REE fractionation in hyperacid sulphate waters during the gypsum precipitation in volcanic hydrothermal systems

CLAUDIO INGUAGGIATO[1*], ENRIQUE IÑIGUEZ[1], LOÏC PEIFFER[1], THOMAS KRETZSCHMAR[1], LORENZO BRUSCA[2], RAUL MORA-AMADOR[3,4,5], CARLOS RAMIREZ[6], SERGIO BELLOMO[2], GINO GONZALEZ[6], DMITRI ROUWET[7]

[1]Departamento de Geología, Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), Carretera Ensenada-Tijuana 3918, Ensenada, Baja California, Mexico (*correspondence: inguaggiato@cicese.mx)
[2] INGV-Palermo, Via U. La Malfa, 153, 90146 Palermo, Italy
[3] Centro de Investigaciones en Ciencias Geológicas, UCR, Costa Rica
[4] Escuela Centroamericana de Geología, UCR, Costa Rica
[5] Laboratorio de Ecología Urbana, UNED, Costa Rica
[6]Volcanes Sin Fronteras, Costa Rica
[7] INGV-Bologna, Via Donato Creti 12, Bologna, Italy

REE (Lanthanides and Yttrium) in hyperacid sulphate waters discharging from volcanic-hydrothermal systems are often depleted in Light REE (LREE) [1, 2]. The precipitation of sulphate minerals is invoked to justify the REE fractionation. This study is the first to evaluate quantitatively such mineral control through an experiment in natural laboratory [3].

The hyperacid sulphate-rich brine of Poás volcano crater lake (Costa Rica) was exploited as a natural laboratory to evaluate and quantify the REE fractionation in water during the natural precipitation of gypsum [3]. REE concentration in Poas water lake is high, ranging from 1.14 to 2.18 mg kg^{-1} (period 2007-2009). The REE patterns in Poas lake water normalized to the average local volcanic rock show two trends: 1) patterns mainly depleted in LREE, and 2) almost flat patterns. REE concentrations in gypsum are higher than lake water, with values ranging from 23.7 to 33.0 mg kg^{-1}. The REE in gypsum normalized to the average local volcanic rock are characterized by patterns mainly enriched in LREE and descending from Sm to Lu [3].

Calculated distribution coefficients (K_D) for REE between the gypsum and the mother brine (Poas lake), indicate a preferential removal of the LREE. The identification of patterns depleted in LREE in hyperacid sulphate waters can be justified by the gypsum precipitation.

[1] Varekamp (2015), Volcanic lakes book (springer), 93-123 [2] Inguaggiato et al. (2017), Appl. Geochem. 79, 65–74 [3] Inguaggiato et al. (2018), Gondwana Res. 59, 87-96.