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Continental rifting and ^{4}He reserves

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Helium is an essential element that has many industrial applications, but notably provides the unique cooling medium for superconducting magnets in medical MRI scanners and high energy beam lines. In 2013 the global supply chain failed to meet demand causing significant concern - the 'Liquid Helium Crisis'[1].

To date, commercial helium is sourced as a byproduct in a few natural gas reservoirs that have focused ^{4}He produced by the dispersed decay (α-particle) of U and Th in the crust. We show here, using the example of the Rukwa helium province, how continental rifting provides the combination of processes reuired to generate helium reserves. The ancient continental crust provides the source of ^{4}He. Rifting and associated magmatism provides the tectonic and thermal mechanism to mobilise deep fluid circulation, focusing flow to the near surface along major basement faults.

Helium-rich springs in the Tanzanian Great Rift Valley were first identified in the 1950's[2]. The isotopic compositions and major element chemistry of the gases from springs and seeps are consistent with their release from the crystalline basement during rifting[3]. Within the Rukwa Rift Valley, helium seeps occur in the vicinity of trapping structures that have the potential to store significant reserves of helium[3]. Soil gas surveys over 6 prospective trapping structures (1m depth, n=1486) show helium anomalies in 5 out of the 6 at levels similar to those observed over a known helium-rich gas reservoir at 1200m depth (7% He - Harley Dome, Utah). Detailed macroseep gas compositions collected over two days (n=17) at one site allows us to distinguish shallow gas contributions and shows the deep gas to contain between 8-10% helium, significantly increasing resource estimates based on uncorrected values (1.8-4.2%)[2,3]. The remainder of the deep gas is dominantly N_2 with trace levels of hydrocarbons, H_2, CO_2 and Ar.

[1] http://www.aps.org/policy/reports/popa-reports/upload/HeliumReport.pdf
[2] T.C. James (1966) Transactions London Institution of Mining and Metallurgy 168-174, B1-18
[3] Danabalan et al. (2016), *Goldschmidt Abstract*, 4150

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