthraquinone) resulting from microbial degradation of aromatic molecules remain unknown.

This thesis project aims to identify the determinants and the mechanisms that jointly govern the dynamics of iron and carbon in quinone / iron bearing mineral / bacteria systems. For this joint approach of the coupling of iron and carbon cycles, this thesis work will focus on the solubilization and the mineralogical evolution of iron bearing minerals (*i.e.* ferrihydrite, nontronite) with the mineralization of organic substrates (*i.e.* release of CO_2) and the production of complexing metabolites (*i.e.* carboxylic acids) or electro-active quinones like molecules.

With the use of multi-parametric experimental designs, this PhD work will exploit the variations of the structural or functional phenotypes of each component of the system and redox conditions

(aerobic / anaerobic oscillation) to identify the determinants of the mechanisms and the kinetics of electrons transfer and mineral transformation.

Key words: Quinone, iron reduction, iron bearing minerals, electron shuttles, bacteria, redox potential

Eligibility Criteria:

Ideal candidates should have a solid background in chemistry and/or spectroscopy and are interested in geochemistry and geomicrobiology. Applicants must have the ability to work in a team, have good management and communication skills and should be highly motivated and committed to pursuing interdisciplinary research. Good computer and language skills (English) are necessary. Experience in R software and geochemical softwares would be advantageous. The candidate will have the opportunity to present his/her results in international journals and conferences. The successful candidate will be responsible for the daily management of his/her research project in coordination with the supervisors and other members of the group. S/he may be involved in the training and co-supervision of master students.

Application package:

• A letter of motivation
• Complete curriculum vita
• Documentation of diplomas (Master degree or equivalent and detailed marks)
• Names and contact information of two references
Application should be sent by email to Dr Christian Mustin (christian.mustin@univ-lorraine.fr) and Dr Asfaw Zegeye (asfaw.zegeye@univ-lorraine.fr).

Applicants should also apply through the University's online application system. Please follow this link http://doctorat.univ-lorraine.fr/fr/les-ecoles-doctorales/sirena/offres-de-these/transferts-delectrons-longue-distance-lors-de-la

Contact:

For further details, please contact Dr Christian Mustin or Dr Asfaw Zegeye