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Mineralogical and geochemical changes of red mud under bacterial activity

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Red mud is, on the one hand, a hazard to the environment and, on the other hand, a potential resource for many elements, including some critical raw materials, after these elements have been pre-concentrated from bauxite.

The potential of red mud is still in the focus of researchers due to the lack of effective extraction, isolation, and recovery methods. The presented research focused on determining the geochemical changes of red mud after exposure to different types of bacteria. Special focus was set on an eluate (leachate) of red mud. The origin of the bacteria was from the three different types of red mud and from wastewater sludge. All cultivated bacteria survived on the red mud and the geochemical analyses were carried out after one and six months. The geochemical analyses were performed on the bulk material, eluates, and residual material from the filter paper. By HR-ICP-MS a multielement analysis of the extracts was performed. Additional information on the samples was obtained using a Philips X'Pert powder diffractometer, and a scanning electron microscope with an EDS.

The results of the geochemical analysis show high standard deviations, indicating a pronounced heterogeneity of the red mud, although the samples were homogenized before the beginning of the experiment. Such heterogeneity may be a consequence of uneven bacterial activity. The main mineral phases in the bulk sample are cancrinite, böhmite, gibbsite, rutile, calcite, and hematite. In samples with bacterial activity, changes in mineralogical composition occurred and a new phase, weddellite ($CaC_2O_4 \cdot 2H_2O$), formed. Some observed higher values of the extracted REE (REE in eluates) may be related to an absence of a nutritive TSB additive (tryptic soy broth) and to a longer exposure time of the bacterial activities in general (Fig. 1). From the SEM micrographs difference between the samples with and without added additional bacteria can be seen as a decrease of the fine-grained matrix in the samples treated with bacteria (Fig. 2). All cultivated bacteria manage to grow on red mud without additional treatment of the red mud, e.g., by changing the pH value.

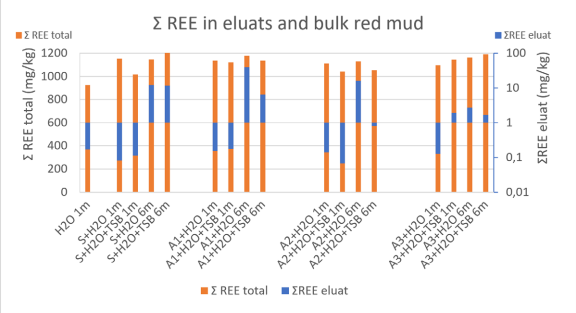

Figure 1. Distribution of ∑REE in red mud as bulk sample (total) and in eluate after leaching. Red mud was treated with water, TSB and different type of bacteria (S, A1, A2 and A3) for 1 and 6 months (1m and 6m).

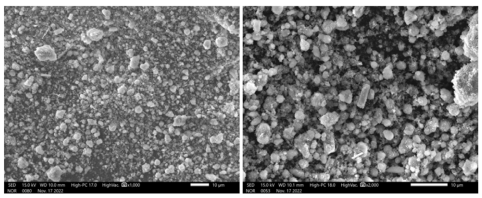

Figure 2. Microphotographs of red mud structure of samples without and with bacteria.