Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.32025

Helium, carbon, nitrogen and sulfur isotopes in thermal fluids from the Albertine Rift, SW Uganda

SÆMUNDUR A. HALLDÓRSSON[1], PETER H BARRY[2], MARK D KURZ[2], JOSHUA CURTICE[2], ANDRI STEFÁNSSON[1], JÓHANN GUNNARSSON-ROBIN[1], JENS FIEBIG[3], SHUHEI ONO[4], PAOLO SCARSI[5], JUSTIN T KULONGOSKI[6], GODFREY BAHATI[7] AND PATERNO R. CASTILLO[8]

[1]Nordic Volcanological Center, Institute of Earth Sciences, University of Iceland
[2]Woods Hole Oceanographic Institution
[3]Goethe University Frankfurt
[4]Massachusetts Institute of Technology
[5]Institute of Geosciences and Earth Resources, National Research Council of Italy
[6]California Water Science Center, USGS
[7]Ministry of Energy and Mineral Development, Directorate of Geological Survey and Mines
[8]Scripps Institution of Oceanography, University of California, San Diego

The East African Rift System (EARS) is Earth's largest active continental rift system. Seismic tomography investigations and noble gas volatiles studies have identified the African Superplume, a continental-scale, thermochemical mantle plume originating at the core-mantle boundary, as the primary driver of topographic uplift, magmatic heat and volatiles throughout the EARS, including its Western Branch. To date, there are limited noble gas and volatile isotope studies of either rocks or geothermal fluids to substantiate these findings for this part of the rift. The Albertine Rift in SW Uganda hosts several geothermal areas and active volcanoes with mafic igneous rocks and, thus, facilitates assessments of deep vs. shallow volatile inputs into a region undergoing continental extension.

We report He-CO_2-N_2-SO_2 isotope and relative abundances in thermal fluids from 16 localities from the Albertine Rift. The localities include the three major geothermal areas of this region, Katwe-Kikorongo, Buranga and Kibiro, that have been extensively explored but lack comprehensive and combined volatile isotopes studies. We supplement the fluid data with He isotope data from olivine crystals.

Fluids show a large range in $^3He/^4He$ (R_C/R_A) but many samples are characterized by highly radiogenic values ($\geq 0.02R_A$). The highest $^3He/^4He$ is from a thermal spring from the Buranga region ($3.2R_A$). In contrast, olivine crystals show consistently higher and remarkably uniform $^3He/^4He$ ($7.67\pm0.44R_A$; n= 12, 1σ). $CO_2/^3He$ span about six orders of magnitude while $\delta^{13}C$-CO_2 values show two distinct populations whereby samples with $^3He/^4He >1R_A$ cluster at –5‰ and samples with more radiogenic values ($<1R_A$) extend towards highly negative $\delta^{13}C$-CO_2 values (≥ –17.9‰). Only one locality has highly negative $\delta^{15}N$-N_2 values and irrespective of $^3He/^4He$, all other localities show uniform values (mean value of +1.5±2.2‰; n= 17, 1σ). A large range is evident in both $\delta^{34}S$ and $\Delta^{33}S$ values of SO_4 and $\delta^{34}S$ shows a negative correlation with $^3He/^4He$. In this case, highly radiogenic values extend to positive $\delta^{34}S$ values (≤ +18.75‰). In contrast to studies from the northern EARS (e.g., Ethiopia), extensive modifications of mantle-derived fluids that appear to largely reflect upper mantle volatile domains is thus evident in this part of the EARS.