Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37308

Active rifting and its association with geothermal energy exploration in Zambia

THOMAS D RENSHAW[1], MIKE DALY[1], FANNY BANDA[2], DARREN HILLEGONDS[1], RŪTA KAROLYTĖ[3] AND CHRIS J. BALLENTINE[1]

[1]University of Oxford
[2]Ministry of Mines and Minerals Development
[3]Snowfox Discovery Ltd

Zambia relies heavily on hydroelectric power and is therefore vulnerable to prolonged droughts. Geothermal energy has been proposed as a potential solution. Where active geothermal energy exploration has taken place in the Kafue Rift, geothermal anomalies in excess of 120°C/km are found in the active extensional border fault[1].

Rift systems have many elements important to geothermal energy development and helium exploration, including increased thermal gradients, sufficient supply of crustal fluids, and increased crustal degassing[2]. Thus, the study of hot springs in this region could provide valuable insights into crustal fluid flow, active rifting processes, and the associated geothermal energy potential.

We collect a suite of geochemical data from seventeen springs both within and proximal to the rift system. They reveal variations in degassing in-rift and off-rift and confirms that observations of mantle signatures, high-temperature degassing, and active rifting in the Kafue Rift by [3] can be extended to the Luangwa and Luano rift segments; a rift system that extends for 1000km.

Our results show that a mantle helium signal is only found in-rift proximal to deep faults, with a common maximum of 0.14Ra. Geothermal springs proximal but off-rift have a crustal end-member helium isotopic composition of ~0.02Ra. Increased crustal degassing at high temperatures is revealed by percent-level helium concentrations found both in-rift and off-rift and $^{4}He^{*}/^{40}Ar^{*}$ ratios approaching crustal values.

Using geothermal springs to characterise the circulating fluids and geothermal energy prospectivity, we show that high crustal temperatures are confirmed by dissolved silicate and cation concentrations, which are used to estimate reservoir temperatures of up to 180°C predicted at a depth of about 4km. Geothermal waters are similar throughout the rift system with TDS values up to 1951ppm. Waters are dominated by sodium, calcium, chloride, and sulphate ions and have a ^{14}C residence time of up to 17,648 years.

The confirmation of active rifting not only redraws the African Rift System but reveals the potential for geothermal energy, a more reliable source of electricity in an ever-changing climate.

[1]Vivian-Neal et al.,(2018) 7th African Rift Geothermal Conference

[2]Jolie et al.,(2021) Nature Reviews Earth & Environment 2(5)

[3]Karolytė et al.,(2026, in review)