Chronic impacts of REE in a bentho-pelagic food web

Chantal K. E. van Drimmelen[1,2], Andrew Hursthouse[2], Susanne Heise[1]

[1]Life Sciences, Hamburg University of Applied Science, Ulmenliet 20, D-21033 Hamburg, Germany

[2]University of the West of Scotland, Paisley, PA1 2BE, UK

Phone: +49-(0)-40428-756217

E-mail: Chantal.vandrimmelen@haw-hamburg.de

Introduction: Rare earth elements (REE) represent a series of 17 chemical elements, consisting of 15 lanthanides, yttrium, and scandium. These elements are often less concentrated than other metals but are relatively abundant in the earth crust. REE possess unique chemical, optical, electrooptic, and paramagnetic properties, which make them crucial to a wide range of modern technologies (e.g. agriculture, animal food, internet, lighting, plasma televisions and GPS). The demand for REE has been projected to keep increasing because of the global demand for green and sustainable products. While less than 5 thousand metric tons (Mt) of REE had been produced before the 1950s, it reached about 123 thousand Mt of REE equivalent in 2016. REE production has at its lowest been predicted to increase with almost 31% to 400 thousand Mt by 2118 [1]. With the rise of potential concerns about the environmental safety of REE, they have now been labelled 'emergent' pollutants. It is already apparent that they can cause disruption of biogeochemical cycles, notably in aquatic and terrestrial environments. REE-availability is strongly influenced by pH and the presence of other cations in the environment. They can bioaccumulate and interfere with cellular functions. However, the role of REE as contaminant and potential toxicant has not yet been extensively studied [2, 3].

The research objective of the Innovative Training Network "PANORMA" is to elucidate the man-induced environmental dissemination of REE and the associated effect on the environmental health. PANORAMA will try to achieve this through 15 different ESR projects.

Project description: PANORAMA has an ambitious research and training program allowing young researchers to contribute and reach scientific and technical objectives. As well as disseminating the results within the scientific community and to relevant stakeholders, it supports Europe in the development of an environmentally clean REE circular economy. The PANORAMA project brings the skills of (geo)chemists, (hydro)geologists, and (eco)toxicologists, working together within a consortium of 14 partner universities and 4 private partners to train 15 PhD students. PANORAMA will combine training and cutting-edge research tools through field, analysis, experimentation, and modelling approaches. Together the PhD students will study the environmental behaviour of rare earths: through their occurrence, speciation, transfer, bioavailability, and biotoxicity from their sources to the various environmental compartments and the consequence for environmental health. Panorama will develop standardized operating procedures for ecotoxicological tests with REE, which shall ensure comparability and scientific quality of REE studies [4].

The study presented here (PANORAMA ESR-9) will identify chronic impact on multiple biological species in a simulated environment. REE adsorbs strongly to sediment particles and fine particulate organic matter, potentially exposing benthic organisms. Pelagic species may also be affected due to coupling between the benthic habitat and the overlying water body. The aim of this project is to develop a simple food web model for one light (La) and one heavy (Gd) REE. For this purpose, and in cooperation with other Panorama partners, a study with indoor microcosms and mesocosms will be carried out under controlled conditions. Organisms from various trophic levels (e.g. bacteria & diatoms, green algae, nematodes, daphnia, ostracodes, chironomides, and mussels) will be exposed in acute and chronic studies to environmentally relevant REE concentrations. Bioaccumulation, (microbial) diversity, abundance of species and biomarkers (mussels) will be monitored. The bentho-pelagic coupling will be studied, applying sediment resuspension devices. This project will be introduced and first results presented on this poster.

References: [1] Wang et al. (2020) Resources Policy **65** : 101569; [2] Hermann et al. (2016) Ecotoxicology and Environmental Safety **124** : 213-238 ; [3] Blinova et al. (2020) Nanomaterials **10**: 328; [4] ITN PANORAMA (2020-2023) PANORAMA H2020 – International Training Networks (https://itn-panorama-h2020.univ-rennes1.fr/)