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V33C-0244 - Rare earth element (REE) metasomatism in iron-oxide-apatite mineral deposits: stability of hydrothermal monazite and xenotime

Alexander P. Gysi (Colorado School of Mines), Albert H. Hofstra (USGS Central Region Office), Daniel E. Harlov (Deutsches GeoForschungsZentrum GFZ), George D. Miron (Paul Scherrer Institute)

Abstract

Monazite-(Ce) and xenotime-(Y) occur as secondary minerals in iron-oxide-apatite (IOA) deposits, and their stability and composition are important indicators of timing and conditions of metasomatism. Both of these minerals occur as replacement of apatite and display slight but important variations in light (e.g. La, Ce, Pr, Nd, etc.) and heavy (e.g. Y, Er, Dy, Yb, etc.) REE concentrations [1,2]. The causes for these chemical variations can be quantified by combining thermodynamic modeling with field observations. Major challenges for determining the stability of these minerals in hydrothermal solutions are the underlying models for calculating the thermodynamic properties of REE-bearing mineral solid solutions and aqueous species as a function of temperature and pressure. The thermodynamic properties of monazite and xenotime have been determined using several calorimetric methods [3], but only a few hydrothermal solubility studies have been undertaken, which test the reliability and compatibility of both the calorimetric data and thermodynamic properties of associated REE aqueous species [4,5]. Here, we evaluate the conditions of REE metasomatism in the Pea Ridge IOA-REE deposit in Missouri, and combine newly available experimental solubility data to simulate the speciation of LREE vs. HREE, and the partitioning of REE as a function of varying fluid compositions and temperatures. Our new experimental data will be implemented in the MINES thermodynamic database (http://tdb.mines.edu) for modeling the chemistry of crustal fluid-rock equilibria [6].

[1] Harlov et al. (2016), *Econ. Geol.* 111, 1963-1984;[2] Hofstra et al. (2016*), Econ. Geol.* 111, 1985-2016; [3] Navrotsky et al. (2015), *J. Chem. Thermodyn.* 88, 126-141; [4] Gysi et al. (2015), *Chem. Geol.* 83-95; [5] Gysi et al. (2018), *Geochim. Cosmochim. Acta* 242, 143-164; [6] Gysi (2017), *Pure and Appl. Chem. 89, 581-596.*