An early stage researcher (ESR) PhD position is available at the University of Rennes 1 as part of the Marie Curie Innovative Training Network "PANORAMA"

Ph.D. Title. Reactive transport of REE in natural porous media: experimental study and modeling

ORGANISATION/COMPANY	University Rennes 1	**TYPE OF CONTRACT**	Temporary
RESEARCH FIELD	Environmental sciences	**JOB STATUS**	Full-time
RESEARCHER PROFILE	First Stage Researcher (R1)	**HOURS PER WEEK**	35
APPLICATION DEADLINE	15th June - Europe/Brussels or until position is filled.	**OFFER STARTING DATE**	As of 01/10/2020
LOCATION		**EU RESEARCH FRAMEWORK PROGRAMME**	H2020 / Marie Skłodowska-Curie Actions

Host institution

University of Rennes 1 (UR1) is a multidisciplinary institution, famous for its excellence and dynamic research, consisting of 4 main scientific areas: Mathematics and ICT (Information and Communication Sciences & Technologies), Life and Health Sciences, Material Sciences, Humanities and Social Sciences. It welcomes about 23,300 students, all surrounded by 1,900 teachers & full-time researchers and about 1,100 administrative & technical staff. As part of UR1, **Géosciences Rennes** is a Joint Research unit supported by the French National Research Centre for Scientific Research (CNRS) and UR1. It is an internationally recognized multidisciplinary laboratory in Earth and Environmental Sciences, with research ranging from lithosphere dynamics, basin analysis, Earth surface processes up to physical hydrogeology/hydrology and biogeochemistry of emergent pollutants, coupling field, experimental and numerical modeling approaches. **Géosciences Rennes** has developed strong links with leading research institutions across Europe and partnerships with industrial, governmental and non-governmental bodies and publishes ~ 120 papers/year in high-quality refereed international journals. It received top marks during the 2016 national evaluation and is one of the outstanding research institutions in the Earth Science French academic landscape. Eleven Professors, 18 Associate Professors, 24 CNRS Researchers, about 30 technical and administrative staff, 43 PhD students and 18 post-doctoral fellows are currently working in Géosciences Rennes. It hosts ~10 foreign researchers/year. **The Graduate school of Chemistry of Rennes** (ENSCR) is included in the "Institut des Sciences Chimiques de Rennes" ISCR (one of the largest French Joint Research Unit UMR). ISCR consists of 210 researchers (professors, assistant professors and CNRS researchers), 180 PhD students and postdocs, and 81 administrative and technical staff. All the research teams are jointly engaged in a scientific project, have an internationally recognized experience in all fields of chemistry, and a strong record of success in public and private grants.

Dr. Rémi Marsac is CNRS researcher at **Geosciences Rennes**. He has large expertise on the fate of contaminants in the environment (heavy metals/radionuclides/emerging organic contaminants), especially on their interaction with natural mineral and organic colloids. His approach combines experimentation, spectroscopy and speciation modeling. He has already co-supervised one (with Prof. K. Hanna) and is currently supervising two PhD students.

Prof. Khalil Hanna leads a research group in "chemical engineering" research team composed of 3 young researchers at **ENSCR**. He has a strong expertise in mechanistic description of interfacial phenomena, transport, fate and analysis of emerging contaminants combining experimentation and modeling. He has already supervised 12 and is currently supervising 3 PhD students.

Research objectives

Context. Rare earth elements (REE) are crucial to a wide range of modern technologies. The high demand with respect to global REE production makes them technologically critical elements. Because of their extensive use and release to the environment, REE are also considered as emerging contaminants, whose negative effects on human and environmental health have been suggested. Because contaminants speciation largely affects their fate in the environment as well as their bioavailability and toxicity, it is necessary to develop reactive transport models to predict the fate of REE in natural systems.

Once released to the environment, the biogeochemical cycle of REE is strongly affected by natural particle. Adsorption onto mineral or organic surfaces can delay the transport of REE. However, REE have strong affinity for natural colloids,

which are ubiquitous environmental (nano)particles (1 nm to 1 µm sized), stable in aqueous suspension and that can be transported by water over large distances. Therefore, it is necessary to investigate the effect of colloids on the transport of REE in water, soils and sediments.
Furthermore, if many studies aimed to determine the kinetic and thermodynamic parameters describing the adsorption of contaminants on the surface of minerals in batch (static conditions), recent studies show that under controlled hydrodynamic conditions (column into which a solution containing the contaminant is injected), the mechanisms at the solid-solution interface can be disturbed compared to experiments carried out in batch. Therefore, it is necessary to translate molecular information (obtained in batch conditions) to larger scales (column) to develop valuable models to assess the fate of REE in environmental systems.

Objectives. The aim of this thesis is to develop a new model allowing an accurate assessment of REE transport through connecting our understanding of molecular interactions of REE with mineral and/or organic reactive phases with the macroscopic behavior in heterogeneous systems. The properties and the dynamics of REE transport at geochemically relevant conditions will be characterized with experiments conducted under flow-through conditions in model (pure sand or sand coated with other minerals) or natural porous media (soil, sediments). The influence of key parameters (pH, Eh, ionic strength, and presence of naturally occurring ions) as well as the impact of natural organic and mineral colloids will also be investigated. Combined experimental and modelling investigations (surface complexation modeling and reactive transport) will be performed.

Methods used.
- Experiments under flow-through conditions (column).
- Reactive transport modeling, including colloidal transport.
- REE concentration determination by ICP-MS.
- Colloid and nano-aggregate characterization: DLS, A4F, SAXS…
- Mineral phase characterization: XRD, HRTEM, surface titration…
- Organic phase characterization: UV-vis, 3D fluorescence, IR, organic carbon concentration analysis...
- Surface characterization: XPS, synchrotron based spectroscopy…

Presentation of the research project (cooperative aspect)

This PhD position is within the framework of a European ITN project named PANORAMAM: EuroPean trAining NetwOrk on Rare eArth elements environMental trAnsfer: from rock to human involving 15 PhD positions.
Such innovative research approach will be effective through association of different skills involving Geosciences Rennes (REE geochemical modelling), ENSCR (reactive transport in porous media, experiment and modelling), Cordouan Technology (colloid and nano-aggregate characterization), AMPHOS21 (coupling geochemical and reactive transport modelling with advanced codes) and 2 other PhD students of the PANORAMA consortium, whose research projects will aim at characterizing molecular-level mechanisms affecting REE interaction with particles and colloids.
The PhD student will work under the supervision of Dr. R. Marsac (Geosciences Rennes) and Prof. K. Hanna (ENSCR). Both institutes are located on the same campus. The project involves a strong collaboration with 2 private companies Cordouan Technologies (Bordeaux, France) and AMPHOS21 (Barcelona, Spain), including one research stay (secondment) during 3 months in each of these companies.
The PhD student will be also involved in scientific/soft-skills meetings and in research activities conducted in other laboratories/companies from Europe and associated countries.
An important component of the training will be the participation to 3 main major **training events**:
WS1-(December 2020) REE as emerging contaminants: Properties, uses and dissemination –Germany-fundamental REE biogeochemistry and currently known anthropogenic REE inputs into the environment
SS1 (May 2021) - AMD and REE contamination mitigation - Portugal-Management and remediation solutions of AMD in old mining areas and Management of WEEE, recycling areas
WS2 - Colloids and nanoparticles as REE vectors -France- Structural characterization of colloids and nanoparticles by innovative and fine spectroscopic and scattering techniques: X-Ray absorption fluorescence and scattering, light scattering. REE interactions with bearing phases.
SS2 - (Eco)toxicology of REE –Germany- Eco)toxicological concepts and approaches, Physico-chemical properties of REE for bioavailability, ecotoxicity and environmental risk
In addition to these major milestones of the program, the PhD students will 1) continuously develop their **core research skills via their own research project** locally and within the network while at secondments and conferences, 2) receive a mandatory amount of **hard and soft-skills training** specific to their own doctoral school, along with mentoring by joint supervising bodies, 3) use **conferences both as dissemination events for ESRs results and network events for progress reports and evaluations**, and 4) **collaborate into practical activities aimed at network-structuring legacy deliverables.**

PANORAMA's research objective is to elucidate the man-induced environmental dissemination of REE and the associated effects on the environmental health. For that purpose, interdisciplinary approaches are **required** combining geochemistry, ecotoxicology, hydrology, chemical analysis and coupling field monitoring, original in and ex situ experimental set-up and modelling from the element speciation to the environmental impact

PANORAMA's key aim is to **set-up an optimal scientific and non-scientific training to the understanding and forecasting of the environmental impacts of new emerging pollutants such as REE.**

Benefits

With indicative financial conditions of the research project (in local currency)

- 3-years full-time employment contract
- Attractive salary tuned to living standards of the hosting country. Brut salary, and excluding family and mobility allowance will be around 2900 euro
- Conditional family allowance of 500€ per month (potentially subject to taxes)
- Mobility allowance of 600€ per month (potentially subject to taxes)
- Based in two leading institutions in Environmental Sciences in Europe, UR1 and ENSCR, with excellent staffs in Géosciences Rennes and friendly working conditions.
- Possibility to collaborate with a large network of international research groups engaged in the ITN

Requirements

- The candidate should be in the first four years of their research career. They should not have a doctoral degree and fulfil the eligibility criteria and mobility rule (see below).
- The candidate should hold or be about to obtain a Master's degree in Earth Science or relevant field.
- Excellent technical skills including experience in aqueous (geo)chemistry (including processes at the mineral/water interface), reactive transport modeling (including colloidal transport).
- Previous experience working in a chemistry laboratory and with reactive transport models.
- The ability to work both as part of a team, and independently, coupled with excellent communication, organizational and problem-solving skills
- Availability to travel for training events and research secondments.

ELIGIBILITY CRITERIA

Recruiting is in accordance with the European rules for Marie Curie Initial Training Networks. Early-stage researchers (ESR) can be of any nationality. They must be, at the time of recruitment by the host organization, in the first four years (full-time equivalent) of their research careers and have not yet been awarded a doctoral degree. The research career starts after the degree that enables a student to proceed with a PhD (usually, the Master degree).

MOBILITY RULE

At the time of the recruitment by the first host institution, the ESRs must not have resided or carried out their main activity (work, studies, etc.) in the country of their first host institution for more than 12 months in the 3 years immediately before the recruitment date. Short stays such as holidays and/or compulsory national service are not taken into account.

How to apply

Send your complete application before June 15th to both contacts below (application will remain open until position is filled).

A **single pdf file** needs to be submitted including:

- a cover letter, stating your research motivation and interests; including relevant background and career plan (max 1 A4 page)
- a Curriculum Vitae, including academic background, previous research and/or industrial experience (max 2 A4 pages)
- Degree transcripts (with marks)
- English language qualification certificates (or equivalent)

Reference letters:

- at least 2 confidential reference letters from academics (including name, position and email address of the referee) (max 1 A4 page, with substantiated assessment of the applicant's technical skills, creativity, innovation ability, working capacity, efficiency and level of independence) must be sent directly to the contacts below.

Contacts:

ESR Supervisors: Dr. R. Marsac (remi.marsac@univ-rennes1.fr) and Prof. K. Hanna (khalil.hanna@ensc-rennes.fr)
Recruitment committee: to be completed after the kick-off meeting

Project website: Created by Cordis when grant agreement will be signed