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Rare earth elements and yttrium in alkaline lakes and hot springs from Tanzania

TIMMU KREITSMANN[1], DENNIS KRAEMER[2], ALBANO MAHECHA[3], SIMONA REGENSPURG[4], FRANZISKA D.H. WILKE[5] AND MICHAEL BAU[6]

[1]Constructor University, Bremen, Germany
[2]Federal Institute for Geosciences and Natural Resources (BGR)
[3]Tanzanian Geothermal Development Company – TDGC
[4]GFZ, German Research Centre for Geosciences
[5]GFZ German Research Centre for Geosciences
[6]CritMET, School of Science, Constructor University Bremen gGmbH

Presenting Author: tkreitsmann@constructor.university

Rare earth elements and yttrium (REY) are vital for emerging high-tech technologies. More specifically, REY are critical for the energy transition; hence, the demand for REY will increase strongly with the move towards carbon neutrality. New alternative resources must be explored to satisfy the increased demand.

In this study, we focused on the REY in alkaline lakes and springs from Tanzania. The pH values of the lake waters range from 8.9 to 10.0 and those of the spring waters from 9.1 to 9.7. Alkaline volcanic rocks, known for their elevated REY concentrations, are widespread in this region. Endorheic lakes which are fed by the fluids percolating through the surrounding alkaline rocks have the potential to accumulate REY over time. The highest total REY (∑REY) concentration was found in Lake Eyasi with ∑REY of 12 µg/L, which is c. 500 times higher than Lake Malawi, a freshwater lake in southern Tanzania and Malawi. Similarly elevated ∑REY concentrations were found in Lake Natron and Lake Manyara. The ∑REY ranged between 0.3 and 2 µg/L in alkaline hot springs. Shale-normalised REY_{SN} patterns of the lakes are flat or enriched in heavy compared to light REY (HREY and LREY, resp; Fig. 1). All alkaline lakes are characterised by a positive Ce_{SN} anomaly, a fractionated Y/Ho ratio leading to a positive Y_{SN} anomaly, and variable Eu_{SN} anomaly. Alkaline hot spring waters exhibit more variable REY_{SN} patterns, from HREY-depleted to HREY-enriched compared to the LREY (Fig. 1). The shale-normalised REY anomalies are also more variable in the springs compared to the lakes.

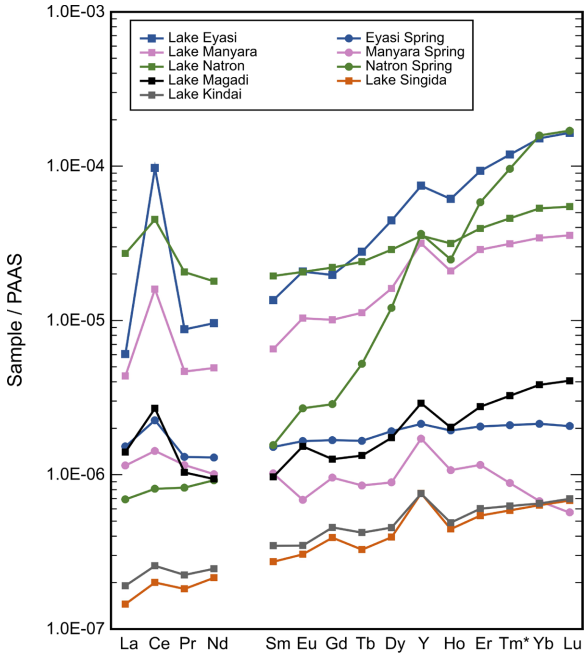

Figure 1: PAAS (Post-Archean Australian Average Shale) normalised REY patterns of alkaline lake and spring waters.