# 1 Master thesis in (environmental) Radiochemistry

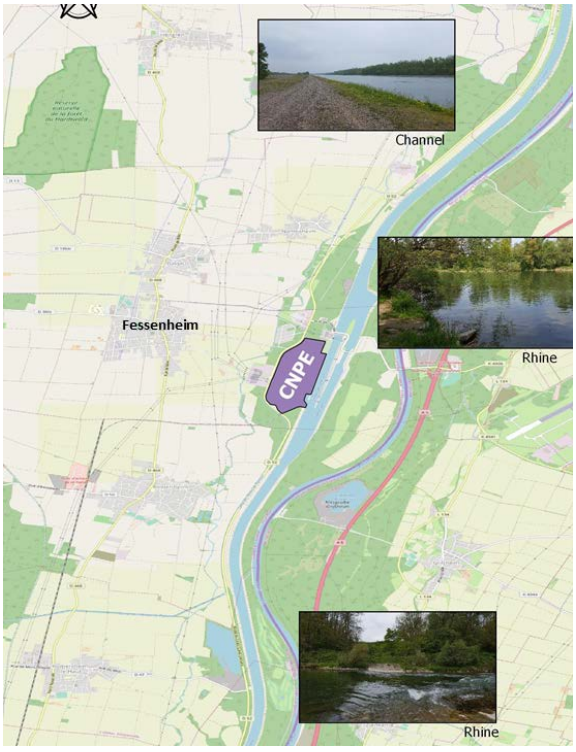
## Topic

**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 with ultrasensitive 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 in several specific tasks. A part of the work will be done in the partner's institutes (Karlsruhe and Strasbourg). Travel and accommodation expenses will be covered by the EUCOR project.

**Master thesis (open March 2021), location UHA (Mulhouse), KIT-INE and IPHC/Uni.Strasbourg, will consist in:**

(i) The synthesis and characterization of Ni/Zn montmorillonite nanoparticles according to well established protocols: they will be used as model nanoparticles, tracers and/or MTE/OM scavengers

(ii) Laboratory simulation and direct on-site use to test their MTE scavenging capabilities

a. Preparation of suspensions containing the naturally present MTE (identified during the first Master thesis work program of the project C4-PON) and the synthetic clay nanoparticles: study and quantification of any interaction

b. Interaction/fractionation of the OM naturally present with/on the synthetic nanoclay particles

c. On-site tracer tests using the synthetic clay as potential MTE scavengers and nanovectors (upstream dispersal and downstream collection at the power plant (Old Rhine and Grand Canal d'Alsace).

## Methods:

- Synthesis and characterization of Ni/Zn-Montmorillonite
- 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)

## Publications


■ Reinholdt, M.; Miehé-Brendlé, J.; Delmotte, L.; Tuilier, M.-H.; Le Dred, R.; Cortès, R.; Flank, A.-M. *Fluorine route synthesis of montmorillonites containing Mg or Zn and characterization by XRD, thermal analysis, MAS NMR, and EXAFS spectroscopy*. Eur. J. Inor. Chem. **2001**, 11, 2831–2841.

■ 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.

■ 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.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