

## REE+Y solubility and speciation in hydrothermal fluids: An updated view from *in situ* XAS measurements

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Despite the continuously growing demand for rare metals, the mechanisms that enable the hydrothermal mobilization, (re)concentration and deposition of HFSE and REE (+Y) in different environments are poorly understood. For example, whereas petrological observations and early thermodynamic modeling suggested a significant role for fluoride in the development of economic REE concentrations [1], solubility experiments and thermodynamic models developed by Migdisov et al. [2,3] have been used to advocate that REE are most likely transported in the form of chloride and sulfate complexes, which have increased stability at  $T > 200$  °C. The extrapolation of Migdisov's data to higher temperature however remains uncertain as the experimental database on which this model is built remains limited to  $T < 300$  °C.

To enable the modeling of REE hydrothermal transport and deposition up to magmatic-hydrothermal conditions and improve our understanding of the physico-chemical controls on the formation of rare metals deposits, we conducted *in situ* X-ray absorption measurements (XAS) to investigate the aqueous solubility and speciation of Sm, Nd, Eu, Gd, Er, Yb and Y up to  $\sim 500$  °C and 50-80 MPa [4,5]. The EXAFS analyses, complemented by MD simulations, enable us to describe the effect of increasing temperature on REE aqueous speciation in Cl, F,  $\text{PO}_4^{3-}$  and  $\text{SO}_4^{2-}$ -bearing fluids with  $1 < \text{pH} < 14$ . These data provide a molecular-level view of REE complexing and hydration and will be used to further discuss the validity of the available thermodynamic database at  $T > 200$ -300 °C.

**References:**[1] Haas et al., 1995. *Geochim. Cosmochim. Acta* 59, 4329-4350. [2] Migdisov and Williams-Jones, 2007. *Geochim. Cosmochim. Acta* 71, 3056-3069. [3] Migdisov et al., 2016. *Chem. Geol.* 439, 13-42. [4] Louvel et al., 2015. *Chem. Geol.* 417, 228-237. [5] Liu et al. *in press Chem. Geol.*