Bryony Richards

Curriculum Vitae 2023

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Profile

My research revolves around imaging analysis in complex geological environments related to exploration and economic geology, encompassing satellite to nanometer scales. I have been fortunate to work in diverse economic geology, energy, and exploration disciplines, including the hydrocarbon industry, on projects spanning every continent except Antarctica. My previous funding has also come from various sources, including the US Federal Government (DTRA, DOD, DOE), the UK government, US State governments, and industry.

Proposals and Research Projects

My current research topics are focused on the use of satellite imagery, specifically hyperspectral, and the analytics that can be used to explore for critical minerals using them.

- Hyperspectral Imaging Analysis for Critical Minerals in Utah's Spor Mountain Region - Lessons in Target Detection Algorithms - *Project in progress.*
- Unearthing Alaska's Hidden Treasures: Exploring Critical Minerals through Hyperspectral Imaging and Machine Learning in Mine Tailings: *Project in proposal stage*
- Unlocking Utah's Potential: Evaluating Historic Tailings for Critical Minerals and Sustainable Resource Utilization: Project in proposal stage - *Project in proposal stage.*
- Gas Basins of Africa: A Combined Geological and Infrastructure Atlas for Hydrogen Resource Potential - *Project in proposal stage.*

Education

Doctor of Philosophy (Ph.D.), University of London (UK) *2005 - 2010*

- PhD jointly coordinated between the University of London (United Kingdom) and GNS Science (New Zealand). Funded Ph.D. under the NERC (National Environmental Research Council, UK Government) Blue Skies research program (NER/S/A/2005/13452).
- **Ph.D. Thesis title:** Petrography, Geochemistry, and Thermochronology of the Milford Sound area, New Zealand: Implications for the Evolution of the Eastern Gondwana Margin.
- Creation of a new tectonic model for the Paleozoic-Mesozoic, eastern Gondwana margin using radiochemical (thermochronological and geochronological), stable isotope, and geochemical data.

Bachelor of Science (honors), Durham (UK) *2002 - 2005*

- Undergraduate B.Sc. Honors degree in geology, completed with first class honors (4.0 GPA) at University College, University of Durham (Dunelm), United Kingdom. All courses completed with 2:1 (GPA 3.7-3.9) grades and above.
- Awarded the John W. Most prize for best undergraduate thesis.
- Top of graduating class (2005), First-Class Honors Degree grade

Proffesional

Senior Research Scientist: University of Utah: Energy and Geoscience Institute *2012 -Present*

As a research geologist at the University of Utah, my work in advanced imaging analysis reflects my expertise in integrating cross-disciplinary scientific methods. I have a strong background in petrological methods, high-resolution imaging, and remote sensing, including magnetic and gravity interpretation, which allows me to effectively handle complex datasets. Additionally, I am well-versed in geochemistry and radiochemistry, particularly in thermochronology, geochronology, and stable isotopes. My research interests primarily revolve around resource exploration, and I utilize these diverse scientific approaches to deepen our understanding of Earth processes.

Senior Geochemist: INV Exploration Namibia (Pty) Ltd. *2011 - 2012*

Exploration geochemist for metals (Cu, Ag) exploration junior INV Exploration Namibia (Pty) Ltd. Job includes the organization, interpretation, and development of soil, rock, and drilling geochemistry over the Kaokoland region from reconnaissance and small-scale to full, extensive geochemical programs. Additional skills include the management and interpretation of large geochemical, rock, and drilling datasets in combination with ArcGIS in addition to basic software (i.e. Excel).

Reason for leaving: Permanent relocation to the USA and termination of the project.

Research Associate (Postdoc): University of Johannesburg *2010 - 2011*

Postdoctoral mineralogical research carried out in conjunction with both established and junior companies including DeBeers Consolidated Mines and Thabex Ltd. and includes the characterization of near craton margin, diamondiferous kimberlites, and the evolution of the diamondiferous lithospheric mantle in South Africa and Lesotho. Kimberlite projects involve the multidimensional study of the mineralogy, textures, petrology, and geochemistry of kimberlite units including lower crustal and mantle xenoliths and their relationship to diamond survival and processing.

Reason for leaving: Job offer at INV Exploration (Pty) Ltd, Namibia. Contract for postdoctoral work was extended for another year (until April 2012) prior to receiving job offer from INV Exploration.

University of London: Teaching assistant, Lecturer, Field Leader *2005 - 2010*

Igneous and metamorphic mineralogy, field studies, and remote sensing (post-graduate, ad-hoc) lecturer, tutor, and teaching assistant. Lecturing focused on small-volume magmatism with an emphasis on kimberlites and carbonatites.

Reason for leaving: Writing-up of Ph.D. thesis and completion of doctoral studies at the University of London.

Remote Sensing (GIS) Consultant: TIDMLIS Rare Earths and Metals PLC, formerly Lisungwe PLC *2008*

Remote sensing (GIS) Consultant for TIDMLIS Rare Earths and Metals plc (Lisungwe plc.) for the Chimimbe Hill Nickel laterite project, Malawi.

Analytical Skills

- Radiochemistry, including Ar-Ar mass spectrometry.
- Stable isotope analyses
- X-ray fluorescence (XRF), X-ray diffraction (XRD).
- ICP-AES/MS/OES geochemistry
- Extensive electron microprobe experience, Scanning-Electron Microscopy (SEM), Transmission Electron Microscopy (TEM/STEM), MLA and QEMSCANTM/Mineralogic
- Extensive laboratory experience, lab manager, and ‘clean-room’ laboratories

Leadership Positions

Critical Minerals Executive Committee, University of Utah *2023 -Present*

As a research geologist at the University of Utah, my work in advanced imaging analysis reflects my expertise in integrating cross-disciplinary scientific methods. I have a strong background in petrological methods,

Committee Chair: AAPG Critical Minerals Committee *2023 -Present*

Current chair of the American Association of Petroleum Geologists.

Committee Member: AAPG Critical Minerals Committee *2021 -Present*

Advisory Committee member to the American Association of Petroleum Geologists (AAPG). The AAPG CMC is interested in the professional opportunities this emerging industry presents to our organization, especially those related to the rapidly growing green energy market.

Supervisor/Mentor *2005 - Present*

Multiple students throughout undergraduate, postgraduate (MS.c., Ph.D.), postdoctoral, and industry vocations (UK, USA, SA). Students at the University of Utah have included those from multiple departments (including Civil Engineering, Nuclear Engineering, Geology, and Chemical Engineering..

Committee Chair: GSSA Egoli *2011*

Egoli (Johannesburg) Branch of the Geological Society of South Africa (GSSA).

Committee Member: GSSA Egoli *2010*

Egoli (Johannesburg) Branch of the Geological Society of South Africa (GSSA).

Professional Memberships and Research Groups

- Energy, Fluids, and Minerals Research Group, Energy & Geoscience Institute (EGI), University of Utah
- American Association of Petroleum Geologists (10094859)
- PETLAB Contributor (New Zealand rock catalog and geoanalytical database, by GNS Science).
- EGOLI Johannesburg branch of the GSSA (Geological Society of South Africa).
- PaleoProterozoic Mineralisation (PPM) Research Group (South Africa).
- SEARG (Royal Holloway College, University of London, United Kingdom).

Personal Interests

Award winning astrophotographer

- Photography featured in Forbes, National Geographic, The Guardian (British newspaper), and many other newspapers, print, and online publications.
- Astronomy Photographer of the Year 2021 People's Choice, multiple other awards from TIFA, PNA.
- Invited speaker at many astrophotography and astronomy conferences.

Keen Hiker, Skiier, Kayaker, reluctant runner

Selected Journal Publications

Ahmed, W., McLennan, J., Bhat, G. M., Kanungo, S., Richards, B., Tran, T., Thusu, B., Hakhoo, N., Hafiz, M. 2023. Geomechanical characterization of the Barren Measure Formation in the Raniganj sub-basin of Damodar Basin, India. Journal of the Geological Society of India, JGSI-D-23-00349R3.

Jacobson, A. T., Chen, C., Dewey, J. C., Copeland, G. C., Allen, W. T., Richards, B., Kaszuba, J. P., d, van Duin, A. C. T., Cho, H., Deo, M., She, Y., Martin, T. P. 2022. Effect of nanoconfinement and pore geometry on point of zero charge in synthesized mesoporous siliceous materials. JCIS Open, Volume 8, 2022, 100069,
ISSN 2666-934X, https://doi.org/10.1016/j.jciso.2022.100069.

Vega-Ortiz, C., Avendaño-Petronilo, F., Richards, B., Sorkhabi, R., Torres-Barragan, L., Martínez-Romero, N., McLennan, J. D. 2021. Assessment of carbon geological storage at Tula de Allende as a potential solution for reducing greenhouse gas emissions in central Mexico. International Journal of Greenhouse Gas Control 109:103362. DOI: 10.1016/j.ijggc.2021.103362

Jackson, M. D., Chen, H., Peterson, J. G., Richards, B., Tamura, N. 2021. Synchrotron X-Ray microdiffraction studies of the mortars of ancient Roman concretes. ISTE Book Chapter for N Tamura et al. How synchrotron X-ray microdiffraction experiments led to the discovery of ancient Roman principles of concrete longevity and mineral cements.

Vega-Ortiz, C., Richards, B., McLennan, J. D., Levey, R., Martínez-Romero, N. 2020. Analysis of mineralogy and porosity on a carbonaceous mudstone of the Pimienta Formation, western margin of the Tampico Misantla Basin, Mexico. Boletín de la Asociación Mexicana de Geólogos Petroleras, A. C. Volumen LXII, Número 1, Enero-Junio 2020.

Olsen, A., Schwerdt, I., Jolley, A., Halverson, H., Richards, B., McDonald, L. 2019. A response surface model of morphological changes in UO2 and U3O8 following high temperature aging. Radiochimica Acta, DOI: 10.1515/ract-2018-3040.

Olsen, A., Schwerdt, I., Richards, B., McDonald, L. 2018. Quantification of high temperature oxidation of U3O8 and UO2. Journal of Nuclear Materials 508, DOI: 10.1016/j.jnucmat.2018.06.025.

Olsen, A., Richards, B., Schwerdt, I., Lusk, R., Smith, B., Jurrus, E., Ruggiero, C.E., McDonald, L. 2017 Quantifying Morphological Features of á-U3O8 with Image Analysis for Nuclear Forensics. Analytical Chemistry 89 (5), DOI: 10.1021/acs.analchem.6b05020.

Levinthal, J. D., Richards, B., Snow, M. S., Watrous, M. G., McDonald, L. 2016. Correlating NORM with the mineralogical composition of shale at the microstructural and bulk scale. Applied Geochemistry 76, DOI: 10.1016/j.apgeochem.2016.11.004.

P. Rosen, A. Morris, G. Payne, B. Keach, I. Harvey, B. Richards-McClung, J. McLennan, R. Polson, R. Levey, T. Ring, E. Jurrus, and G.M. Jones. 2015. Klareco: An Indexing-based Architecture for Interactive Visualization of Heterogeneous Data Sources, In the 1st Workshop on Data Systems for Interactive Analysis (DSIA), Oct 2015.

Richards, B., Taylor, L., Levey, R., Mulligan, P. 2018. New Insights into the Exploration Prospects of the Central and Northern Karoo Basin, South Africa. American Association of Petroleum Geologists (AAPG), ACE Global Unconventional Systems II (EMD/SEPM).

Shu Jiang, Hongliu Zeng, Jinchuan Zhang, Neil Fishman, Baojun Bai, Xianming Xiao, Tongwei Zhang, Geoffrey Ellis, Xinjing Li, Bryony Richards-McClung, Dongsheng Cai, and Yongsheng Ma. Introduction to special section: China shale gas and shale oil plays. Interpretation, May 2015, v. 3:SJi-SJii, doi:10.1190/INT2015-0317-SPSEINTRO.1

Technical Publications

Evaluation of the Porosity Distribution, Characteristics, and Sequence Stratigraphy and Depositional Facies of the Samples of the Astrakhan Region, Russia. Principal Investigator. EGI Publication I 01299_4, 2019.

Nanoscale-Resolution Large-Area SEM Imaging and Characterization of Unconventional Reservoir Rocks, Western Sedimentary Basin, Canada. Principal Investigator. EGI Publication RS00004, 2016.

Nanoscale-Resolution Large-Area SEM Imaging and Characterization of Unconventional Reservoir Rocks: Energy Dispersive Spectrometry (EDS) Analysis of SEM Images. Principal Investigator. EGI Publication RS00005, 2019.

Advanced Petrological Evaluation of the Astrakhan Field, Russia. Principal Investigator. EGI Publication I 01299_2, 2018.

Petrological Evaluation of the Astrakhan Field, Russia. Principal Investigator. EGI Publication I 01299, 2016.

EGI Research Services Folio: Diagenetic Discussion of Key Samples of the Astrakhan Region, Russia. Principal Investigator. EGI Publication I 01299_3, 2017.

Reservoir Characterization of the Karoo Basin, South Africa – Regional Geological Characterization and Unconventional Reservoir Evaluation. Principal Investigator. EGI Publication I 01242, 2017.

Magnetics and Gravity interpretation: Leads of the Karoo Basin, South Africa. Principal Investigator. EGI Publication I 01209, 2018.

Integrated Assessment of Prospects, Northern Karoo Basin, South Africa – Phase 2: Gravity and Magnetic Assessment of Rhino Resources Technical Cooperation Permit Areas. Principal Investigator. EGI Publication I 01298_5, 2017.

Petrological Summary for Newfield Exploration Duchesne County, Utah. Principal Investigator. EGI Publication RS00002_2, 2018.

Gronant Core Reservoir Characterization. Principal Investigator. EGI Publication I 01320, 2017.

Characterization of Karoo Basin Acreage TCP23 and TCP24. Principal Investigator. EGI Publication I 01165, 2017.

China Shale Gas and Shale Oil Plays. Phase 2: Integrated Shale Reservoir Characterization in Primary Basins. Senior Petrologist. EGI Publication I00980_2, 2014.

Indian Subcontinent Shale Resource Plays. Phase 1: Regional Characteristics and Play Modeling. Senior Petrologist; EGI Publication I101028, 2013.

Liquids from Shales. Phase 2: Reservoir Description and Dynamics. Senior Petrologist; EGI Publication I00973_2, 2013.

South America Shale Gas and Shale Oil Plays. Phase 1: Regional Geological Characteristics and Play Modeling. Principal Senior Petrologist; EGI Publication I01005, 2013.

Flow in Nanoporous Rocks – Measurement of Relative Permeabilities in Synthetic Nanoporous Materials & Shale Samples. Senior Petrologist; EGI Publication I01209_2, completion date: 2016.

South America Shale Gas and Shale Oil Plays. Phase 2: Advancement of Shale Reservoir Characterization of the Phase 1 Basins and Preliminary Shale Reservoir Characterization of Additional South American Basins. Principal Petrological Investigator; EGI Publication I01005_2, completion date: 2016.

Central Eurasia Potential of Shale Liquids and Gas. Senior Petrologist; EGI. Publication I01021, 2015.

UK Shale Gas. Senior Petrologist; EGI Publication I01023, 2015.

Thematic Research & Funding

Principal Investigator: Hyperspectral Imaging Analysis for Critical Mineral Exploration *2022 - Present*

Hyperspectral Imaging Analysis for Critical Minerals in Tailings from Satellite to Drone scales - Lessons in Target Detection Algorithms

This project uses hyperspectral imaging, with derived reflectance data, at different spatial scales secondary prospectivity ts exploring mine tailings for critical minerals. Satellite imagery provides wide-area reconnaissance, allowing an overview of large expanses of terrain. This broad perspective is crucial for identifying areas of potential interest. Meanwhile, drone-based imaging complements this by delivering high-resolution data. This close-up view is essential for the detailed analysis to pinpoint specific mineral deposits.

Principal Investigator: Remote Sensing of Igneous Intrusives *2016 - Present*

Reservoir Characterization of the Karoo Basin, South Africa: Regional Geological Characterization & Unconventional Reservoir Evaluation

Ongoing research related to the identification of igneous Intrusives using remote sensing data. Areas of research include the Karoo Basin, South Africa where remote sensing, gravity, and magnetics data is used to maps subsurface structures related to oil and gas plays. Integrated results used to define and evaluate the fundamental factors important to shale hydrocarbon potential in the Karoo Basin.

Karoo Basin intrusives; similarities to Mars igneous complexes

Additional remote sensing work relates to analogous igneous systems to the Karoo on Mars, looking at the similarities between structures and potential emplacement histories.

Principal Investigator: Core through Pore® *2013 - Present*

Ongoing Trademarked research related to the use of correlative microscopy in relation to reservoir characterization. Correlative microscopy includes research related to the established trademark Core through Pore® and includes; mapping of cores and samples using computed tomography (CT), XRF mapping, petrology, including the interpretation of optical microscopy, QEMSCAN®/Mineralogic, XRD and XRF analyses, high-resolution microscopy and ion milling of samples, including SEM, FIB-SEM, and STEM analyses, in addition to the correlation, evaluation and presentation of complex data sources from multiple analytical techniques.

Principal Investigator: MUSE Energy Frontiers Research Center (EFRC) *2018 - 2022*

The mission of the Multi-scale Fluid-Solid Interactions in Architected and Natural Materials (MUSE) center is to develop a new fundamental understanding and models of the transport and interfacial properties of fluids confined by porous media by integrating multi-scale experimental and theoretical methods including state-of-the-art microscopy imaging, and validated multi-scale, physics-based modeling of hierarchical and natural nanostructured materials of varying levels of physical and chemical heterogeneities.

Co-Principal Investigator: Nuclear Forensics *2015 - 2018*

Forensic signatures for identifying processing history in nuclear forensics

Research related to the morphological changes that take place during the processing and storage of uranium oxides providing valuable information on the processing history and storage conditions of potentially interdicted samples. Modeling of the crystallographic changes in UO_2 and α-U_3O_8 related to varying environmental conditions e.g. elevated temperatures in controlled oxygen environments. Forensics signatures derived from this work are used to identify, compare, and contrast the processing history in relation to other sample signatures e.g. interdicted material.

TENORM elemental assessment of shales related to hydrocarbon production

Assessment of shale formations for TENORMS (Technologically Enhanced Naturally Occurring Radioactive Materials) produced via hydraulic fracturing. Research investigates the elemental composition of shale formations at the bulk and microstructural scale to better understand the relationship between major naturally occurring radioactive elements (NORM) and organic phases within shales.