Rare earth elements and yttrium in different duckweed species

ANNA-LENA ZOCHER[1]*, FRANZISKA KLIMPEL[1], DENNIS KRAEMER[1], MICHAEL BAU[1]

[1]Center for Resource and Environmental Studies (CERES), Department of Physics and Earth Sciences, Jacobs University Bremen, Germany
*a.zocher@jacobs-university.de

The constantly increasing use of rare earth elements and yttrium (REY) in high-tech processes and products has resulted in an increased input of anthropogenic REY into the environment. Hence, sound knowledge of the biogeochemical behavior of REY is of increasing importance. However, our understanding of uptake of (anthropogenic) REY by living organisms is scant, and further hampered by published data of uncertain analytical quality.

Duckweeds are small, fast-growing aquatic plants typically found in lentic water bodies. Here, we report REY concentrations for different, naturally grown duckweed species and respective ambient waters. The duckweeds show total REY concentrations in the µg/kg range (dry matter). All duckweeds are characterized by similar flat shale-normalized REY (REY_{SN}) patterns regardless of the investigated species. These patterns correspond well with the REY_{SN} pattern of BCR-670, a certified reference material for duckweed (*Lemna minor*), which confirms, together with the general smoothness of our REY_{SN} patterns, the high analytical quality of our data.

The water samples show lower REY concentrations compared to the respective duckweed samples. While the REY_{SN} patterns of all 0.2 µm-filtered water samples increase from light to heavy REY (LREY and HREY, resp.), only a few samples display large positive Gd anomalies. Such positive anomalies have been detected in surface waters worldwide and can be traced back to the use of Gd-based contrast agents in magnetic resonance imaging; hence, they are anthropogenic. Regardless of the presence or absence of anthropogenic Gd anomalies in ambient waters, none of the duckweed samples is anomalously enriched in Gd, indicating that duckweeds do not incorporate anthropogenic Gd. Partition coefficients for REY between duckweeds and ambient water further show preferential uptake of LREY relative to HREY by the duckweeds. These results are similar to previous findings for *Corbicula fluminea* shells in the Rhine River [1] and further corroborate the conservative behavior of anthropogenic Gd in the environment.

[1] Merschel & Bau (2015) *Sci. Total. Environ.,* 533, 91-101.