Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16679

Helium migration in post-Variscan collision batholiths : new insight from the Corsica Island

HUGO DUTOIT[1], FRÉDÉRIC VICTOR DONZÉ[1], LAURENT TRUCHE[1], DR. CAMILLE DUSSÉAUX[2], CAROLINA DANTAS CARDOSO[3], DIMITRI LAURENT[1] AND RAPHAËL PIK[3]

[1]University Grenoble Alpes
[2]Université de Franche-Comté
[3]Centre de Recherches Pétrographiques et Géochimiques (CRPG)

Presenting Author: hugo.dutoit@univ-grenoble-alpes.fr

Most of the current He reserves originate from fortuitous discoveries, mainly made during oil and gas exploration in intra-cratonic sedimentary basins overlying Archean-Proterozoic crystalline bedrocks (3.8-0.54 Ga). As helium generation depends on U and Th α-decay, old geological provinces gather key ingredients for high He accumulations. However, numerous He-rich springs have also been documented in much younger rocks, like granites of post-Variscan age (320-250 Ma). These latter discoveries question the current exploration guidelines and require to revisit some of the long-standing paradigms that drive our reasonings.

Here, we investigate He migration along a major fault rooted in the Corso-Sardinian batholith (France). Two thermal springs, Caldanelle and Guagno-Les-Bains, show significant outgassing activity of crustal sourced He with concentration up to 1.6 vol% and flow rate of 3000 Nm^3/year. These two springs are calco-alkaline and low in Mg, and reflect little chemical basement variations. Beside He, the gas phase is dominated by N_2 (≈98 vol%) and minor CH_4. Calculated reservoir temperatures are approximately 130°C. Their surface water temperatures (35°C and 62°C respectively) and their age (9500 and 6000 years respectively) suggest a rapid upwelling without mixing with surficial aquifers. A multi-methods approach enabled us to detect the presence of a major fault between Caldanelle and Guagno as well several fracture sets, all of them draining the fluids, including He from a common reservoir to Caldanelle.

From these observations and measurements, we state that i) an efficient He production occurs at the early stage of radioactive decay, ii) the presence of a fault and a dense draining networks fractures drain the He, iii) the heat is above the closure temperature of minerals with respect to He retention, iv) there is a liquid-gas partitioning during the rapid fluid assent, v) there is an absence of high-CO_2 flux diluting the resource but the low N_2 flow rate acts as a carrier gas, and finally vi) a minimal diffusion leaks out of the drainage system, should be considered in addition to the U-Th concentrations and the age of the rocks. In that sense, young post-orogenic granites represent promising helium plays.