PROJECT TITLE: The Organic Geochemistry of Peat in Transition

Part of the £2.4 million UKRI-funded grant CERES, Climate, Energy and Carbon in the Earth System.

Lead Institution: University of Bristol, School of Earth Sciences and School of Chemistry
Lead Supervisor: Professor Rich Pancost, School of Earth Sciences, University of Bristol
Co-Supervisor: Dr David Naafs, School of Chemistry, University of Bristol
Other Co-Supervisors: Dr Casey Bryce, School of Earth Sciences, University of Bristol; Professor Angela Gallego-Sala; Geography, University of Exeter

Project Enquiries: r.d.pancost@bristol.ac.uk

Project keywords: Climate Change; Palaeoclimate; Earth System; Methane; Wetlands; Peatland Degradation and Restoration

CERES Project Background

Microbial processes in terrestrial settings are critical to governing greenhouse gas emissions. The modern carbon soil reservoir exceeds that of terrestrial vegetation and the atmosphere combined, and soil microorganisms annually cycle 1/3 of the carbon photosynthesised and account for the largest natural methane flux to the atmosphere. In doing so, they govern the chemical and climatic state of our planet. And yet these processes remain poorly understood as they are mediated by a range of environmental factors. Insight can be derived from geological archives that document the responses of biogeochemical systems to past environmental perturbations across a range of timescales from 1000s to millions of years. Our previous studies on peat and lignites provide tantalising insights into climate-driven disruption of the carbon cycle, but the underlying mechanisms remain unresolved. This PhD, as part of the wider CERES project, will address that by exploring the organic geochemistry of peatlands that have undergone radical transformation – from drying and degradation to restoration to flooding.

Project Aims and Methods:

Peat and lignite deposits have long been used to explore past changes in climate, especially changes in temperature and precipitation. However, peat deposits can also document the biogeochemical responses to those environmental changes. To explore these, a wide range of approaches have been developed based on changes in the bulk composition of peat, transformations in specific environmentally sensitive biomolecules and tracers for specific microbial communities. However, they have been developed and applied to a relatively narrow range of relatively unaltered temperate and subarctic peatlands. This project will focus on a range of peatlands that have experienced dramatic transformations, including drainage, drying and restoration and from a range of climate regimes from the Arctic to the Tropics.
We will explore and compare environmental and biogeochemical disruptions in Welsh, English, Swedish, Panamanian and Colombian peatlands (and potentially peatlands from Uganda, the DRC and Papua New Guinea). The specific sites and time intervals will be developed in collaboration with the PhD student and the supervisory team, but we are particularly interested in documenting sites that have experienced drying, drainage and restoration, allowing us to explore the biomolecular signature of disruption as well as its persistence. We will determine how these disruptions affected rates of carbon accumulation and the overall chemical composition of the peat, as well as the associated microbial communities that are involved with its stepwise degradation to simpler substrates and eventually CO₂ and methane. Working with the wider CERES team, the PhD student will apply new lipidomic techniques, especially those arising from the distribution of unusual archaeal and bacterial membrane lipids, to ascertain the relationships between past changes in peatland hydrology, microbial metabolism, and carbon cycling.

Candidate requirements
The Organic Geochemistry Unit (OGU) has a long history of interdisciplinary research; as such, we are looking for intellectually diverse applicants, welcoming your new perspectives into our lab and our obligation to train you in the methods you will use. Similarly, we welcome and encourage student applications from minoritized and marginalised and value a diverse research environment.

Project partners
This project builds on a long-standing Bristol-Exeter collaboration in which we have developed and applied new approaches to understanding peatland processes. We also have collaborations in Wales, Colombia, and Panama, ensuring access to samples and sites

Training
As part of CERES, there will be outstanding opportunities for field work and associated training. We recognise the constraints field work imposes on applicants from some backgrounds, however, and field work is not mandatory (with samples provided by partners). The PhD focuses on geochemical investigation of peat, including characterisation of organic matter, quantification of biomarkers and cutting-edge stable isotope methods. As the Bristol node of the NERC Natural Environment Isotope Facility (NEIF) specialised in organic isotope analyses, the OGU has a long track record of providing such training to diverse students from all backgrounds. Similarly, the Earth Sciences Biogeochemistry and Geomicrobiology labs have fantastic facilities and opportunities for training and career development. Successful applicants will also be able to access the extensive transferable skill training associated with the NERC GW4+ Doctoral Training Partnership, as well as those of Bristol’s Doctoral College.

Background reading and references
Inglis, G.N. et al., 2019, δ13C values of bacterial hopanoids and leaf waxes as tracers for methanotrophy in peatlands. Geochimica Cosmochimica Acta 260, 244-256.

Useful links
To apply: http://www.bristol.ac.uk/earthsciences/courses/postgraduate/
For information on the OGU: http://www.bristol.ac.uk/chemistry/research/ogu/

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

The application deadline is Friday 20 January; Interviews will take place during the period 13 to 22 February, 2022. The preferred start date will be Oct 2023 but the funding of the project allows flexibility. Funding is available for 3.5 years at standard UKRI rates.