REE enrichment processes in the Ambohimirahavavy Complex ion adsorption deposit, Madagascar using Y-Nd µ-XANES Spectroscopy

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Conventional lateritic ion adsorption deposits (IADs) hosting heavy rare earth elements (HREE) are currently only mined in China. A globally increased demand for these elements (Gd-Lu) has led to increased exploration outside of China. The Ambohimirahavavy Complex in Madagascar is currently in the advanced stages of mineral exploration and consists of an IAD which has formed by intense tropical weathering of peralkaline granite, pegmatitic dykes and a syenite ring, forming supergene enrichment in the form of a deep (1-30 m) lateritic clay deposit. REE contents vary from 400-5000 ppm, with HREE varying from 10 to 20 % of the Total-REE.

Here we present data from four drill cores obtained in 2015, with the aims of delineating the REE enrichment processes from the primary bedrock to the IADs. XRD and SEM indicate kaolinite to be the predominant clay mineral hosting the REE, but that there are also correlations between REE concentrations and relic minerals such as Zircon and REE-fluorcarbonates in the lateritic protoliths.

µ-XANES spectroscopy was utilised as a tool for evaluating REE coordination onto kaolinite and the relic minerals. Sythetic standards were used to provide a proxy of coordination states of Y and Nd to kaolinite, REE-fluorcarbonates and zircon. The XANES of Y and Nd associated with the kaolinite were found to be closely comparable to those of the REE-fluorcarbonates, notably parisite, indicating that the REE have similar coordination states. The REE in parisite is in a low point-symmetry 9 coordinate site. We infer similar coordination for Y and Nd. Preliminary interpretation of these data suggests that Y and Nd are present as 8-9 coordinated, hydrated, outer-sphere, basal surface complexes, rather than 5 or 6 coordinated edge complexes, or 6 or 8 coordinated interlayer complexes.