

Hydrolysis of erbium in near neutral to alkaline aqueous solutions from 25 to 75 °C with implications to heavy REE mobilization in regolith-hosted ion adsorption deposits

HANNAH JUAN HAN AND ALEXANDER P GYSI

New Mexico Institute of Mining and Technology

Presenting Author: juanhanw@gmail.com

Rare earth elements (REE) have raised an increased interest in society because of their applications in modern technologies. Thermodynamic modeling can be used to gain insights on stability of aqueous REE complexes that control adsorption in regolith-hosted REE deposits [1, 2], and REE fractionation in higher temperature fluids [3]. However, the thermodynamic properties of REE hydroxyl complexes are still poorly known and based on extrapolations from Haas et al. [4]. Here, we present UV-Vis spectrophotometric experiments from pH ~6.5 to 9.5 and determined the Er hydrolysis constants and the optical properties and dissociation constants of *m*-cresol purple (mCP) from 25 to 75 °C. The mCP is used to determine *in situ* pH based on the method developed by Stepanchikova et al. [5] at 25 °C. Addition of variable Er concentrations to the experimental starting solutions results in a pH decrease due to the release of protons from the Er³⁺ hydrolysis: $\text{Er}^{3+} + n\text{H}_2\text{O} = \text{Er}(\text{OH})_n^{3-n} + n\text{H}^+$. The Er speciation is derived from the measured *in situ* pH, which permits deriving the average ligand number (OH⁻ ligand coordinated to Er³⁺). The experimental data indicates an increase in the average ligand number from ~1.0 to 2.5 at 25 °C (pH of 7.2–9.5) and from ~1.2 to 3.2 at 75 °C (pH of ~6.5–9.0). These results suggest that the predominant species at the experimental conditions include Er(OH)²⁺, Er(OH)₂⁺, and Er(OH)₃⁰. Comparison of the Er speciation 25 °C using the hydrolysis constants derived in this study to the predictions by Haas et al. [4] indicates a higher stability of the Er(OH)₂⁺ and Er(OH)₃⁰ over the Er(OH)₄⁻ species. The updated hydrolysis constants from this study have significant implications for reliably predicting the REE mobility in the groundwater of regolith-hosted ion adsorption deposits. This work is supported by the U.S. Department of Energy under Award DE-SC0021106.

References

- [1] Li et al. (2019), *Econ. Geol.* 114, 541-568.
- [2] Li et al. (2022) *Geochim. Cosmochim. Acta* 330, 258-277.
- [3] Gysi and Perry (2018), *Geofluids*, <https://doi.org/10.1155/2018/5382480>.
- [4] Haas et al. (1995), *Geochim. Cosmochim. Acta* 59, 4329-4350.
- [5] Stepanchikova and Biteikina (2011), *Russ. J. Coord. Chem.* 37, 64-71.