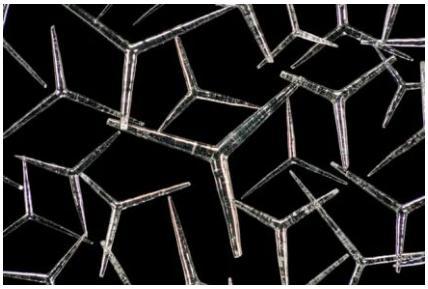
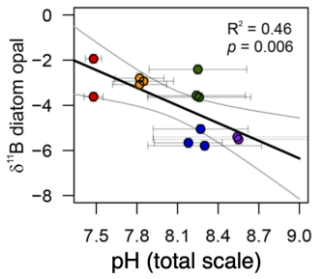
PROJECT TITLE: Advancing the boron isotope-pH proxy in biogenic silica

University of Bristol Theme: Net Zero and Climate Change

Research Group(s): Geochemistry Group/MATES Group, School of Earth Sciences
Lead Supervisor: Dr. Michael Henehan (School of Earth Sciences, University of Bristol)
Co-Supervisors: Prof. Kate Hendry (British Antarctic Survey), Dr. Sophie Westacott (School of Earth Sciences, University of Bristol), Dr. Franziska Stamm (Institute of Applied Geosciences, Technical University of Graz)
Project enquiries: Michael.Henehan@bristol.ac.uk
Project keywords: palaeo-pH, ocean acidification, pCO_2, sponge, silica, boron isotopes
Funder: University of Bristol Scholarship



Sponges produce spicules of biogenic silica that could prove a useful palaeo-archive (Image credit: Solvin Zankl / Nikon Small World)



Diatom biogenic silica has been shown to respond to pH (fig. modified from Donald et al. 2020), but the mechanism for this is unclear

Project Background

The boron isotope-pH proxy – applied to mainly foraminiferal carbonates – has rapidly established itself as a trusted proxy for past ocean pH and atmospheric CO_2 levels. However, for much of Earth's history, planktic foraminifera did not exist, and even today there are many areas of the oceans where $CaCO_3$ is not preserved. It has been shown that boron isotopes in diatom silica respond systematically to seawater pH, but their fossil record is patchy. If boron isotopes in sponge spicule and radiolarian silica also reflect ocean pH, it could open up a huge array of potential new applications – both in palaeoceanography and in understanding silicifier physiology and biomineralization pathways – spanning the half-billion years of the fossil record of silicifiers. Before we can apply boron isotopes to biogenic silica, however, we need to a) establish the inorganic baseline for the proxy, b) constrain other confounding factors that may affect boron isotopes, and c) determine any additional biological fractionations that may be superimposed on the inorganic baseline as a result of the physiological processes of the silicifier.

Project Aims and Methods

We expect the project to approach the issue from multiple angles, synthesising laboratory experiments, analyses of samples from field collections, and palaeoceanographic application. Specifically, we plan to:

1. Precipitate synthetic silica in seawater across a range of pHs, temperatures and seawater chemistries to calibrate the inorganic response of boron isotopes and boron partitioning.
2. Compare this synthetic boron isotope calibration to the pH response seen in sponge spicules, sampled from all around the world and already in-house. We anticipate using laser ablation MC-ICPMS, comparing with Si isotopes to detangle physiological and inorganic fractionations.
3. Apply the nascent proxy to fossil sponge spicules (e.g. from the early Cenozoic or Cretaceous greenhouse climates- according to the student's wishes) to demonstrate the utility of the proxy.

This plan is however open to negotiation and discussion, should the student wish to bring their own ideas or push the project in a somewhat different direction. Other potential avenues for investigation could include theoretical modelling of how boron (and other trace elements) are incorporated in the amorphous silica structure, how diagenetic influences can be screened for and avoided, or how sponges biomineralize.

Candidate

The ideal candidate should have:

- A degree in relevant disciplines such as Earth science, chemistry, biochemistry or biology.
- A capacity to work, think and plan independently, but also to interact well within a research team.
- Good skills in scientific writing in English, and good oral communication skills.
- Laboratory experience (e.g. clean lab/micropalaeontology/mass spectrometry/synthetic chemistry) and/or coding ability (e.g. Python/R) are beneficial, but are by no means essential prerequisites.

We welcome and encourage student applications from under-represented groups, and value a diverse research environment.

Project partners

The project is co-supervised by Prof. Kate Hendry at BAS, one of the foremost polar research centres in the world. Her group has worked extensively on stable isotope analyses of spicules, and she will be able to train the student in sample identification and preparation methodologies. BAS holds biological collections of marine sponges, in addition to the specimens at the University of Bristol, and there will be the opportunity to interact with and potentially collaborate with specialist marine biologists like Katrin Linse. BAS co-ordinates frequent sea-going expeditions, providing potential opportunity for fieldwork experience.

The project also dovetails with an ongoing €2M ERC Consolidator grant at the University of Bristol (www.petrarch-project.science, now funded through the UKRI Horizon Funding Guarantee). PETRARCH aims to establish radiolarian biogenic silica as a palaeo-pH archive through culturing of live radiolarians and core-top measurements, and then apply this proxy to Cretaceous Ocean Anoxic Events. The student will therefore work amongst a dynamic and fun team, and the findings of their research will immediately be put to use in palaeo-studies and in studying biomineralisation processes.

Training

The student will be trained in the analysis of boron and silicon isotopes by MC-ICPMS, via solution and laser. There will also be the opportunity to travel to TU Graz to carry out inorganic synthesis experiments, before setting up a similar apparatus here at the University of Bristol. The student would receive training in sponge spicule taxonomy, with the aid of an extensive collection of specimens taken from all over the global oceans.

Background reading and references

H. Donald et al. (2017, Biogeosciences) https://doi.org/10.5194/bg-17-2825-2020
F. Stamm et al. (2019, GCA) https://doi.org/10.1016/j.gca.2019.03.035
M. Henehan et al. (2013, EPSL) http://dx.doi.org/10.1016/j.epsl.2012.12.029
G. Foster & J. Rae (2016, Annual Reviews) https://doi.org/10.1146/annurev-earth-060115-012226
L. Cassarino et al. (2018, Biogeosciences) https://doi.org/10.5194/bg-15-6959-2018

Useful links

http://www.bristol.ac.uk/earthsciences/courses/postgraduate/
https://www.bristol.ac.uk/science-engineering/postgraduate-research/pgr-scholarships/
https://www.bristol.ac.uk/directory/visas/student-visa/apply/money
http://www.petrarch-project.science/

Eligibility

UK and International students are eligible for University of Bristol Postgraduate Research Scholarships. These are funded for 4 years and cover university fees, living expenses at the UKRI standard rate, and an allowance towards research expenses. Scholarships do not cover visa or NHS surcharge costs. See links above for details.

Application deadline: **Monday 19th January, 2026 , 23.59 GMT**
(Interviews are expected to take place in mid/late February)

Application

During application select "**University of Bristol Scholarship**" for funding source and "**Geology (PhD)**" for programme. If you are applying this specific project upload this PDF as the "research statement". All studentships must have a September 2026 start date.