PROJECT TITLE: How habitable has planet Earth been?

DTP Research Theme(s): Dynamic Earth, Changing Planet

Lead Institution: University of Bristol

Lead Supervisor: Dr Lewis Alcott, School of Earth Sciences, University of Bristol

Co-Supervisor: Dr Michael Henehan, School of Earth Sciences, University of Bristol

Co-Supervisor: Dr Caitlyn Witkowski, Schools of Chemistry and Earth Sciences, University of Bristol

Co-Supervisor: Professor Tim Lenton, Geography, University of Exeter

Co-Supervisor: Dr Erik Sperling, Earth and Planetary Science, Stanford University

Project Enquiries: michael.henehan@bristol.ac.uk

Project keywords: Planetary Habitability, Earth Evolution, Tipping Points

Project Background

Planetary habitability is generally constrained by two key variables that are prerequisites to support life as we know it. Firstly, a global temperature that is neither too hot or too cold, and secondly, an atmosphere not too dissimilar from our own with abundant oxygen in the atmosphere and oceans to allow life to thrive as we know it. However, the dynamics and variability of habitability over time change, and the Earth, has apparently been fortunate in sustaining habitable conditions throughout the majority of its ~4.5-billion-year history. Even with this broad habitability, there have been periods when Earth became less habitable to animal life, such as during mass extinctions. This implies a fine balance between a planet able to support abundant animal life and one which is harsh and inhospitable. Understanding how the Earth has remained habitable, and envisioning what our planet looked like through its history, is key to understanding not only how we ourselves have evolved, but also whether other planets might sustain complex life, and what we may expect in the future with our changing climate.

Project Aims and Methods

This project will take a new approach to assimilating and understanding planetary habitability with respect to both temperature and the availability of oxygen. Several key questions will be addressed, but the nature of the project would allow the researcher to engage with a wide variety of collaborators to investigate aspects of the Earth system they see fit.

1) How did Earth’s temperature evolve through time?
2) How did Earth’s oxygenation play a role in life’s evolutionary steps?
3) How vulnerable is Earth’s habitable surface to dramatic events like Large Igneous Province eruptions?

The researcher in this position would utilise the Sedimentary Geochemistry and Paleoenvironments Project database (https://sgp.stanford.edu/) and leverage machine learning techniques and biogeochemical modelling to analyse ever-growing datasets that attempt to reconstruct Earth’s habitability, including redox and temperature proxies throughout Earth history. In doing so, the researcher will gain a vast amount of knowledge of biogeochemistry through time and the ways in which it is interpreted. Interactions with numerous global collaborators will allow the researcher to continue to explore ways in which Earth’s habitable surface is recorded in the rock record.
Candidate requirements
Ideally candidates will have knowledge, or an interest in, key events throughout Earth history or planetary habitability. While a computing background isn’t needed as training will be offered, an interest in developing computer models is advantageous. We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

Project partners
Expertise in proxies for Earth evolution will be conferred by the supervisory team at the University of Bristol, including inorganic and organic proxies to reconstruct oxygen availability and temperature through time. Professor Tim Lenton at the University of Exeter will provide world-leading expertise in Earth system modelling, as well as the intricacies of planetary tipping points for habitability. In addition to the supervisory team based in the UK at the Universities of Bristol and Exeter, this project allows for collaborations with researchers globally. The Sedimentary Geochemistry and Paleoenvironments Project (https://sgp.stanford.edu/) is driven by collaborations with groups and institutes around the world and is continually being expanded upon, meaning this work will be at the forefront of our understanding. The SGP database itself is led by Dr Erik Sperling at Stanford University, USA, who offers insight into data availability but also physiological limits for oxygen requirement, and – more generally – Earth history and the co-evolution of life and the environment.

Training
In addition to the training and skills development as part of the DTP project, there is wide scope within this project to develop a wide range of approaches in Earth system and biogeochemical modelling as well as machine learning for geoscience research. These methodologies would allow the researcher to tackle several additional questions of interest using the skills gained, including but not limited to; present day climate change or other periods of interest in Earth history and (exo)planetary habitability. The researcher will have the opportunity to collaborate with leaders in the fields of understanding planetary habitability and long-term environmental change. This position will offer opportunities for travel for collaborations and to present work at conferences including the international Goldschmidt Conference.

Background reading and references

Useful links
http://www.bristol.ac.uk/earthsciences/courses/postgraduate/

Bristol NERC GW4+ DTP Prospectus:
https://www.bristol.ac.uk/study/postgraduate/research/great-western-four-doctoral-training-partnership-nerc/

How to apply to the University of Bristol:
http://www.bristol.ac.uk/study/postgraduate/apply/

Please note: If you wish to apply for more than one project please contact the Bristol NERC GW4+ DTP Administrator to find out the process for doing this.

The application deadline is Tuesday 9 January 2024 at 2359 GMT. Interviews will take place from 26 February to 8 March 2024.

For more information about the NERC GW4+ Doctoral Training Partnership please visit https://www.nercgw4plus.ac.uk

General Enquiries: Bristol NERC GW4+ DTP Administrator
Email: bristol-nercgw4plusdtp-admin@bristol.ac.uk