University of St Andrews

UNIVERSITÄT BONN

Global Phd Scholarship – St Andrews and Bonn

A new proxy for ocean circulation and its impact on rapid climate change

Project description

The Atlantic meridional overturning circulation (AMOC) plays a fundamental role in transporting heat from the tropics to NW Europe. The finding that AMOC can rapidly weaken, resulting in major cooling in the Northern Hemisphere, remains one of the most fascinating yet enigmatic results in the study of past climates, with critical lessons for our rapidly warming world. The potential impacts of a future shutdown in Atlantic overturning are closely informed by these changes in the past, as recently highlighted in the IPCC's AR6. However, despite its critical importance, our ability to reconstruct past changes in ocean circulation remains rudimentary.

To advance our understanding of changing ocean circulation and its impact on the carbon cycle and climate, we need new ways of reconstructing past ocean circulation. In this project we will develop a brand-new circulation proxy, based on redox sensitive elements in fossil foraminifera shells, which can vary based on the strength of the circulation. Preliminary data highlight the potential to obtain a remarkably clean and coherent record of change of overturning circulation over rapid millennial climate change events, supporting the use of this novel proxy.

This PhD project will use both new geochemical measurements and novel modelling approaches to probe the potential of this proxy for ocean circulation.

A first step will be the creation of a test dataset in modern samples. Sites have been chosen to span a wide range of current speeds and sedimentary redox conditions and have nearby geochemical measurements in bottom waters. The student may also have the option to supplement these data by participation in a research cruise. In parallel, we will compare these redox sensitive elements in sediments with additional elements (e.g. Si, Al, K) that we predict will undergo some shared and some distinctive sedimentary processes. This, alongside sequential leaching and in situ analyses of foraminiferal shells, will allow us to better constrain the processes leading to enrichment of redox sensitive elements in shells.

To build a quantitative understanding of the operation and limitations of the proxy, the project will then examine the controls on redox sensitive elements in a sediment biogeochemistry model. This is a well-established tool for the examination of sedimentary element cycling and will be expanded to incorporate novel elements. Having established a robust framework of understanding, we will then apply this exciting new tool to address fundamental questions about the control of ocean circulation on CO_2 and climate. An initial target will be the rapid climate and CO_2 change events of the last ice age, although there will be flexibility to pursue topics of greatest interest to the successful student.

The project will be managed jointly between the School of Earth and Environmental Sciences at St Andrews and the Institute for Geosciences at Bonn. The student will be supervised by Dr James Rae and Dr Andrea Burke (St Andrews) and Prof. Dr. Christian März (Bonn).

Informal enquiries regarding this scholarship may be addressed to the co-supervisors:

- **Dr James Rae:** jwbr@st-andrews.ac.uk
- **Dr Andrea Burke:** ab276@st-andrews.ac.uk
- **Professor Christian März:** cmaerz@uni-bonn.de

For further information, please visit Joint Doctoral Program St Andrews and Bonn and Global Doctoral Scholarships – St Andrews and Bonn.

Application deadline: March 31, 2023