# PROJECT TITLE: Walking the plank between conservation and sustainability: Using geochemistry, microbiology and modelling to protect our heritage

**University of Bristol Theme:** Climate and Environment Research Challenge Area
**Research Group(s):** Marine and Terrestrial Environments
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**Project keywords:** Heritage, iron cycling, corrosion, sustainability, machine learning, modelling
**Funder:** University of Bristol Scholarship

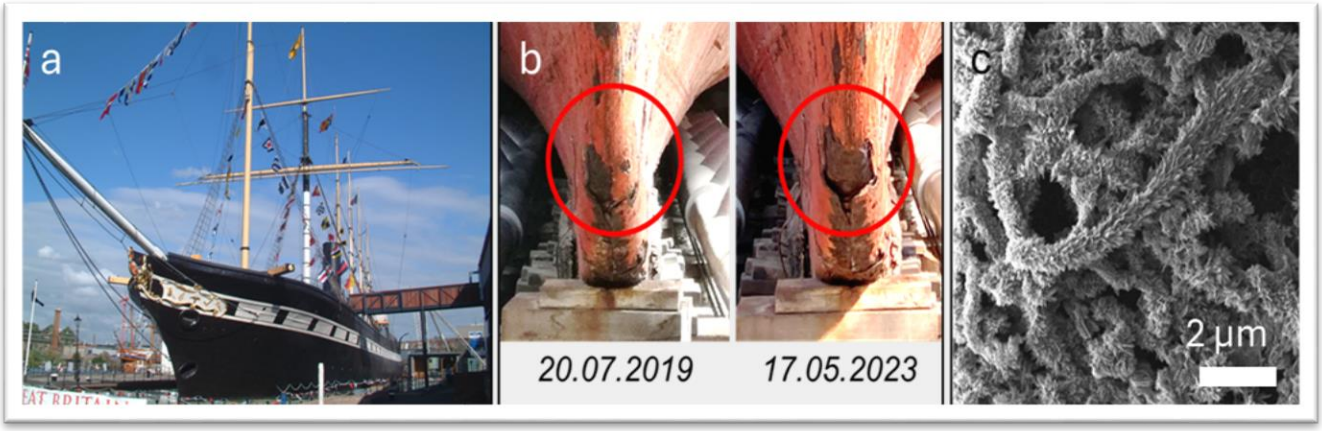


*Figure 1 - SS Great Britain is a cultural icon of the city of Bristol (a), but corrosion (b) is causing extensive damage. This project will investigate the role of bacteria (c) in this corrosion and determine how it can be interrupted to preserve the ships legacy.*

## Project Background

The SS Great Britain (SSGB), an iconic landmark in Bristol, was designed by Isambard Kingdom Brunel in 1843. At the time of her launch, she was the largest passenger ship and the first to feature an iron hull capable of ocean travel. After several decades of service, the SSGB was abandoned off the Falkland Islands but just over 50 years ago, she was returned to her original dock in Bristol, where she has been preserved ever since. However, despite efforts to maintain her integrity using dehumidifiers and temperature control, visible corrosion continues to be a challenge (Figure 1). This corrosion is likely partly due to abiotic influences (i.e. rusting by air), but it is also thought that microbiology might play a significant role.

Microbial iron redox cycling between iron(II) and iron(III) phases is ubiquitous in almost every environment on Earth, environment on earth and yet understanding of their contribution towards the corrosion of man-made iron objects is limited. Perhaps the best known example is the Titanic which is currently being degraded by iron(II) oxidizing bacteria at the bottom of the ocean. Similar kinds of processes might be at work on the SSGB but this remains a hypothesis.

The SSGB's preservation team is committed to sustainability, aiming to minimize energy consumption. Therefore, optimizing the storage conditions of the ship is crucial to ensure her preservation for future generations. Learning more about how to protect this icon will help ensure not only the legacy of the SSGB, but also help us understand how to protect other large heritage objects (e.g. Mary Rose) and other man made iron objects like wind turbines that are going to play such a vital role in a green future.

## Project Aims and Methods

This **interdisciplinary** project will combine laboratory based **microbial cultivation** experiments with **computational modelling** to establish the most suitable conditions for ensuring the legacy of the SSGB. The initial focus will be on microbial iron redox cycling which represents a possible metabolic pathway for bacteria in the cracks and crevice's of the ship. Supported by a range of analytical techniques, the candidate will consider what type of transformation products, result from microbial iron cycling and determine how these can be stopped. The student will focus on:

- Investigating the role of bacteria on the ships corrosion, designing laboratory experiments to simulate the current conditions of the ship.
- Mapping out corrosion of the ship using state of the art analytical instruments e.g. XRF.
- Use modelling and data analysis to investigate how the flow of air around the ship is creating pockets of refuge for microbially induced corrosion.

## Candidate

This project is suitable for a student passionate about the intersection between environment, engineering and history. The student will have a background in environmental science, chemistry (bio)geochemistry, or another Earth Science related field (preferably to MSc-level). Highly motivated multi-disciplinary students from other backgrounds will also be considered. The work will involve the planning, setup and running of experiments under the supervision of the supervisors including data analysis, presentations in group seminars and at conferences, as well as writing of publications together with supervisors. The PhD student will be sent on relevant training workshops to learn new techniques where appropriate. We welcome and encourage student applications from under-represented groups. We highly value a diverse research environment.

## Project partners

This project will take advantage of world leading research happening within the Schools of Earth Science, and Engineering. The SSGB will collaborate on the project, providing access to the ship, details about its history and enabling sampling of corrosion products. Collaboration with additional trusts involved in conservation efforts is expected, in order to further develop the research and enable translation of key findings.

## Training

The student will be trained in a range of laboratory-based techniques including mineral synthesis, microbial cultivation, geochemical measurements and analytical methods including Mossbauer spectroscopy, FTIR, and electron microscopy. Training in scientific computing will also be available. They will be encouraged to participate in training courses and be able to access training opportunities from Bristol such as lectures within BSc/MSc courses. Funding is provided for the student to present their research at a high-profile international conference and will be encouraged to apply for grants that support further travel opportunities.

## Background reading and references

https://www.ssgreatbritain.org/
https://www.bristol.ac.uk/earthsciences/research/marine-and-terrestrial-environments/

## Useful links

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

## Eligibility

UK and International students are eligible for a University of Bristol Scholarship. UoB Scholarships are fully funded for 4 years and cover university fees, living expenses at the UKRI standard rate, and an allowance of £2100 per year towards research expenses.