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Rare Earth Element Phyto-Availability in Abandoned Mining Areas

KAISA HELEN PATTERSON[1], ALINE DIA[1], ROSA MARQUES[2,3], JOÃO CARLOS WAERENBORGH[2,3], BRUNO J. C. VIEIRA[2], MARIA ISABEL PRUDENCIO[2,3], CATARINA DIAMANTINO[4], EDGAR CARVALHO[4], MARTINE BOUHNIK-LE-COZ[1], MELANIE DAVRANCHE[1] AND MATHIEU PÉDROT[1]

[1]Univ Rennes, CNRS, Géosciences Rennes, UMR 6118
[2]Centro de Ciências e Tecnologias Nucleares (C2TN), Instituto Superior Técnico, Universidade de Lisboa
[3]Departamento de Engenharia e Ciências Nucleares (DECN), Instituto Superior Técnico, Universidade de Lisboa
[4]EDM - Empresa de Desenvolvimento Mineiro

Presenting Author: kaisa.patterson@univ-rennes1.fr

Rare Earth Elements (REE) are emergent anthropogenic contaminants. Currently, there are knowledge gaps in assessing the environmental risks posed by these contaminants. High demand for modern technology has led to increased REE use, resulting in elevated REE concentrations in the environment. Therefore, demonstrating a need to understand the behavior, fate, and cycling of REEs as emergent pollutants.

The physical and chemical speciation of REE is (i) reflective of their origin and the encountered processes within the environment and (ii) potentially influences their availability and toxicity. To date, very few publications have focused on how the physical and chemical speciation of REE controls phyto-availability. Thus, an evaluation of the spontaneous vegetation at three abandoned mining sites in Portugal was carried out in November 2020 (Figure 1). Spontaneous vegetation and related media (soils and surface waters) were collected from inside and outside of mining areas with the intention of analyzing REE dynamics in rhizosphere soils and subsequent REE dissemination in plants. Trace element concentrations were analyzed in soil and plant samples using inductively coupled plasma mass spectroscopy (ICP-MS). Measurements of key parameters (pH, Eh, and major anions) and determination of dissolved organic carbon and trace element concentrations were performed in water samples by multi-meter, ion chromatography, total carbon-analyzer, and ICP-MS, respectively. Measurements were then used to decipher how the chemical compositions of waters and soils can be linked to that of plants and, more precisely, to the fate of REE in planted environments. Contrasting REE concentrations and patterns were observed in water samples regarding the prevailing environmental conditions.

In addition, the complex biogeochemical interactions in rhizospheres potentially alter the speciation and phyto-availability of REE. Therefore, rhizosphere soil samples were paired with bulk soil samples to elucidate the impact of plant and microorganism bioweathering processes on REE speciation.

Ultimately, this field study aims to evaluate the environmental risk posed by anthropogenic REE contamination and contribute to a body of knowledge on the circular economy of REE. Further study of plant REE uptake mechanisms and toxicological responses to REE contamination is planned for future laboratory experiments.

Figure 1: Map of field sites where samples were collected in November 2020.