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Survey for Critical Raw Materials in Tanzanian East African Rift Geothermal Areas

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The energy and digital transitions require ample critical raw materials (CRM), which can be found in geothermal fluids. In the EU-funded project "CRM-geothermal," we aim to environmentally co-produce CRMs while harnessing geothermal energy. In the East African Rift System (EARS), significant levels of rare earth elements (REEs), Sr, F, etc. are anticipated in water and solids, in areas with carbonates. Kenya benefits most from the eastern EARS branch, where hot rift water migrates along permeable faults, providing around 80% of its energy demand. A 2022 survey in Tanzania along the EARS sought to determine CRM content in geothermal water, gas, and surrounding rocks.

Water samples were collected from hot springs (26-74°C) and nearby alkaline lakes, with lake waters ranging from pH 7.6 to 10.0 and spring waters from pH 6.9 to 9.7. These samples exhibit high carbonate alkalinity, elevated chloride, sulphate, and fluoride content, with sodium concentrations up to 9,000 mg/kg. The highest total rare earth elements and yttrium (Σ REY) concentration was found in northern Lake Eyasi at 12 µg/L, around 500 times higher than in Lake Malawi, south Tanzania. Springs display variable rare earth element patterns compared to lakes, with alkaline springs showing more variability. Noble gas analysis indicates a mixed crustal-mantle contribution, with helium concentrations reaching up to 7 vol % and $^3\text{He}/^4\text{He}$ ratios up to 3.4 Ra, mainly in the southern part. Two geological settings are dominant in Tanzania: basement with gneisses ± granulites and alkaline volcanics associated with rifting. Geothermal sites are found in both settings, with craton-based samples dominated by Na-K±Ca silicates rich in Fe- and Ti-oxides. Minerals and rocks hosting elevated REEs, alkali-rich sulphates, and Sr-carbonates were sampled at and near Lake Eyasi in the north and in the south along the Mbaka fault. Thorium-rich minerals occur predominantly in central Tanzania.