PROJECT TITLE: Biogeochemistry of a subterranean estuary and fluxes of solutes and nutrients to coastal waters in the Northern Bahamas.

University of Bristol Research Theme(s): Climate/Environment,

Lead Supervisor: Prof. Fiona Whitaker, School of Earth Sciences, University of Bristol
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Project keywords: subterranean estuaries; submarine groundwater discharge; groundwater biogeochemistry; carbonate island aquifers; Bahamas

Project Background: In areas of permeable bedrock, the subterranean estuary plays a critical role in controlling the discharge of fluid and terrestrial solutes to coastal oceans via submarine groundwater discharge (SGD), with profound impacts on benthic primary productivity, algal blooms and ocean acidity. These coastal aquifers are characterised by steep gradients in salinity and redox that drive a range of reactions and nutrient transformations. Much prior work has considered the physical hydrology of idealised aquifer systems and focussed on the effects of density and tides, whilst the effects of aquifer heterogeneity and of episodic and longer-period forces remain poorly understood. Physical studies have remained largely decoupled from geochemical work that is required to understand freshwater contributions to coastal nutrient budgets, and even less is known about the reaction dynamics of marine-derived solutes circulating through the near shore aquifer that return to the ocean.

Project Objectives and Approach: This study will adopt a multidisciplinary approach to unravel interactions between groundwater flow, biogeochemistry, and reaction dynamics in the coastal carbonate aquifer on North Andros Island in the Bahamas.

The biogeochemistry of groundwaters will be characterised across the northern part of the island using samples from a suite of research wells that penetrate through the fresh-salt water mixing zone into the underlying saline zone. These will be compared to samples of SGD from creeks and caves and via seepage in the offshore sediments, comparing the barrier-reef fringed east coast and the more restricted west coast. This data will be used to parameterise reactive-transport simulations of mixing, organic matter remineralisation and water-rock interaction using TOUGHREACT at a range of scales.

Combining these approaches will enable the student to unravel the influences of meteoric and sea water composition, organic matter inputs, and hydrogeological characteristics of the aquifer on biogeochemical processes within the subterranean estuary. The resulting understanding of spatial heterogeneities and temporal dynamics in the magnitude of solute and nutrient fluxes to the coastal ocean will allow upscaling of data to generate estimates of SGD discharge in tropical coastal carbonate systems and contribute to sustainable management of coastal water resources under the influence of anthropogenic and climate changes.
**Candidate requirements:**
This project requires a student with an undergraduate degree in environmental science, geology, chemistry, or a related discipline. Some experience in the collection and analysis of water samples and/or the use of coupled models to simulate subsurface flow/geochemistry would be beneficial but not essential. The candidate must be prepared to undertake fieldwork in physically challenging conditions in the Bahamas.

**Project partners (if any):**
Bahamas Department of Environmental Planning and Protection

**Training:**
Training will be provided in the field and laboratory biogeochemical techniques, analysis of samples and evaluation of resulting datasets, including the use of TOUGHREACT to simulate coupled subsurface processes. You will have the opportunity to undertake fieldwork on North Andros, and work as part of a collaborative team of PhD and Masters students spanning aquifer geology, hydrology, hydrogeophysics and isotope geochemistry.

**Background reading and references:**


**Useful links**
http://www.bristol.ac.uk/earthsciences/courses/postgraduate/

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

The application deadline is Monday 14 February 2022 at 2359 GMT.

Interviews will take place during the period 10 March – 18 March 2022.

**General Enquiries:**
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Northern North Andros Study Area