Rare earths elements cycling in reclaimed ion-adsorption mine tailings

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Rare Earth Elements (REEs) have become essential components of many high-tech products. Among the various known REEs deposits, the ion-adsorption ones, only found in Southern China, represented around 30% of the worldwide production in 2017. Reclamation of the resulting mine tailings is limited by their poor physical conditions, their low organic matter and nutrient levels as well as their relatively high residual REEs content. Reclamation practices of such sites can include natural attenuation or phytoremediation, using soil amendment or construction, and planting of tolerant species or economic crops. These practices induce drastic changes in the biogeochemical conditions of the soils and thus potentially modify REEs and nutrients availability, impacting the sustainability of the reclamation.

To gain understanding on the impact of reclamation practices on REEs dynamics, we study a mine tailing in Ganzhou city, Jiangxi province, that has been abandoned for 10y. Phytoremediation techniques are currently tested on the tailings material in experimental plots (2x2m) in which plants and soil development are monitored over time. More specifically, the techniques include phytostabilization using perennial grasses or fiber plants, and phytoextraction using REEs hyperaccumulators.

An objective of this study is to develop a geochemical model to be able to evaluate the various practices. A process-based multi-surface model has been parameterized for REEs in soils and sediments in the platform ORCHESTRA. Based on measured contents of REEs, clays and Al/Fe-(hydr)oxides and solution pH and DOC concentration, we predicted dissolved REEs concentrations in pore water and $CaCl_2$-extract. The model is evaluated by comparing modelled vs. measured REEs solid:solution partitioning. Once validated, such a model could be used to gain more detailed insights on the impact of organic exudate or amendment rates on reclamation sustainability.