

**PROJECT TITLE: Meals on wheels: does physical structure influence community development and longevity in cryoconite?**

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

**Lead Institution: University of Bristol**

**Lead Supervisor: Liz Bagshaw, University of Bristol, School of Geographical Sciences**

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**Project keywords: cryoconite, glaciers, microbiology, biogeochemistry, geography**



*Cryoconite holes on a glacier surface in McMurdo Dry Valleys, Antarctica*



*Dust transport onto the surface of Russell Glacier to form cryoconite, Greenland*

## Project Background

Cryoconite is a matrix of mineral and organic matter that accumulates on glacier surfaces worldwide. Numerous studies have assessed the impact of the cryoconite on local and regional ecosystems processes, and explored the microbial communities that inhabit them. They are comprised of cyanobacteria, algae, fungi and other bacteria and protists. Research work to date has demonstrated that organic matter produced by the microbial community, and the presence of cryoconite itself, can impact glacier and ice sheet albedo. It has also shown that cryoconite acts as a microbial hotspot in an otherwise hostile environment. Curiously, cryoconite can also act as an accumulator of radioactive material. What remains poorly understood is how the cryoconite matrix develops: is it purely a function of physical processes, or do different microorganisms have different effects? How do nutrient distribution and organic matter influence structure? This project will explore the physical and microbiological processes that govern formation of cryoconite, and the influence the physical structure has on microbial assemblage longevity.

## Project Aims and Methods

The project will be codeveloped with the research team at Bristol and the Natural History Museum (NHM) to suit the applicants' interest and existing expertise, so students will be encouraged to contribute their ideas throughout the experimental design. Using state of the art laboratories in Bristol and London NHM, we will assess the structure of cryoconite from a sample archive that includes samples from Greenland, Antarctica, Svalbard, Canada and the Alps. Cutting edge high throughput DNA sequencing methods will be employed to compare microbial community composition in between different cryoconite types, and biogeochemical analytical techniques will assess the geochemical properties and how they vary with cryoconite typology. Following the initial assessment, the project will undertake physical experiments in the laboratory and the field to determine the key processes that influence the development of cryoconite structures, including granulation. The project will include opportunities for polar fieldwork, where students can collect their own samples and also conduct physical experiments on the ice [we note that fieldwork is not compulsory, and the project can be adapted to individual requirements]. Students are welcome to contribute their own ideas to project design. The key outcome of the project is an improved understanding of how cryoconite communities persist, how they accumulate contaminants, how microbes and minerals interact, and how they release chemical and biological material to downstream ecosystems.

### Candidate requirements

We welcome and encourage student applications from under-represented groups. We value a diverse research environment, and we also recognise that few students will have all the skills necessary to complete the project at the application stage. We therefore encourage students who have expertise or interest in some of the following research areas: microbiology, glaciology, geography, chemistry or earth sciences.

### Project partners

The project benefits from a key partner: the Natural History Museum (NHM), London. NHM will provide access to state of the art molecular facilities and full training for the candidate. They also provide opportunities for development of public engagement and outreach skills unique to the museum environment.

### Training

The student will receive exemplary laboratory training at two world-class institutions: Bristol and NHM. At Bristol they will use state of the art analytical facilities to assess biogeochemistry, and use unique low temperature experimental facilities to explore physical processes. At NHM they will receive training on up to date molecular analyses and imaging. The student will also have opportunities to participate in polar fieldwork and collaboration with a wide network of polar researchers. Throughout the project the student will have the support of a supervisory team to develop their scientific skills, and access to a range of training opportunities across the GW4 and NERC.

### Background reading and references

Clason et al. 2023 Global variability and controls on the accumulation of fallout radionuclides in cryoconite, *Science of the Total Environment*, <https://doi.org/10.1016/j.scitotenv.2023.164902>

Park, C. and Takeuchi, N. (2021), Unmasking photogranulation in decreasing glacial albedo and net autotrophic wastewater treatment. *Environ Microbiol*, 23: 6391-6404. <https://doi.org/10.1111/1462-2920.15780>

Millar et al. 2021 Polar Cryoconite Associated Microbiota Is Dominated by Hemispheric Specialist Genera *Frontiers in Microbiology*, <https://doi.org/10.3389/fmicb.2021.738451>

Ramoneda et al. 2021 FEMS Microbiology Ecology, Importance of environmental factors over habitat connectivity in shaping bacterial communities in microbial mats and bacterioplankton in an Antarctic freshwater system <https://doi.org/10.1093/femsec/fiab044>

Rozwalak et al. 2022 Cryoconite – From minerals and organic matter to bioengineered sediments on glacier's surfaces, *Science of the Total Environment*, <https://doi.org/10.1016/j.scitotenv.2021.150874>

### Useful links

<http://www.bristol.ac.uk/geography/courses/postgraduate/>

### Bristol NERC GW4+ DTP Prospectus:

<http://www.bristol.ac.uk/study/postgraduate/2024/sci/phd-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>

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