

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

Does soil REE speciation control REE phyto-availability and dissemination within plants?

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

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 institution in the Earth Science French academic landscape. Géosciences Rennes. 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.

Research objectives

Context. Rare earth elements (REE) are crucial to a wide range of modern technologies regarding their chemical, optical, electro-optic, and paramagnetic properties. The increasing demand with respect to global REE production makes them technologically ‘critical elements’. These elements are too used in agriculture (e.g. fertilizers) and animal production (e.g. micronutrients) and medicine (e.g. contrast-agents). However, their extensive use and all strategies developed to increase the REE supply result in an onset of the released REE fluxes concomitant to environmental and occupational exposures. As a consequence, REE are now also considered as ‘emerging contaminants’, whose negative effects on environmental health have been suggested. Crucial research needs therefore to emerge to assess the impacts and fate of REE in the environment and the interactions that ensue from the occurrence of REE in natural mediums. Considering the key role the plants play within the ecosystems, special attention has emerged to decipher the possible REE effects induced on plants and to shed light on the involved key mechanisms. Because whichever the contaminant can be considered, its speciation largely affects its fate in the environment and their bioavailability and toxicity as well, it is necessary to understand how does soil REE speciation control REE phyto-availability and associated dissemination within plants.

REE can be indeed released in the environment as truly dissolved, colloidal or particulate species, whose transfer is controlled by their chemical speciation, relative to the prevailing physico-chemical conditions (Eh, pH, soluble and particle organic and inorganic ligands, etc.). Once released to the environment, the biogeochemical cycle of REE should be thus,

strongly affected by its speciation. Within the biogeochemical cycle of REE understanding, the bioavailability of REE regarding plants has to be urgently more investigated to predict the fate and effects of REE on biota, since:

- depending on a large extent on their speciation, possibly changing markedly the uptake, bioavailability and bioaccumulation;
- only free or small inorganic complexes of REE have been tested representing only a little fraction of the species encountered in natural samples; little studies focused the bioavailability of REE at rhizosphere scale, taking account microbiota of soil and plants together;
- **most of REE studies on biota were often dedicated to one single REE and not to the whole set of REE, although the man-induced disruption of the REE biogeochemical cycles concerns more than one REE.**

Objectives and approach. The aim of this thesis is to provide new understanding tools - through a coupled approach linking natural samples and experimentation-sourced ones' analyses - to decipher whether the REE speciation controls or not the REE phyto-availability, and to which extent. Moreover, this thesis can participate to determine how microbiota and plants activities can modify REE speciation and availability by changes physico-chemical parameters within rhizosphere. This study will be conducted through the investigation of the REE dynamics in rhizosphere and subsequent REE dissemination in plant organs. 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. The approach developed in this study will combine in and ex situ experiments involving plant model growth monitoring and REE speciation studies. The REE dissemination in the vegetation during its life cycle will be studied through the interactions occurring within the rhizosphere and within the different plant parts. Soil solution composition (ICP-QQQ-MS, IC, TOC analyzer), physicochemical properties (pH, Eh, etc.), microbial biomass C and N, speciation and bioavailability of REEs to roots (A4F/ICP-MS), analysis of biomass and pigment levels, redox homeostasis indicators (concentrations of reactive oxygen species, activity levels of enzymatic antioxidants, etc.) and phyto-concentration of REE in aerial parts will be monitored (ICP-QQQ-MS, HR-TEM-EDS, NanoSIMS). Natural plant samples collected in REE-enriched PANORAMA sites, whose speciation will be thoroughly characterized at a molecular level, will also be investigated.

Expected results. The identified effects will be thoroughly linked to the dominant REE speciation in relation to the involved physical, chemical and biological control parameters, whichever the natural or experimental samples will be considered.

The research will address not only, (eco)toxicological challenges related to the recognition of potential impacts on soil biology, fertility and response to the REE spread, but also help to improve the performance of remediation processes through specific catalysis factors for these contaminants (REE phytoremediation/phyto-concentration).

Ultimately, the highlighted intimate prevailing mechanisms and key control parameters as well, eventually distinguishing different action modes across the REE series will allow - through the network cooperation of geochemists and (eco)toxicologists - first steps towards a biotic ligand model for REE. Such model will describe how REE interact with living organisms to predict how the organisms will respond to exposure of REE to enable a reliable assessment of environmental risk.

Presentation of the research project (cooperative aspect)

This PhD position is within the framework of a European ITN project named PANORAMA: 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 consortium's collaborators and 2 other UR1-hosted PhD students of the PANORAMA consortium, whose research projects will aim at characterizing molecular-level mechanisms affecting REE interaction with particles and colloids and REE transport.

The PhD student will work under the supervision of Dr. A. Dia and Dr M. Pédrot (Geosciences Rennes). This specific PhD project involves collaborations with:

- 1 private company: Empresa de Desenvolvimento Mineiro S.A. (EDM), a state-owned company responsible for the environmental recovery of all degraded former mining sites (Portugal)
- 3 academics: (i) the Department of Nuclear Sciences and Engineering Research in the Instituto Superior Técnico (IST), the largest and most reputed school of Engineering, Science and Technology in Portugal. (ii) The Department of Physics and Earth Sciences and the Earth & Environmental Sciences program in Jacobs University Bremen (Germany) (JUB). (iii) The Department of Biology in the Aldo Moro Bari University (Italy) (UNIBA).

Field-work will be done with EDM (2x15 days), whereas research stay (seconments) will occur during 2 months each in IST (2x1 month time-related to field work), JUB and UNIBA, dedicated to support to field and REE water/soil/plant transfer experiment, REE rhizosphere siderophore binding and REE phyto-toxicity, respectively.

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 €
- *Conditional family allowance of 500€ per month (potentially subject to taxes)*
- *Net mobility allowance of 600€ per month (potentially subject to taxes)*
- Based in 4 leading institutions in Environmental Sciences in Europe and 1 private companies, Geosciences Rennes as the host institution (30 months) and secondments: IST/EDM (2 months), JUB (2 months) and UNIBA (2 months), with excellent staffs in Geosciences Rennes and secondment institutions and friendly working conditions as well.
- 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 and analytical skills including experience in aqueous geochemistry (monitoring of trace element dynamics at soil/water/plant interface,
- Previous experience working in a chemistry laboratory and more especially in clean laboratory,
- Ability to deal with multidisciplinary topics linking geochemistry and biology,
- 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 here below contacts (application will remain open until the position will be 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 and/or ranking within the school year group. Marks/ranking can also be provided in a letter (with signature) from the Professor responsible for the Master degree.
- English language qualification certificates (or equivalent)

Reference letters:

- at least 2 possible referees' (academics) names and email addresses or 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. A. Dia (aline.dia@univ-rennes1.fr) and Dr. M. Pédrot (mathieu.pedrot@univ-rennes1.fr)

Recruitment committee: **to be completed after the kick-off meeting?**

Project website: **created by Cordis when grant agreement will be signed?**