Development of an environmentally sustainable method for the extraction and processing of Rare Earth Elements (REE)

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Increasing supply risks and the volatile market price development of critical technology materials (e.g. Heavy Rare Earth Elements, HREE [1]) require the development of innovative mineral extraction and processing techniques - also under economic and environmental considerations. In the frame of the r^4 research call “Raw Materials of Strategic Economic Importance” of the Federal Ministry of Education and Research as part of our research project “Economically strategic materials: Rare Earth Elements metallurgy-advanced methods for optimized extraction and beneficiation by ion adsorption clays” (SEM², 033R127B), we develop an environmentally sustainable process for the extraction and processing of HREE from Ion Adsorption Clay deposits (IAC). Their particular physicochemical properties make HREE essential components of key technologies for the generation of electricity (e.g. wind power stations) and e-mobility (e.g. electric and hybrid vehicles).

Ion-adsorption clay deposits in southern China are currently the main source of these critical raw materials worldwide. For more than two decades have HREE been extracted there applying *heap leaching* and *mountain-top mining* leading to in parts significant environmental impacts (e.g. soil erosion, destruction of ecosystems, contamination of surface and groundwater bodies). About 200 comparable HREE-rich deposits are currently known worldwide (e.g. in Madagascar, Laos, Suriname, Brazil). Consequently, any alternative and optimized mining technology developed for this type of deposit will lead to a significantly improved resource efficiency and environmental sustainability worldwide.

The main aim of this research project is the development of methods for the in-situ extraction and processing of HREE from ion adsorption clays via efficient and sustainable processes. For this purpose, we use sample material of the Tantalus Rare Earths Malagasy S.A.R.L. deposit in the Northwest of Madagascar [2]. The deposit contains appreciable amounts of critical rare earths such as Dysprosium (Dy), Europium (Eu), Neodymium (Nd), Terbium (Tb), and Yttrium (Y).

In detail, our project aims to:

a) **enhance sediment porosity and permeability** via pneumatic fracturing,
b) **optimize** traditionally employed **geochemical processes** for the mobilization of HREE and to develop **new biogeochemical processes based on** organic lixiviants and chelators,
c) develop **(bio)chemical methods** for the **specific recovery of HREE** on biomaterials such as algae and modified yeast strains and
d) model and **optimize HREE extraction and recovery processes** by numerical process simulation that are based on experimentally derived thermodynamic data.

In our presentation we will focus on the geotechnical conditioning of the lateritic sediment samples and the presentation of the necessary geotechnical laboratory investigations. Its objective is to increase sediment permeability and reactive surface areas in preparation for a consecutive optimized in-situ leaching. We will also highlight the most important

bio(geo)chemical investigations for the mobilization and recovery of HREE that are applied within the project.

References:

[1] European Commission, 2014: Communication from the commission to the European Parliament, the Council, The European Economic and Social Committee and the committee of the regions on the review of the list of critical raw materials for the EU and the implementation of the raw materials initiative, //eur-lex.europa.eu/legal-content, pp. 7.

[2] SGS, 2016: Resources for the Tantalus Rare Earth Ionic Clay Project Northern Madagascar, Updated NI 43-101 Technical Report, pp. 149.

www: //r4-sem2.gub-ing.de/en/