PhD Project	Tracking the source of Helium in the huge Virginia Gas Project, Witwatersrand Basin, South Africa.
Supervisor(s)	Prof. Fin Stuart (fin.stuart@glasgow.ac.uk) Dr. Stuart Gilfillan (stuart.gilfillan@ed.ac.uk) Dr. Stefano Marani (stefano@renergen.co.za)
Funding Status	Available to international applicants
Application Deadline	Open
How to Apply	http://www.gla.ac.uk/research/opportunities/howtoapplyforaresearchdegree/
PhD Programme (for online application purposes)	SUERC The student will graduate from University of Glasgow
Project Description	Summary: Natural gases found in the Witwatersrand Basin, South Africa, contain up to 15% helium, making them the richest helium deposit ever discovered. This project aims to determine the source of the He and refine the reserve estimates using analytical and modelling. Project background: The global shortage of helium has led to an unprecedented increase in exploration in the last decade. Helium is produced in the Earth's crust by the radioactive decay of uranium (U) and thorium (Th), so the helium concentration in any rock is dependent on the radioelement concentration and the age. The extent to which Helium deposits are analogous to petroleum systems remains an open question. Since the late 19th century the Witwatersrand Basin, South Africa, has been the focus of gold exploration. Helium-rich methane gases have been known for several decades. Exploration by Renergen Ltd. in the Virginia licence area in the Free State has led to the discovery of gases with up to 12% He emanating along faults in the basin. Based on our understanding of the regional geology we have estimated that over 400 billion cubic feet of helium has been retained in the Renergen Production Right area since at least the deposition of the capping Karoo sediments 270 million years ago. While this represents decades of global He use, it likely underestimates the reserve given the old age (> 3 Ga) of the likely He source rocks. Despite the immense economic potential of the helium (and the methane!) for the region's economy, the ultimate origin of the helium, the nature of the trap, and how the helium migrated to the trap are all unclear. The link to the world-

*Required fields

	class gold “reefs” of the 2.8 billion year old Witwatersrand Supergroup sediments is intriguing. As well as being the largest gold anomaly on Earth, the main reef strata in the Witwatersrand Basin contain extraordinarily high concentrations of U and Th, hosted by detrital minerals in the palaeo-placer deposits. While the reef rocks are a prime candidate for the source rock, the huge volume of Proterozoic granite basement beneath the Witwatersrand Supergroup sediments cannot be ignored as the main faults penetrate into the basement. This PhD will use petrography, (U-Th)/He dating techniques and natural gas analysis to determine the source rock and the mechanism of helium loss from minerals to the gas phase, and ultimately to develop a model for the accumulation of He in the main rock types of the Witwatersrand Basin. Samples will be collected from the field and from existing collections within South Africa and the UK. Research questions: 1. What contribution do the main rock types make to the gas phase He? 2. How is the He lost from the minerals and how did it migrate to the trap? 3. What is the role of methane and groundwater in focussing He to the surface? 4. Will CO2 injection into deep water aquifer stimulate helium production? 5. Does 3He/4He variation between geological structures track difference in origin? Methodology: The project will require optical and micro-petrography (SEM), and electron microprobe analysis of U- and Th-bearing phases in the main lithologies. The retention of radiogenic He will be determined using standard (U+Th)/He dating techniques, laser extraction-quadrupole mass spectrometry and ICPMS. The He content and isotope composition of free gases will be determined by magnetic sector mass spectrometry. Year 1. Collection of main lithologies, petrographic and mineralogic study, training in U, Th and He analysis Year 2. Determination of U and Th inventory for the main lithologies, He retention characteristics and quantification of contribution to gas phase, analysis of He in natural gases Year 3. Establish model for He production, and test using the analysis of free gases. Training: A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. The student will be primarily based in the SUERC laboratories and will be allied to active GeoEnergy research group at University of Edinburgh. Training at Renergen Ltd. base in South Africa will include Helium exploration techniques.

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	Background reading: Evaluation of certain helium prospective resources on the Tetra4 Virginia gas project, 2020 https://www.renergen.co.za/wp-content/uploads/2020/07/2020-Helium-Prospective-Resources-Final-signed-v21.pdf	
Start Date	October 2022 to February 2023	
Funding	Funding is available to cover tuition fees for 3.5 years, as well as full stipend at the UK Research Council rate (estimated £15,800 for 2022-23). Bench fees will cover all analytical and fieldwork costs.	
Eligibility Criteria	Student should have undergraduate degree in Physical Sciences.	
Informal discussion	Please contact Prof Fin Stuart for more details about the study fin.stuart@glasgow.ac.uk	

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