2 Master thesis in (environmental) Radiochemistry

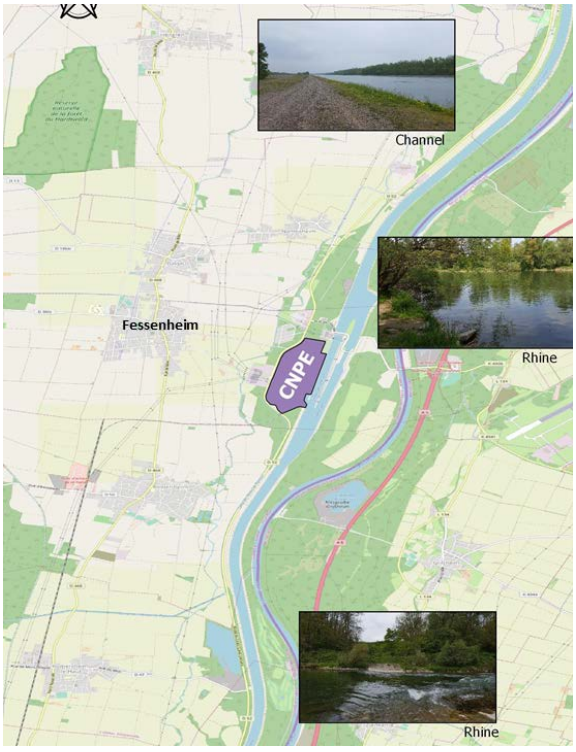
Topic

Characterization of (micro)pollutants and their (in)organic nanovectors around a decommissioning site: Application to the Grand Canal of Alsace and the Old Rhine (Fessenheim, Alsace, france)

Background

Over the last decades numerous human activities have emitted and released to terrestrial and aquatic ecosystems around urbanized and industrialized territories various metallic (micro)pollutants including radioactive isotopes (called hereafter more generally metallic trace elements, MTEs). This is a main environmental issue due to their variety, their potential toxicity and the complex mechanisms controlling their fate in the environment. Thus, an emerging scientific challenge at international level is to identify and to model the interactions between the MTEs and the main vectors of their aquatic mobility, i.e. the organic matter (OM) and the (in)organic nanoparticles (NPs).

These issues also arise in the context of the decommissioning of nuclear facilities as the potential conversion of these industrial areas to other types of land use calls for a comprehensive methodology to assess the site and its status. In this context, a scientific in-depth analysis based on the use of moder ultrasensitive analytical methods is required for the assessment of the environmental impact caused by decommissioning operations *before*, *during* and *after*.



In the frame of the European Campus EUCOR, we have initiated a project involving three partners: the INE (KIT, Germany), the IPHC (University of Strasbourg, France), the ENSCMu (University of Haute-Alsace, France). The objective is to initiate a cross-border expertise center (*via* the pooling of the specific expertise and advanced analytical techniques) to study and better understand the MTEs dynamic in natural aquatic biotopes.

The aim of our project and of the present Master thesis is to gain data providing valuable information at hitherto not available sensitivity and quality on the environmental status of a specific region. It refers presently to the Rhine aquatic biotope (limited to the Upper Rhine region and the Grand Canal of Alsace, see Figure), thus close to the future decommissioning site of Fessenheim (France).

Work description

The work will be distributed into several specific tasks. A part of the work will be done in the partner's institutes (Strasbourg and Mulhouse, France). Travel and accommodation expenses will be covered by the EUCOR project.

Master thesis nr. 1, (open Autumn 2020), location mainly at KIT/INE, will consist in:

(i) On-site samplings (Fessenheim site, France) and sample conditioning,
(ii) Accurate MTEs analysis,
(iii) Exhaustive determination of the potential MTE vectors, i.e. the (in)organic NPs and (macro)molecules of natural and anthropogenic (terrestrial and aquatic) origins,
(iv) Elucidation and quantification of physicochemical processes occurring at these solid/liquid interfaces at various scales,

Master thesis nr. 2, (open Autumn 2020) location mainly at IPHC/Uni.Stras., will consist in:

(v) Laboratory simulation of interactions at the OM-NP-ETM interfaces using OM extracts and silica / iron oxides or synthetic clay nanoparticles;
(vi) Molecular-scale studies to identify the metallo-organic species formed at the interfaces,
(vii) Assess effect of a potential change in water chemistry due to climate change (e.g., acidification, increased concentrations of OM, etc.).

Methods:

- Sample collection, extraction
- Elemental analysis (ICP-OES/ICP-MS, IC, DOC)
- Hyphenated size fractionation methods (LC/OCD, AsFlFFF/UV-Vis/MALLS/ICPMS)
- Solid phase characterisation (XRD, ESEM, TEM)
- Molecular scale characterization (ESI-FTMS)
- Spectroscopic techniques (IRTF-RTA, XPS)
- Ultra-trace analysis (AMS)

Publications

▪ Bouby, M., Geckeis, H., Geyer, F.W. *Application of asymmetric flow field-flow fractionation (AsFlFFF) coupled to inductively coupled plasma mass spectrometry (ICPMS) to the quantitative characterization of natural colloids and synthetic nanoparticles.* Anal. Bioanal. Chem., **2008**, 392 (7-8), p. 1447-1457.

▪ Fleury G., Del Nero M., Barillon R. *Effect of mineral surface properties (alumina, kaolinite) on the sorptive fractionation mechanisms of soil fulvic acids: molecular-scale ESI-MS studies.* Geochim. Cosmochim. Acta, **2017**, 196, p.1.

▪ Quinto F., Blechschmidt I., Garcia Perez C., Geckeis H., Geyer F., Golser R., Huber F., Lagos M., Lanyon B., Plaschke M., Steier P., Schäfer T. *Multiactinide Analysis with Accelerator Mass Spectrometry for Ultratrace Determination in Small Samples: Application to an in Situ Radionuclide Tracer Test within the Colloid Formation and Migration Experiment at the Grimsel Test Site (Switzerland).* Anal. Chem. **2017**; 89, p. 7182−7189.

▪ Plaschke, M., Rothe, J., Denecke, M. A. *Synchrotron-based X-ray spectromicroscopy of organic nanoparticles complexing actinides, in Kalmykov S. N., Denecke, M. A. (eds), Actinide Nanoparticle Research, Springer Verlag, Berlin Heidelberg*, **2011,** p. 161-184.

▪ Altmaier, M., Gaona, X., Fanghänel, T. *Recent advances in aqueous actinide chemistry and thermodynamics,* Chem. Rev. **2013**, 113 (2), p. 901-943.

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