PROJECT TITLE: Carbon (CO\(_2\)) cycling mechanisms in early algae: Implications for past climate and life on Earth

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

Lead Institution: University of Bristol

Lead Supervisor: Dr. Caitlyn Witkowski, University of Bristol, Schools of Earth Science & Chemistry

Co-Supervisor: Dr. Ernest Chi Fru, Cardiff University, School of Earth and Environmental Sciences

Co-Supervisor: Dr. Clemens Vinzenz Ullmann, University of Exeter, Camborne School of Mines

Co-Supervisor: Dr. David Naafs, University of Bristol, Schools of Earth Science & Chemistry

Project Enquiries: caitlyn.witkowski@bristol.ac.uk

Project keywords: climate change; CO\(_2\); paleoclimate; algae; evolution

Project Background
The Phanerozoic Era (the past 540 million years) has been a rollercoaster: lineages for modern species first appeared, life transitioned to land, and several mass extinctions devastated Earth. Algae have been the unsung heroes of the Phanerozoic, shaping major earth systems like carbon dioxide (CO\(_2\)), climate, and atmospheric/ocean chemistry, and providing a pillar for life itself. Even beyond the grave, fossilized molecules from algae show us what past CO\(_2\) concentrations were, based on how algae fix CO\(_2\) during photosynthesis, where they take up more \(^{13}\)CO\(_2\) instead of \(^{12}\)CO\(_2\) (a proxy known as isotopic fractionation). However, most isotopic fractionation studies focus on alkenone-producers (who evolved ~45 million years ago) or diatoms (who evolved ~250 million years ago), meaning that the early algae who were around for most of the Phanerozoic remain understudied. This leaves a knowledge gap in evolution, as well as changes in CO\(_2\), which could provide insights as our current CO\(_2\) rises higher than ever in human history.

Project Aims and Methods
You, as the PhD candidate, will explore the mechanisms for isotopic fractionation in early algae. The overall project design consists of laboratory cultures, mechanism development, and application, each with a high degree of flexibility. You will grow early algae in laboratory culture experiments to tease out factors that impact isotopic fractionation, in the context of (and possibly challenge) our current framework. You will form hypotheses on the mechanisms for isotopic fractionation which you will then test in additional culture experiments and/or modern ocean environments, which can include fieldwork (see pictures above) in places like Japan, Italy, or Fiji. You will then apply your findings to determine CO\(_2\) concentrations across the Phanerozoic Era, with the possibility of providing the longest spanning record of CO\(_2\) to date.

Throughout this PhD, you will have the opportunity to shape this project based on your own interests and strengths, with guidance from the supervisors. You will be embedded in the organic geochemistry unit (OGU) in the Schools of Chemistry and Earth Science at the University of Bristol, a diverse and dynamic...
international research team of ~35 MSc students, PhD candidates, and postdocs. There, you will have full access to state-of-the-art laboratories and analytical instrumentation. You will work closely with lead supervisor Dr Cait Witkowski to shape your project. Dr Cait Witkowski, as well as co-supervisor Dr David Naafs, are experts in organic geochemistry, stable isotope geochemistry, paleoclimate, and CO₂ proxies, the heart of this project. You will also work together with co-supervisor Dr. Ernest Chi Fru at the University of Cardiff, an expert in geomicrobiology, marine biogeochemistry, and the evolution of life to provide critical context for mechanisms in early algae, and with co-supervisor Dr. Clemens Ullmann at the University of Exeter, an expert in inorganic geochemistry and macrofossil calcite to provide critical context for the Phanerozoic application.

Candidate requirements
We welcome and encourage student applications from under-represented groups. We value a diverse research environment and aim to integrate intersectionality within our group. An Earth Sciences, Geography, Biology, and/or Chemistry background is required, with a broad interest in evolution and paleoclimate.

Training
You will receive training in a world-leading research group using exciting and state-of-the-art analytical methods. Specifically, you will be provided with extensive training in laboratory cultures, organic geochemistry, and isotope geochemistry methods, and learn the broad context of algae evolution and climate change over Earth history. We encourage the candidate to participate in NERC GW4+ DTP training courses to develop both technical and personal skills. Funding is provided to present the results of your research at major international conferences around the globe.

Background reading and references
- Bidigare et al., 1997. Consistent fractionation of ^13C in nature and in the laboratory: Growth-rate effects in some haptophyte algae, Global Biogeochemical Cycles. https://doi.org/10.1029/96GB03939

Useful links
http://www.bristol.ac.uk/chemistry/research/ogu/
https://www.cardiff.ac.uk/people/view/481889-fru-ernest-chi
https://csm.exeter.ac.uk/staff/cu211
http://www.p-co2.org/biomarkers

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2023/docotoral/phd-great-western-four-dtp/

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 Monday 9 January 2023 at 2359 GMT.
Interviews will take place during the period 22 February – 8 March 2023.

NERC GW4+ DTP Website:
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