

Dr Mark George Fox-Powell

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Research interests

My interests centre around aqueous brines and their role in planetary processes, with a particular focus on the ocean-bearing icy moons of Jupiter and Saturn, which bear the potential for extraterrestrial life. In my research, I couple experimental and computational simulation with detailed analytical approaches to build fundamental understanding of icy moon processes.

Employment and Education

- 2020-present **Research Fellow**, *AstrobiologyOU; Open University*
- 2016-2019 **Postdoctoral Research Fellow**; *School of Earth and Environmental Sciences, University of St Andrews*
- 2016 **Postdoctoral Research Assistant**; *School of Earth and Environmental Sciences, University of St Andrews*
- 2012-2016 **PhD in Astrobiology**; *UK Centre for Astrobiology, School of Physics and Astronomy, University of Edinburgh*
- 2011-2012 **MRes in Marine Biology (with Distinction)**; *School of Marine Science and Engineering, University of Plymouth/Marine Biological Association*
- 2008-2011 **BSc (Hons) Marine Biology with Coastal Ecology: 2.1**; *School of Marine Science and Engineering, University of Plymouth*

Publications

- (13) Moreras-Marti, A., **Fox-Powell, M. G.**, Stueeken, E., Di Rocco, T., Galloway, T., Cousins, C. R. & Zerkle, A. L. (2021) Quadruple sulfur isotope biosignatures from terrestrial Mars analogue systems. *Geochimica et Cosmochimica Acta* 308: 157-172 <https://doi.org/10.1016/j.gca.2021.06.007>
- (12) Moreras-Marti, A., **Fox-Powell, M. G.**, Zerkle, A., Stueeken, E., Gázquez, F., Brand, H., Galloway, T., Purkamo, L. & Cousins, C. R. (2021) Volcanic controls on the microbial habitability of Mars-analogue hydrothermal environments. *Geobiology* <https://doi.org/10.1111/gbi.12459>
- (11) **Fox-Powell, M. G.** & Cousins, C. R. (2021) Partitioning of crystalline and amorphous phases during freezing of simulated Enceladus ocean fluids. *Journal of Geophysical Research: Planets* 126 (1) e2020JE006628. <https://doi.org/10.1029/2020JE006628>
- (10) Macey, M. C., **Fox-Powell M.G.**, Ramkissoon, N. K., Stephens B., Barton T., Schwenzer, S. P., Pearson, V., Cousins C. R., Olsson-Francis, K. (2020) Sulfide oxidation: a potential metabolism driving primary production in late Noachian Mars. *Scientific Reports* 10 (10941). <https://doi.org/10.1038/s41598-020-67815-8>
- (9) **Fox-Powell, M. G.**, Osinski, G. R., Applin, D., Stromberg, J., Allender, E., Gázquez, F., Cloutis, E. & Cousins, C. R. (2019) Natural analogue constraints on Europa's non-ice surface material. *Geophysical Research Letters* 46 (11): 5759-5767. <https://doi.org/10.1029/2018GL081339>
- (8) Payler, S. J., Biddle, J. F., Sherwood Lollar, B., **Fox-Powell, M. G.**, Edwards, T., Ngwenya, B. T., Paling, S. M. & Cockell, C. S. (2019) An Ionic Limit to Life in the Deep Subsurface. *Frontiers in Microbiology* 10 (426). <https://doi.org/10.3389/fmicb.2019.00426>
- (7) **Fox-Powell, M. G.**, Channing, A., Applin, D., Mann, P., Cloutis E. & Cousins, C. R. (2018) Cryogenic silicification of microorganisms in hydrothermal fluids. *Earth and Planetary Science Letters* 498: 1-8. <https://doi.org/10.1016/j.epsl.2018.06.026>

- (6) **Fox-Powell, M. G.** & Cockell, C. S. (2018) Building a geochemical view of microbial salt tolerance: Halophilic adaptation of *Marinococcus* in a natural magnesium sulfate brine. *Frontiers in Microbiology* 9 (739). <https://doi.org/10.3389/fmicb.2018.00739>
- (5) Stevens, A. H., Childers, D., **Fox-Powell, M. G.**, Nicholson, N., Jhoti, E. & Cockell, C. S. (2018) Growth, viability and death of planktonic and biofilm *Sphingomonas desiccabilis* in simulated martian brines. *Astrobiology* 19 (2). <https://doi.org/10.1089/ast.2018.1840>
- (4) Cockell C. S., Biller B., Bryce C., Cousins C., Direito S., Forgan D., **Fox-Powell M. G.**, Harrison J., Landenmark H., Nixon S., Payler S. J., Rice K., Samuels T., Schwendner P., Stevens A., Nicholson N., & Wadsworth J. (2018) The UK Centre for Astrobiology: A Virtual Astrobiology Centre. Accomplishments and Lessons Learned, 2011–2016. *Astrobiology* 18 (2) 224-243. <https://doi.org/10.1089/ast.2017.1713>
- (3) **Fox-Powell, M. G.**, Hallsworth, J. E., Cousins, C. R. & Cockell, C. S. (2016) Ionic strength is a barrier to the habitability of Mars. *Astrobiology* 16 (6) 427-442. <https://doi.org/10.1089/ast.2015.1432>
- (2) Cockell, C. S., Bush, T., Bryce, C., Direito, S., **Fox-Powell, M. G.**, Harrison, J. P., Lammer, H., Landenmark, H., Martin-Torres, J., Nicholson, N., Noack, L., O'Malley-James, Payler S. J., Rushby, A., Samuels, T. Schwendner, P., Wadsworth, J. & Zorzano, M. P. (2016). Habitability: A Review. *Astrobiology* 16: 89-117. <https://doi.org/10.1089/ast.2015.1295>
- (1) Stevenson, A., Burkhardt, J., Cockell, C. S., Cray, J. A., Dijksterhuis, J., **Fox-Powell, M. G.**, Kee, T. P., Kminek, G, McGenity, T. J., Timmis, K. N., Timson, D. J., Voytek, M. A., Yakimov, M. M. & Hallsworth, J. E. (2014) Multiplication of microbes below 0.690 water activity: implications for terrestrial and extraterrestrial life. *Environmental Microbiology* 17 (2) 257-277. <https://doi.org/10.1111/1462-2920.12598>

Grants and Awards

Research funding:	Europlanet Transnational Access Grant, 2021 (Principle Investigator) - £15,000 NASA Solar System Workings Grant, 2021 (collaborator) - \$300,000 Leverhulme Trust Research Project Grant, 2019 (Co-I) - £195,649 Leverhulme Trust Research Project Grant, 2016 (named PDRA) - £165,903 Europlanet Field Analogue support, 2017 (Co-I) - £2,000
Training:	ARCTIS Arctic Winter Field Course, Murmansk Region, Russia, 2019 - €2,500 Deep Earth Water Model training course, JHU, Maryland, 2017 - \$1,500 DCO Yellowstone Summer School attendance award, 2014 - £1,250
Events support:	Royal Astronomical Society support for 3 rd British Planetary Science Conference: £2,500 Univ. of St Andrews ECR Forum training and retreat, 2018: £750 SUPA Events Programme; support for early-career workshop 'Building Habitable Worlds', 2015: £600
Other travel awards:	Totalling over £2,500 between 2014 and 2018

Teaching

Undergraduate:	S111 <i>Questions in Science</i> Topic 4 review and re-write, Open University (2021) Lecture 'Cryovolcanism in the Solar System'; MSc Geochem., School of Earth and Environmental Sciences, U. St Andrews (2021) Lecture 'Water in the Solar System,' module <i>Astrobiology</i> , U. St Andrews (2019) Supervisor for undergraduate summer project; data processing and laboratory work, U. St Andrews (2019) Lecture 'Mars as a habitat for life,' module <i>Astrobiology</i> , U. St Andrews (2018)
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Teaching assistant, module *Origin and Diversity of Life*; School of Biological Sciences, U. Edinburgh (2013-2014)

Teaching assistant, module *Astrobiology*; School of Physics and Astronomy, U. Edinburgh (2013-2014)

Postgraduate: Tutor, European Astrobiology Network Association *School on Hydrothermal Vents*, virtual (2021)
 Co-supervisor of PhD student (A. Del Moral Jiminez, Open University; 2019-present)
 Co-supervisor of PhD student (A. Moreras Marti, U. St. Andrews; completed 2020)
 Supervisor for MSc Research Review Essay, U. St Andrews (2019)
 Supervision of MPhys laboratory project, U. of Edinburgh (2013-2014)
 Tutor, STFC *Introductory Astrobiology*, Open University (2020)
 Tutor for STFC *Astrobiology Summer School*, Univ. Edinburgh (2018)

Distance learning: Tutor for 'Astrobiology and the Search for Extraterrestrial Life' MOOC; Online course with 18,000+ registrants (<https://www.coursera.org/learn/astrobiology>)

Professional activities

Peer Reviews: Grant proposals (NASA FINESST, NASA Postdoctoral Program, NASA Habitable Worlds, STFC, Carnegie Trust Research Incentive Grant)
 Journals (*Nature Communications*, *Planetary Science Journal*, *Astrobiology*, *Space Science Reviews*)

Invited seminars: Lunar and Planetary Institute (2021, upcoming); Geomicrobiology Network (2021); NASA Jet Propulsion Laboratory (2021); NASA Goddard Spaceflight Center (2018); Open University (2018); Univ. St Andrews (2016); Univ. Nottingham (2014)

Management: Co-management of PDRA (with U. St Andrews)
 AstrobiologyOU Research Group meeting chair, Open University
 Earth Sciences Seminar series coordinator, U. St Andrews
 Early Career Researcher Forum treasurer (2018-2019), secretary (2018), U. St Andrews
 Network co-organiser; Geological Repositories Network (2015-2016)
 UK Centre for Astrobiology seminar series coordinator (2014-2015)
 Board member, UK Centre for Astrobiology (2013-2016)

Community activities: Organisation of 5 UK and European conferences, including the 3rd British Planetary Science Conference (Open University, 2022), European Astrobiology Network Association conference (2014) and 1st 'Building Habitable Worlds early career workshop (2015; 4 subsequent iterations)
 NASA FINESST Review Panel member (2021)
 Session chair, 52nd Lunar and Planetary Science Conference, 2021 (Virtual)
 Session convener, Goldschmidt 2021 (Virtual)
 Session convener, Goldschmidt 2019 (Barcelona)
 Session chair, Volcanic and Magmatic Studies Group 2019 (St Andrews)

Impact and knowledge exchange

2021 Highlands Astronomical Society Lecture: *Exploring the ice-covered oceans of the outer Solar System (Virtual)*

2020 Cosmic Cast podcast: <https://youtu.be/RFgEsfkTLQ0>

2020 National Astronomy Week Panel: *Mars on Earth*

2017 Tutor for 'Space School,' a day of planetary science activities for Fife primary school children. St. Andrews

- 2015 Scientist in the UK Space Agency 'UK in Aurora' film series :
<https://www.auroramarsfilm.com/>
- 2014 Inaugural lecture, student Astrobiology Society, U. Edinburgh
- 2014 Tutor for 'Astrobiology Summer Academy', U. Edinburgh
- 2013 Deep Carbon Observatory field expedition outreach filming: https://youtu.be/vMsQ9yice_k

Fieldwork experience

- Canada: Sampling effort **lead** for expedition to Axel Heiberg Island, Canadian High Arctic (2017)
Lead for winter expedition to Basque Lakes, Cariboo Plateau, BC, Canada (2015)
- Iceland: Kerlingarfjöll and Kverkfjöll volcanos, Iceland (2017)
Lead for winter expedition to Geysir geothermal field (2017)
 Kverkfjöll volcano (2014)
- Greenland: Disko Island expedition (2013)
- UK: 1.1 km-deep subsurface salt deposits, Boulby Mine, UK (2015); Scientific SCUBA diver for CRESH (Cuttlefish Recruitment in English Channel Spawning Habitats) (2010)
- Other: Microgravity parabolic flight; preparation for ISS experiment (2015)

Selected conference & meeting abstracts

- Fox-Powell, M. G.**, Semprich, J., Ramkissoon, N., Buffo, J. J., Vance, S. D., Schwenzer, S. P. & Pearson, V. K. Brine evolution and transport-driven fractionation of ocean fluids within Europa's icy shell. **Oral presentation**, 52nd Lunar and Planetary Science Conference, March 2021 (Virtual)
- Fox-Powell, M. G.** & Cousins, C. R. Production of crystalline and amorphous phases during freezing of simulated Enceladus ocean fluids, **Oral presentation**, European Planetary Science Congress, September 2020 (Virtual)
- Fox-Powell, M. G.** & Cousins, C. R. Freezing-induced fractionation of glass, ice and salts from simulated Enceladus ocean fluids, **Oral presentation**, 51st Lunar and Planetary Science Conference, March 2020, The Woodlands, TX, USA [conference cancelled]
- Fox-Powell, M. G. & Cousins, C. R.** Freezing-induced fractionation in aqueous cryomagmas relevant to Enceladus and other icy moons. **Oral presentation**, VMSG, January 2019, St Andrews, UK
- Fox-Powell, M. G.**, Osinski, G. R., Applin, D., Stromberg, J., Allender, E., Gasquez, F., Cloutis, E. & Cousins, C. R. Low-temperature hydrated salts from Axel Heiberg Island as an Analogue for Europa's non-ice surface material. **Oral presentation**, Europa Deep Dive II: Composition, October 2018, Houston, TX, USA
- Fox-Powell, M. G.**, Channing, A., Applin, D., Cloutis E., Preston L. J. & Cousins, C. R. (2018) Cryogenic silicification of microorganisms in hydrothermal fluids. **Oral presentation**, 49th Lunar and Planetary Science Conference, March 2018, The Woodlands, TX, USA
- Fox-Powell, M. G.** & Cockell, C. S. Geochemical evolution drives differential habitability on the Earth and Mars. **Oral presentation**, Geological Society meeting: Puzzle of Earth's Uninterrupted Habitability, 11 November 2015, London, UK