The thermodynamics of hydroxylbastnasite in aqueous solutions

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The mobility of rare earth elements (REE) in natural aqueous solutions is of increasing interest due to their application in numerous high-tech and renewable energy technologies (e.g., wind turbines, electric vehicles) [1], as well as their critical role as tracers in Earth Sciences. Data for basic thermodynamic parameters for water-rock interactions are, however, sparse and partially inconsistent (e.g., [2]), even for carbonate minerals of the bastnasite group (REE(CO$_3$)(OH,F)), which currently represent the most exploited REE ore [1]. Therefore, experiments were carried out to quantify these parameters.

Pure hexagonal hydroxylbastnasite (REE(CO$_3$)(OH)) was synthesized at hydrothermal conditions ([3]) and subsequently used as starting material for experiments in aqueous solutions. Closed system dissolution and precipitation experiments were performed in equilibrium with air (log(p_{CO_2})=-3.34(1)) as well as with fixed amounts of dissolved inorganic carbon. Reaction progress was followed by measuring pH, and REE concentrations were quantified by ICP-MS at regular intervals.

Experiments at 25 °C and selected concentrations of HCl and NaOH were run for up to 1.5 months until steady-state pH and Nd was observable. The results from closed system experiments suggest that the solubility product (K_{SP}) for hydroxylbastnasite-Nd (HB-Nd), corresponding to the reaction Nd(CO$_3$)(OH)$_{(HB-Nd)}$ = Nd^{3+} + CO$_3^{2-}$ + OH$^-$, has a value of log(K_{SP})= -23.83(40) at 25 °C.

[1] Jordens *et al.* (2013), *Miner. Eng.* **41**, 97-114. [2] Cetiner *et al.* (2005), *Chem. Geol.* **217**, 147-169. [3] Vallina *et al.* (2014), *Mineral. Mag.* **78**(**6**), 1391-1397.