THE UNIVERSITY OF OXFORD
DEPARTMENT OF

# EARTH SCIENCES MAGAZINE

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UNIVERSITY OF OXFORD

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EXPLORING THE QUATERNARY MERCURY CYCLE

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FROM 60 DEGREES SOUTH TO 60 DEGREES NORTH – A TALE OF TWO RESEARCH CRUISES

# WELCOME

## TO THE OXFORD EARTH SCIENCES ALUMNI MAGAZINE

### MIKE KENDALL - HEAD OF DEPARTMENT

Dear Alumni,

The 2024-25 academic year is off to a great start. Back in October we welcomed a brand-new cohort of undergraduate and postgraduate students who have settled in quickly and thrown themselves into department life. Field courses continue to be a highlight of the academic year, with successful trips to Bermuda, Greece, Dorset and Pembrokeshire in the Autumn, and many more upcoming. Our undergraduate student numbers have grown modestly thanks to the creation of a new tutorial fellow position at St. Hugh's.

The department has recently invested time in recruiting DPhil students, and as a result the number of applications has increased three-fold compared to last year. We are excited by this trend, which shows greater interest in our cutting-edge research. Our DPhils contribute massively to the department and the prospect of a larger cohort should mean more exciting outputs in the coming years. Funding these projects continues to be a challenge, which we are keen to meet through industrial sources and donations.

As well as new tutorial fellows, we are recruiting new Associate Professor posts in Environmental Geophysics, Climate Sciences and Natural Resources Innovation. These positions reflect our strategic goals to work on some of societies most pressing problems, and showcase how Earth Sciences is at the heart of their solutions.

The Department is leading a new £3.4 million initiative funded by the University called Oxford EARTH. This will involve research in the area of sustainable resources to aid the transition to net zero. The generation, storage and transmission of renewable energy places demand on critical raw materials, and the challenge is to find sufficient supplies to meet this demand. The multidisciplinary programme team includes individuals from nine departments/faculties across two divisions.

I am pleased to say that members of our department continue to be recognised by national and international awards, including Ros Rickaby, who was appointed an OBE, Tamsin Mather, who was elected Fellow of the Royal Society, David Pyle, who was awarded the Murchison Medal from the Geological Society, Erin Saupe, who received the Schuchert Award from the Palaeontological Society and Lot Koopmans, who was awarded an MPLS Teaching Award.

Our outreach initiatives are going from strength to strength, and we have worked with over 3,000 students across Oxfordshire in the past couple of years, plus many more from around the UK. I am pleased to see us leading the way in our involvement in the Oxplore festival, which aims to prevent children from low income areas disengaging with science during Year 7 and 8.

I look forward to seeing many of you at this year's alumni dinner in April.

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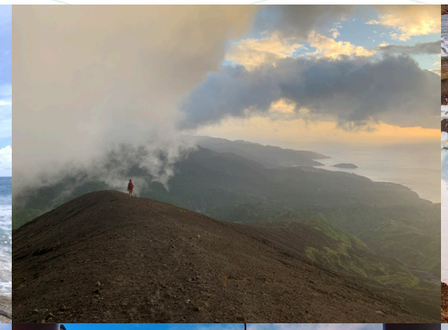
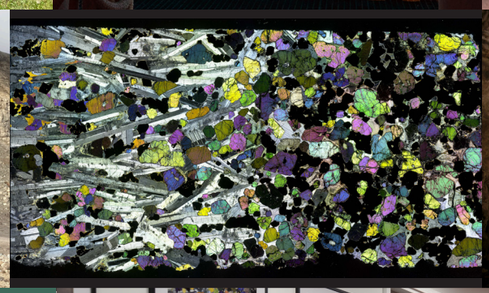









*The corridor on Floor L2 has had a makeover! The 10 winners of the departmental photo competition have had their pictures framed and displayed on the walls outside the meeting rooms. Congratulations to: (front cover) Cathy Baldwin, (above, left to right, top to bottom) Zoe Guy, Bei Bei Morrison Evans, Benedict Schofield, Haleema Khan, Max Wylder, Stuart Robinson, Elena Melekhova, Lot Koopmans and Marin Mag.*

*Photo competition winners*

# RESEARCH NEWS

For all the latest Oxford Earth Sciences Research News, visit www.earth.ox.ac.uk/news

## NEW ARCHIVE OF ANCIENT HUMAN BRAINS CHALLENGES MISCONCEPTIONS OF SOFT TISSUE PRESERVATION

Soft tissue preservation in the geological record is relatively rare, and, except where deliberate intervention halts the process of decay (like embalming or freezing), the survival of entire organs is particularly unusual. The spontaneous preservation of the brain in the absence of any other soft tissues – that is, the brain's survival amongst otherwise skeletonised remains – has historically been regarded as a 'one-of-a kind' phenomenon. A new study, led by DPhil student Alexandra Morton-Hayward, has challenged previously held views that brain preservation in the archaeological record is extremely rare. The team compiled a new archive of preserved human brains comprising over 4,000 specimens, which highlighted that nervous tissues actually persist in much greater abundances than traditionally thought, assisted by conditions that prevent decay. This global archive, drawing on source material in more than ten languages, represents the largest, most complete study of the archaeological literature to-date, and exceeds 20-fold the number of brains previously compiled.

*The 1000-year-old brain of an individual excavated from the c. 10th Century churchyard of Sint-Maartenskerk (Ypres, Belgium). The folds of the tissue, which are still soft and wet, are stained orange with iron oxides. (Image Credit: Alexandra Morton-Hayward).*

## STRESS MAPPING REVEALS SECRETS OF COUPLED SUPRAGLACIAL LAKE DRAINAGES BY HYDRO-FRACTURE

A new study, led by Associate Professor Laura Stevens, has mapped stress evolution during supraglacial lake drainages, revealing a physical explanation for what causes these lakes to drain via hydro-fracture. Greenland, home to the second largest ice sheet in the world, is particularly vulnerable to present-day climate change. Throughout the summer season, the ice surface melts and this water collects in topographic lows on the surface of the ice sheet, forming huge bodies of water referred to as "supraglacial lakes". Around 70–90% of supraglacial lakes either refreeze at the end of the summer, or drain via channels over the ice-sheet surface. The rarer (and somewhat cinematic) phenomenon is where kilometre-scale fractures form across the lake, and the water in the lake drives these fractures down through the ice sheet, draining the lake rapidly all the way to the bedrock. Known as "hydro-fracture", this process can empty lakes more than three kilometres across in a few hours, like pulling the plug from a sink. Since the first observations of hydro-fracturing lakes, scientists have been puzzled by the processes which trigger these rifts in the ice. This new study, which made use of Global Positioning System (GPS) data from sensors circling a cluster of supraglacial lakes, in addition to satellite imagery, to map tensile stress in the local area, found that by far the biggest influence on the ice stress state during drainages was the formation and migration of kilometre-scale blisters of water beneath the ice sheet. The blisters force the overlaying ice upwards, which causes the ice surface to crack.

*Neighbouring supraglacial lakes on the western margin of the Greenland Ice Sheet exhibit stress coupling during rapid drainage events (Image Credit: Laura Stevens).*

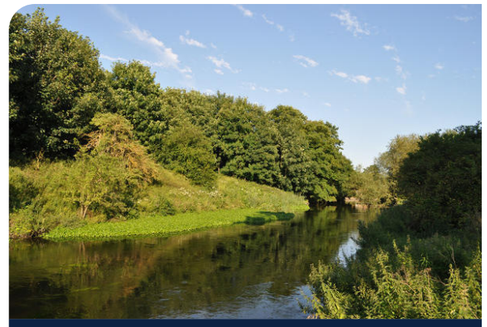
## GOLDEN BUGS: SPECTACULAR NEW FOSSIL ARTHROPODS PRESERVED IN FOOL'S GOLD

A team of researchers led by Associate Professor Luke Parry have unveiled a new 450-million-year-old fossil arthropod from the Ordovician Period. The specimens, detailed in a new publication for the journal Current Biology, are spectacularly preserved in 3D by pyrite, giving them a beautiful gold appearance. The new fossil, named Lomankus edgecombei, after arthropod expert Greg Edgecombe of London's Natural History Museum, belongs to a group called megacheirans, an iconic group of fossil arthropods with a large, modified leg (called a "great appendage") at the front of their bodies that was used to capture prey. Megacheirans like Lomankus were very diverse during the Cambrian Period but were thought to be largely extinct by the Ordovician Period, when this new fossil was preserved. Today, there are more species of arthropod than any other group of animals on Earth. Part of the key to their success is their highly adaptable head and its appendages that performs many functions, like a biological Swiss army knife. These can include sensing the environment and feeding. While other, older megacheirans used the great appendage for capturing prey, in Lomankus the typical claws are much reduced, with three long and flexible whip-like flagella at their end. This suggests that Lomankus was using this frontal appendage to sense the environment, rather than to feed, indicating it lived a very different lifestyle to its more ancient relatives in the Cambrian Period. This discovery offers important new clues towards solving the long-standing riddle of how modern-day arthropods evolved the appendages on their heads.


*The holotype specimen of Lomankus edgecombei. Photograph at left, other images at right are 3D models from CT scanning. Image Credits: Luke Parry (photograph), Yu Liu, Ruixin Ran (3D models).*

## NEW COMPUTATIONAL METHOD COULD PROVE GAME-CHANGER IN TRACKING DOWN RIVER POLLUTERS

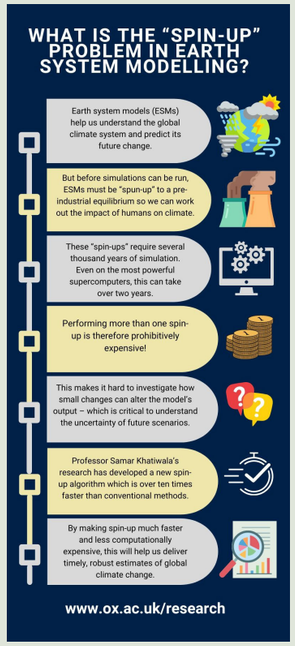
A new computational method developed by Dr Alex Lipp uses an innovative new technique to track down the sources of river pollutants. Recent months have seen national outcry over water companies allowing sewage pollution in rivers to breach acceptable limits. Combined with pollution from agricultural fertilisers and chemicals, this has led to only 14% of rivers in England currently meeting 'good' ecological status. But to date, there has been no robust method to identify the likely sources of river pollution, making it almost impossible to effectively address the problem. Alex's new method utilizes 'inverse modelling' to work backwards from observations of pollution in rivers, tracing them back to the probable source and providing a simple approach that could be scaled up nationwide. In a case study, the model identified the source of a harmful neonicotinoid pesticide – banned for agricultural use – in a rare chalk stream habitat.



*River Wandle (Image Credit: stevekeiretsu, Flickr).*

## NEW COMPUTER ALGORITHM SUPERCHARGES CLIMATE MODELS AND COULD LEAD TO BETTER PREDICTIONS OF FUTURE CLIMATE CHANGE

Earth System Models – complex computer models which describe Earth processes and how they interact – are critical for predicting future climate change. By simulating the response of our land, oceans and atmosphere to manmade greenhouse gas emissions, these models form the foundation for predictions of future extreme weather and climate event scenarios, including those issued by the UN Intergovernmental Panel on Climate Change (IPCC). However, climate modellers have long faced a major problem. Because Earth System Models integrate many complicated processes, they cannot immediately run a simulation; they must first ensure that it has reached a stable equilibrium representative of real-world conditions before the industrial revolution. Without this initial settling period – referred to as the "spin-up" phase – the model can "drift", simulating changes that may be erroneously attributed to manmade factors. Unfortunately, this process is extremely slow as it requires running the model for many thousands of model years which, for IPCC simulations, can take as much as two years on some of the world's most powerful supercomputers. However, a study by Professor Samar Khatiwala has described a new computer algorithm which can be applied to Earth System Models to drastically reduce spin-up time. During tests on models used in IPCC simulations, the algorithm was on average 10 times faster at spinning up the model than currently-used approaches, reducing the time taken to achieve equilibrium from many months to under a week. Currently, the lengthy spin-up time of many IPCC models prevents climate researchers from running their model at a higher resolution and defining uncertainty through carrying out repeat simulations. By drastically reducing the spin-up time, the new algorithm will enable researchers to investigate how subtle changes to the model parameters can alter the output – which is critical for defining the uncertainty of future emission scenarios.




*The Spin-Up Problem in Earth System Modelling (Image Credit: Caroline Wood).*

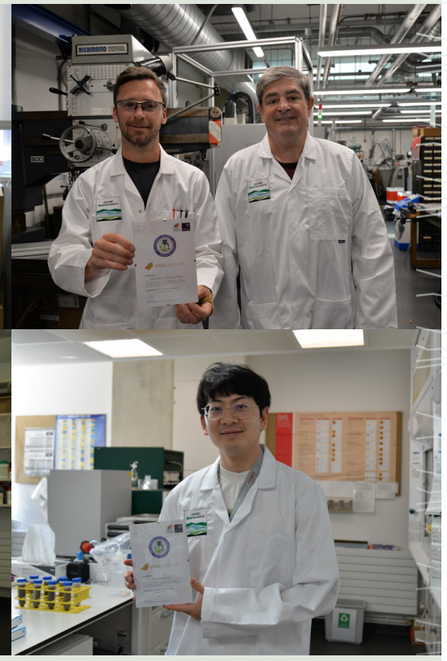
# DEPARTMENT NEWS

## CHAMPIONING LAB SUSTAINABILITY

We are proud to announce that this year six Earth Science facilities received a LEAF Award for sustainable laboratories, of which four were certified as Gold standard. The LEAF (Laboratory Efficiency Assessment Framework) awards are an innovative scheme created to drive improvements in laboratory efficiency. Labs across the University undergo self-assessment and peer review. Participants complete a set of criteria to reach Bronze, Silver or Gold standard, and can estimate the carbon and financial savings their actions have achieved. This work is incredibly important, as laboratory buildings are responsible for over 60% of total energy consumption and carbon emissions across the University. Successful labs were the Rickaby & Cosmidis Labs (Gold), Wet Chemistry Lab (Gold), Oxford Earth Sciences Workshop (Gold), Water Geochemistry & Trace Element ICP-MS SRF (Gold), Rock Preparation Labs (Bronze) and Clean Suite SRF (Bronze).

The Department was also awarded a Gold level in the University's Green Impact Awards. Green Impact is an award-winning programme that breaks down the often complex world of sustainability into practical steps that staff and students can take to improve sustainable practice within their building, department or college. This award recognises the hard work of the Buildings and Facilities Team, with help from technical staff across the Department, in their endeavours to make the Department more sustainable.





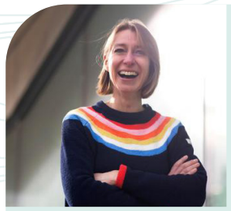
## THE DEPARTMENT WELCOMES PARAMOUNT+ SERIES *THE AGENCY*

The Department was transformed into the fictional *Institute of Geophysics at the London School of Sciences* in August for the Paramount+ series *The Agency*. The show, based on the French espionage thriller *Le Bureau des Légendes*, counts George Clooney amongst its producers, and number of famous faces are featured in the cast, including Michael Fassbender, Jodie Turner-Smith and Jeffrey Wright. A film crew filmed a number of scenes throughout the building, including the atrium, elementary lab, numerous offices, and the analytical labs. They even featured some details on Distributed Acoustic Sensing (DAS), an optic fibre seismic wave detecting technique used by some of the researchers in our Department. You can watch the full show on Paramount+ (and catch our big moments in Episodes 4, 5, 7 and 9)!



# FOR THE RECORD

## RECENT AWARDS



### Ros Rickaby – OBE

Professor Ros Rickaby, marine biogeochemist and Chair of Geology in the Department of Earth Sciences, has been appointed Officer of the Order of the British Empire (OBE) by His Majesty the King for her services to Biogeochemistry. Ros joined the University of Oxford in 2002 and has been a Professor of Biogeochemistry since 2010. For the past 30 years, Ros' research has utilised the past co-evolution of life, environmental chemistry, and Earth's climate to inform predictions of future change. Her passion for the natural world has been an enduring theme of Ros' work, and she has spent time on various conservation projects, even volunteering as a penguin carer in the Boston Aquarium during her time at Harvard. Ros has pioneered an interdisciplinary blend of Biology, Geology and Chemistry to define the evolving role of mineralising phytoplankton in driving climate. Her research has unravelled the interplay between their adaptation and the carbon cycle over timescales ranging from hundreds to millions of years. Throughout her career, Ros has been committed to investigating climate solutions, and is currently researching methods to sequester carbon within the natural system and mechanisms to direct finance towards climate and sustainability goals, acting as a technical advisor to the Global Returns Project.

### Erin Saupe - Schuchert Award

Professor Erin Saupe was the recipient of the 2024 Schuchert Award, presented by the Paleontological Society annually to a member early in their career whose work reflects excellence and quality. Professor Saupe works at the heart of palaeobiology research here in the Department of Earth Sciences. Her research centres around investigations of the interactions between life and environments over geological timescales, addressing fundamental questions on the origin, maintenance and conservation of biological diversity. Erin leads the Saupe Lab, an exciting community of researchers who utilise a broad tool-kit of investigative methods to delve into the field's most exciting questions. A large part of Erin's research aims to integrate biological data with information from the fossil record to elucidate the controls on community and species' responses to environmental change. Highlights of her work to-date include examination of why diversity is higher in the tropics, how diversity has varied over Earth history, and whether species' abiotic tolerances change over long timescales. Professor Saupe also contributes significantly to the Department's Equality, Equity, Diversity and Inclusion Initiatives, serving as Chair of the EEDI Committee.

### Lot Koopmans – MPLS Teaching Award

The Mathematical, Physical, and Life Sciences (MPLS) Division each year celebrates the innovative teaching practices across all career stages with its Teaching Awards. One of this year's winners was Lot Koopmans, a DPhil in the Department of Earth Sciences. Lot received 22 nominations from staff and students, all of which were endorsed by the Department. Many of Lot's nominations noted how Lot goes 'above and beyond' for students, after stepping in to cover while another member of staff is on sabbatical. Students and staff really value Lot's enthusiasm and willingness to take the time to help break down complicated topics, describing him as a kind, patient, and approachable teacher. Various nominations also mentioned Lot's significant contributions to Earth Sciences field trips and his supervision of Masters students. Many of the nominations noted how Lot goes far beyond what is usually expected of a graduate student and how his dedication to students is both impressive and admirable. Students described Lot as a 'great teacher' and 'a joy to learn from'.

### Tamsin Mather – FRS

We are incredibly proud that Professor of Earth Sciences Tamsin Mather has been elected a Fellow of the Royal Society. The Royal Society is the UK's national academy of sciences and the oldest science academy in continuous existence and each year elect new Fellows who have made "a substantial contribution to the improvement of natural knowledge, including Mathematics, Engineering Science and medical science". Tamsin's research interests centre on the science surrounding volcanoes and volcanic behaviour. Her expertise spans Volcanology and magmatism, Atmospheric Chemistry, and Palaeoclimatology; a diverse skillset which allows her to tackle questions surrounding the role of volcanism as a local to planetary-scale driver of environmental change (and stasis) throughout Earth's history in novel ways. Tamsin has also applied her extensive experience to further our understanding of volcanic eruption patterns and precursors, the hazards resulting from volcanism, and the potential of volcanoes as a resource of both power and critical metals. Alongside her impressive research career, Tamsin has contributed significantly to a range of science advisory and communication activities, and has been a champion for Equality, Diversity and Inclusion (EDI), leading the Department's Athena SWAN submission in 2016.

### David Pyle – Murchison Medal

Congratulations to Oxford Earth Sciences faculty member Professor David Pyle, recipient of the 2024 Murchison Medal. This accolade was presented to David by the Geological Society of London for his considerable contributions to the field of Volcanology. The Murchison Medal is awarded to geologists who have contributed significantly to 'hard' rock studies, and was established under the will of Scottish geologist Sir Roderick Impey Murchison (1792-1871), who first described the Silurian and Devonian successions in Britain. David is an internationally recognised volcanologist who has made outstanding contributions to understanding volcanic deposits and processes. He was awarded the accolade for his decades of research using pioneering methods to characterise and classify tephra fall deposits and infer erupted volumes. Highlights of David's work include his research on the frequency and triggers of eruptions, the geochemistry of gas emissions, the effects of volcanism on climate, environment and society, and on understanding volcanic risk. He is also involved in many public engagement projects and was the first Academic Director of Oxford's Doctoral Training Partnership in Environmental Research from 2013-2022.

# FROM 60 DEGREES SOUTH TO 60 DEGREES NORTH - A TALE OF TWO RESEARCH CRUISES

SARAH LE BESQUE, DPHIL STUDENT

Jacques Cousteau said "The sea, once it casts its spell, holds one in its net of wonder forever". I am well and truly captivated by our oceans, enough so to pursue a career studying them. Throughout my DPhil, I have participated in sea voyages, and assisted in improving our understanding of the dynamics of our oceans, all the way down to the tiny algal cells that help regulate our atmosphere.

## Introduction

Since the industrial revolution, the ocean has stored approximately 30% of the anthropogenic $CO_2$ (Gruber et al., 2019). Part of this oceanic storage of carbon is driven by the biological carbon pump (BCP), wherein phytoplankton photosynthesise, storing carbon within themselves, and potentially sinking to the ocean interior.

The efficiency of the BCP to transport carbon from the surface ocean to the interior depends partly on the community structure of phytoplankton (their abundance and diversity). The presence of certain phytoplankton can change the export efficiency of carbon to the deep ocean. For example, diatoms are large phytoplankton that use silicate to form their cells, increasing the organism's mass, and thus increasing its likelihood of being exported to depth.

My research aims to investigate how the phytoplankton community structure changes under different environmental conditions, because different phytoplankton have different requirements. Larger cells can be considered the "Goldilocks" of phytoplankton, requiring ample nutrients to maintain their cellular functions, as well as the light to be sufficient. We therefore find larger phytoplankton in nutrient rich coastal areas or upwelling zones, while smaller cells dominate the tropical gyres of our ocean.

But how will phytoplankton communities shift in a changing climate?

One study that models the link between climate and the BCP suggests that the doubling of atmospheric $CO_2$ would see a potential increase in the productivity of phytoplankton by up to 40%, resulting in more carbon export (Schippers et al., 2004). Conversely, the impact of increased heating of the surface ocean could prevent mixing of nutrients from the interior ocean to the surface, reducing phytoplankton productivity, and therefore export (Beardall et al., 2009).

We can measure the elements of the BCP using a combination of automated underwater vehicles and floats, satellites, and ocean models. However, these methods all need validating using in-situ observations. While boat work is costly, the data is invaluable to measure the complexities of the BCP.

## My First Expedition

This has led me to the rite of passage many early career oceanographers get to experience: an offshore boat expedition.

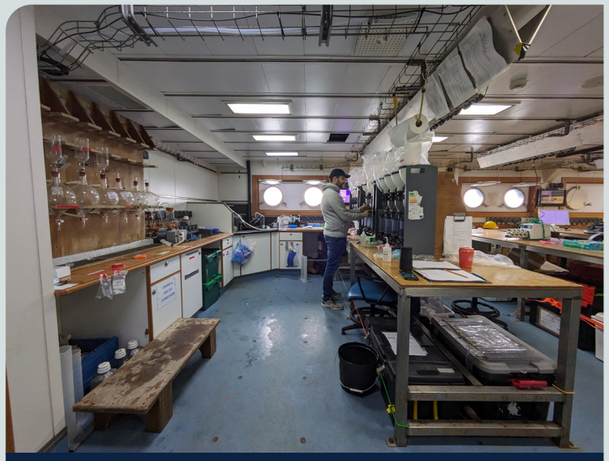
The first project I was involved with was "new Perspectives on Ocean Photosynthesis" (nPOP) aboard the RRS Discovery to the Southern Ocean during January 2024. This voyage sailed from South Africa, heading South to the High Nutrient, Low Chlorophyll (HNLC) region of the Southern Ocean at 60°S, before traversing north towards the South Atlantic Sub-Tropical Gyre at 35°S. Along the latitudinal transect, we saw a huge range of environmental regimes, from iron limited HNLC waters to the nitrate limited waters of the gyre. With these different nutrient conditions, we saw variations in the community structure, from larger cells further south and a more diverse community, to smaller cell dominated regimes north. We were offshore for 5 weeks, with no land in sight, but plenty of Pilot Whales and even some rogue icebergs!

*Photos taken on the nPOP voyage. An iceberg (top), pilot wales (left) and Sarah on the RRS Discovery (right).*

## To the North Atlantic

I was then fortunate enough to be invited to sail on the RRS James Cook for the IDAPro project ("Integrating Drivers of Atlantic Productivity") autumn expedition to the North Atlantic – part of the broader project called BIO-Carbon. During this expedition, we were sampling at the locations of various autonomous vehicles in the Icelandic Basin. We did this to use the in-situ samples to validate the floats that would be sampling over winter - a time of year where it is difficult to collect continuous boat samples due to rough seas. However, as the IDAPro cruise took place during autumn, the science was often interrupted by storms – leading to trips to the sauna onboard to pass our downtime!

## Experimental Procedures

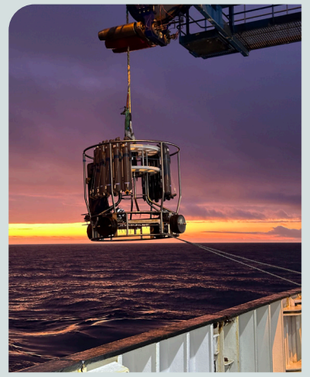


*The deck lab on the RRS Discovery with various filtration rigs set up. Photographed is Declan Proctor – PhD student at the University of Southampton.*

My main role on the research vessels was filtering seawater through glass fibre filters to collect the particles in the water column which can be processed in various ways to indicate the composition of this particulate matter. One component of the sample material is phytoplankton and we collected samples for analysis by High Performance Light Chromatography (HPLC) to measure the concentration of different photosynthetic pigments, and for Particulate Absorption Spectra analysis (PABS). Both of these can inform us about the phytoplankton community structure of these samples due to their photosynthetic properties. Throughout the two cruises, I filtered thousands of litres of water in what we called the deck lab and was surrounded by a permanent puddle of water.

The water was collected by two methods: the CTD (Conductivity, Temperature, Depth) rig which has large Niskin bottles attached to collect the water at chosen depths in the water column and is deployed over the side; and through the ship's Underway water system – essentially a pipe that connects the ocean to a tap in the lab.

Another of my responsibilities was the preservation of water samples for analysis by the CytoSense instrument. This is a specialised flow cytometer that counts photosynthetic cells by measuring their fluorescence and scattering properties, indicating the phytoplankton groups present. On the nPOP cruise, I brought the CytoSense aboard, and measured the community structure in real time to show how the phytoplankton communities were shifting as we traversed different environmental regimes.

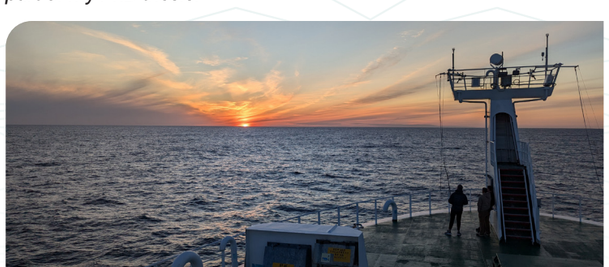


*Collecting Samples. The CTD being deployed at sunrise (left) and Sarah sampling from the CTD (right).*

## Final Thoughts

My time at sea has been the highlight of my research career so far - to be surrounded by ocean specialists, to learn from them, and feel their equal, is an incredible experience. Within the space of a year I have sampled the seas at both 60°S and 60°N, officially earning my sea legs. I have found my place at sea and will continue to travel the ocean waves, doing what I can to contribute to our understanding of our formidable and mysterious oceans.

*With special thanks to the Burdett Coutts Foundation, The Challenger Society for Marine Science, and St John's College, Oxford, the nPOP project, and IDAPro project for contributing to my expenses to join the expeditions. The data collected during this voyage will be used as part of my PhD thesis.*



*RRS James Cook at sunset (Image Credit: Arianwen Herbert).*

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# PROTECTING CORAL ATOLLS FROM SEA LEVEL RISE WITH HYDRAULIC UPLIFT

CLAUDIA BERTONI, VISITING RESEARCHER
RICHARD WALKER, PROFESSOR OF TECTONICS

**Claudia Bertoni and Richard Walker report on an ongoing project to assess the potential for hydraulic uplifting of low-lying coral atolls to partly counter projected sea-level rise.**

Climate change is causing rising sea levels that put low-lying island nations at risk, and even small relative increases can have large repercussions from inundation during storms. We are currently involved in an industry-academia joint project assessing the potential to locally raise populated coral atolls through the injection of sea-water into deep parts of the sedimentary sequence.

*A disappearing island. Tuvalu's Foreign Minister Simon Kofe gives a COP26 statement while standing in the ocean in this handout picture taken in Funafuti, Tuvalu, November 8, 2021. Image Credit www.reuters.com.*

The project, funded through the Norwegian Space Agency, and coordinated by the georesources company Ruden AS, is at a feasibility stage and hopes to contribute towards the urgent need to mitigate against sea-level changes in low-lying regions through a case study in Funafuti, Tuvalu.

## Background: 1896-1898 Expedition

An essential component of the study is to assess the porosity and permeability of the sedimentary bedrock in coral atolls, which requires knowledge of the subsurface. In this effort we were aided by the findings of the Royal Society Coral Reef Expedition to Funafuti (Tuvalu), which occurred over several visits between 1896 and 1898. The costly expeditions were undertaken to test Darwin's idea that coral atolls in the ocean interiors form above slowly subsiding islands.

The project was initially led by Professor William Sollas, soon to make his move to Oxford, and then by the Australian-Welsh Professor Edgeworth David, from the University of Sydney, who had been an Oxford alumnus himself. Sollas and David organized multiple expeditions to Funafuti, the largest atoll in Tuvalu, chosen for its ideal structure and accessibility. Using hand-drilling techniques and early mechanical drills, the team bore into the coral reef to depths exceeding 1000 feet (300 meters). These efforts were physically demanding and technologically challenging for the time.

Though they failed to reach the underlying volcanic rocks, the expedition nonetheless returned with valuable core samples from depths of over 1000 feet, and confirmed Darwin's predictions. Coral and limestone layers extended far below sea level, providing evidence that the atoll had formed on a sinking volcanic base. Later seismic surveys indicated that the old volcano, on top of which the lagoon has been built, lies some 600 m beneath the waves. The absence of non-marine sediments further confirmed that the structure was formed in a continuously submerged environment, aligning perfectly with Darwin's subsidence theory.

The Funafuti Coral Reef Boring Project was among the first major scientific efforts to test geological theories through physical evidence. It not only supported Darwin's hypothesis but also paved the way for future studies in oceanography and coral reef science. This work provided critical data that underscored how natural processes, over millions of years, create the intricate and beautiful atoll structures we see today. Funafuti remains a landmark in the scientific exploration of coral reefs and an enduring testament to the power of Darwin's ideas.

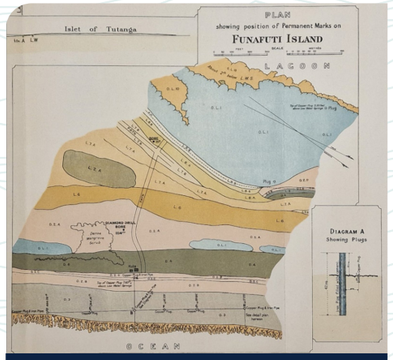
These samples, and the contemporary lithological descriptions, offer important data to help with our new study.


*Commemorative plaque for David's Drill Site, installed at the location of the 'Main Boring' of the Royal Society Coral Reef Expedition to Funafuti (Tuvalu), which reached a depth of 1114 ft in 1898.*

## Finding the Samples

Our search took us first to the Earth Sciences Departmental Library, which holds a copy on its shelves of the report of the Royal Society expedition. The main part of the report was written by the team of Australian Geologists led by David, who performed the third (and by far the most successful) leg of the expedition. The team cheerily relate various near-disasters and adventures rescuing shipwrecked mariners. Importantly for us the book contains beautiful sections, and detailed borehole descriptions. They also describe the treasure trove of samples returned to archives in the UK and New Zealand.

The samples themselves still exist, and are carefully curated within the petrological collections of the Natural History Museum in London. The curator, Aimee Smith, kindly arranged for us to visit in December 2024 and to have a preliminary look through the collections. After spending so long going through the report it felt magical to finally be holding the actual rocks in our hands, and it was a clear demonstration of the importance in keeping sample collections safe for when need arises (in this case over a century after they were first collected and analysed).




*Geological map of part of the Funafuti atoll, published in Armstrong et al. (1904).*

The samples we have seen so far are only a small part of the core, with potentially much more held in the NHM storage facility in Wandsworth. With Aimee's help we are planning a visit to the storage facility in 2025. Until then, we are happy to have seen rather porous coral bedrock, and samples of the coarse coralline sand in which it is interbedded.

*Richard and Claudia visit the London Museum to explore the drill core samples.*

**Funafuti 1st boring (C) samples C1-C36.** *This was the first drill site that reached a depth of 105 ft. The samples are composed mostly of weathered coral rubble.*

*Samples from the 2nd boring, which reached 72 ft. The samples are composed mostly of weathered coral rubble.*

## Initial Observations

A remarkable first impression of the Edgeworth cores is the widespread karst/microkarst developments that appears to be widespread over the entire underlying carbonate section. The carbonates have been subject to rather intense dissolution and karst development by carbonic acid ($H_2CO_3$), apparently from rainwater during last glacial maximum (LGM) sea level minima, when the island topography and geometry were rather different and much more extensive than the miniscule remnants we see today. The wide areal extent in the LGM was conducive to karst development, forming connected spaces in the rock facilitating water flow, and potentially creating a high-quality reservoir for geo-engineered storage.

## Assessing the Potential for Hydraulic Uplifting

The use of fluid injection to counter subsidence is not a completely new idea, and shares many of the same geological, engineering, monitoring, and safety considerations encountered in geothermal power exploitation, and the present-day efforts to sequester carbon dioxide through injection into the subsurface (such as the In Salah project in Algeria). There are several examples where fluid injection has been undertaken to cause surface uplift, with resulting uplift from a few millimeters to tens of centimetres in a few cases. One example is Long Beach, California, where a large programme of water injection began in the late 1950s to mitigate coastal subsidence caused by oil extraction. There are also several examples relating to mitigation of land subsidence following depletion of freshwater reservoirs, including Tokyo where a subsidence of 4.5 m took place between early 1920s and 1999. Finally, in Venice, where the world heritage site is threatened by flooding events, a pilot study has been performed to assess potential to uplift a large part of the Venice lagoon by seawater injection. As a summary of all the cases reviewed in the project, surface ranged from few millimeters to 35 cm, and the time scale of the injection process spanned years to a few decades.

Based on these previous studies, our team carried out simulations of 5 different scenarios in Funafuti, considering variable injection depth, physical properties of rocks, and other injection parameters such as pressure. The outputs predict an uplift varying from 3 to 30 cm. The project was also able to highlight best practices for avoiding or minimizing the main risks, which are related to contamination and hydraulic fracture and destabilization of the ground, and for monitoring, including remote sensing. We are hopeful that a next phase will be funded, and will allow validation of these preliminary results, provide new data, narrow down the choice of the geological model and provide 2D and 3D simulations.

*With thanks to Elizabeth Quiroga and Fridtjov Ruden at RudenAS for permission to publish the results of this project, and for their help in writing the article.*

# DEPARTMENT RESEARCH REPORTS

# SEARCHING FOR EVIDENCE OF ANCIENT MAGNETIC FIELDS IN CANADA

CLAIRE NICHOLS, ASSOCIATE PROFESSOR OF THE GEOLOGY OF PLANETARY PROCESSES

In September 2024, a team of geologists met at Heathrow airport with several trolleys-worth of field-gear ready to embark on a long journey to a remote part of the Northwest Territories in Canada. Breathing a sigh of relief as multiple rock drills, power supplies, hammers, chisels and other paraphernalia cleared airport security, we could finally focus on the task ahead. The goal of the project is to uncover the ancient history of Earth's magnetic field and its possible role in the oxygenation of Earth's atmosphere. This is a fairly radical idea – magnetic fields are typically thought to protect planetary atmospheres from change, but recent models and spacecraft observations are challenging that idea. It's now thought that magnetic field lines near Earth's polar regions, rather than reconnecting in the opposite hemisphere, act as motorways into space, facilitating the escape of elements such as hydrogen from Earth's atmosphere. A loss of hydrogen has an oxidizing effect, and so the question we are aiming to answer is: Did the magnetic field play a role in oxidizing the surface of our planet during the Great Oxygenation Event (GOE) 2.5 billion years ago?

To address this question, we need to recover records of Earth's magnetic field prior to the GOE. This time period (the Archean) is inherently challenging to work in; ancient metamorphic rocks have had long and complex histories and their records are often overprinted by extensive deformation, fluid flow and metamorphism. The Northwest Territories are home to some of the oldest, and in some cases well-preserved, rocks on Earth. This is because they host the Slave Craton, a region of anomalously thick lithosphere that has dodged extensive tectonic re-working. This particular craton is perhaps most famous for hosting the Acasta gneiss – the oldest known rock on Earth with a U-Pb age exceeding 4 billion years. The rocks we were after are (relatively) rather young in comparison, with ages between 2.6 – 2.8 billion years. This is a time period we're particularly interested in as it immediately pre-dates the rise in Earth's atmospheric oxygen.

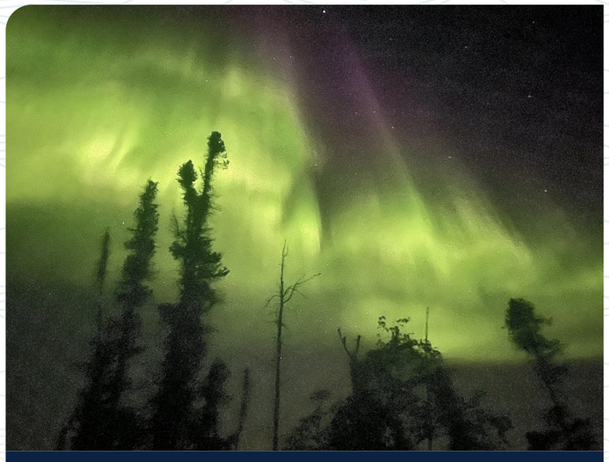
*The field team ready to fly out to the field area. From left to right: Jane MacDonald (PhD student at the University of Cambridge), Claire Nichols (project leader), Darryl (local bear monitor), Redmond Coleman (PhD student) and Joe Lacey (Masters student).*

After arriving in Yellowknife, we met our 'bear monitor' Darryl, from the North Slave Métis Alliance, a society that represents all Indigenous Métis people from the territories. Working with local communities in these regions is absolutely critical – there are significant risks posed by the wildlife (bears, moose, wolves, wolverines), wildfires in the summer and extreme cold in the winter – a rather daunting prospect for a team from Oxford, but just part of everyday life for those who have spent their lives in the region. Equipped with a rifle, survival kit, machete, satellite phone and a large quantity of steak – we immediately felt we were in safe hands with Darryl! The next challenge was getting to our field area. This involved taking float planes to about 30 miles north of Yellowknife, and then clambering into canoes with our gear to find a camp. The land in this region is predominantly made up of lakes and dense forest interspersed with rocky outcrop (thankfully!), so finding anywhere flat and open to set up a camp is challenging. We were fortunate to find a perfect island, around 25 meters in diameter, where we could set up home for the next couple of weeks.

*Carefully documenting the orientation and field-context of each core that we drilled before extracting it to bring back for analysis in the Oxford Magnetism Group laboratory.*

Each day we would use the canoes to paddle to various outcrops surrounding the lake, and collect oriented drill cores and block samples. Knowing the orientation of samples is critical for paleomagnetic research, since this information allows us to verify the age of magnetization and is also used for plate tectonic reconstructions (although that kind of analysis is a stretch with rocks this old). The sampling is labour intensive, and collecting 30 cores can be a very long day's work depending on the terrain and the distance we have to carry the gear. We were primarily focused on sampling banded iron formations, pillow basalts and doleritic sills as these are the most likely to have reliable magnetic carriers within them. Once the samples were drilled, each would be carefully documented so we know exactly where it came from, and how it relates to the surrounding geological features. We collected hundreds of samples during our trip (much to the annoyance of the float plane pilots on the return journey) and had surprisingly few wildlife encounters. We were relieved to discover the haunting call of Loons at night was a bird, rather than a wolf, and a little disappointed to find very fresh moose droppings, but no moose. The bears were also conspicuous in their absence although we did find some magnificently large trout (and failed to catch any for dinner!).

On returning to Oxford, sample analyses have been in full-swing. Joseph Lacey, a current 4th year undergraduate, is looking at these samples for his MEarthSci project. He has been busy preparing core samples to measure on the magnetometer in the Oxford Magnetism Group laboratory. By applying strong alternating magnetic fields, or heating the samples up, he has been gradually removing and measuring their ancient magnetic signals. We're still a few steps away from uncovering the strength of the magnetic field preserved by these samples, and determining whether the magnetic field at this time led to the GOE, but the data so far look tantalizing. If we are able to show the magnetic field played a role, this suggests that magnetic fields may play a slightly different role in planetary habitability than we previously thought. The origins of life require a lack of oxygen, while complex life today requires abundant oxygen; did the magnetic field help to drive this change? Hopefully, soon we will have the answer.



*We were treated to fantastic displays of the northern lights almost every night – a nice reminder of the present magnetic field as we try to uncover its behaviour in the past.*

*Fishing for trout for tea from our camping island.*

*Sampling oriented cores in a pristine platform of banded iron formation. Water has to be pumped continuously through the drill to ensure the cores don't get hot during the sampling process.*

# DEPARTMENT RESEARCH REPORTS

# EXPLORING THE QUATERNARY MERCURY CYCLE

**ALICE PAINE, DPHIL AT OXFORD EARTH SCIENCES (2020 - 2024)**
**CURRENTLY POSTDOCTORAL RESEARCHER AT UNIVERSITÄT BASEL**

Vital elements flow through the atmosphere, oceans, living organisms, and rocks in intricate loops known as biogeochemical cycles. Advances in biogeochemistry have given us new perspectives on the evolution of a range of these cycles. However, little is known about the history of the global mercury (Hg) cycle. Mercury is rare in the Earth's crust and does not blend geochemically with more common elements, meaning it is often found in highly concentrated 'ores' along tectonic boundaries. Gaseous mercury is released into the atmosphere by natural processes such as volcanism, and by human activities. Here it can reside for several years, before being deposited in the terrestrial environment, and actively cycled between the atmosphere, ocean, and lakes[1]. It is an enigmatic substance that has historically fascinated cultures across the world, but also caused immeasurable tragedy when mis-handled; most notable being the Minamata Disaster of 1956. Understanding the sensitivity of the Hg cycle to climate change is therefore critical; not only to constrain the 'natural' Hg cycle, but also to assess the efficacy of recent regulatory actions[2]. However, human activities have altered the Hg cycle to such an extent that using modern instrumental data to study solely climate-driven Hg cycling has become near-impossible. Direct measurements are also only available for a very small window of Earth's history, which is problematic given that processes within the Hg cycle operate over hundreds, thousands, even millions of years.

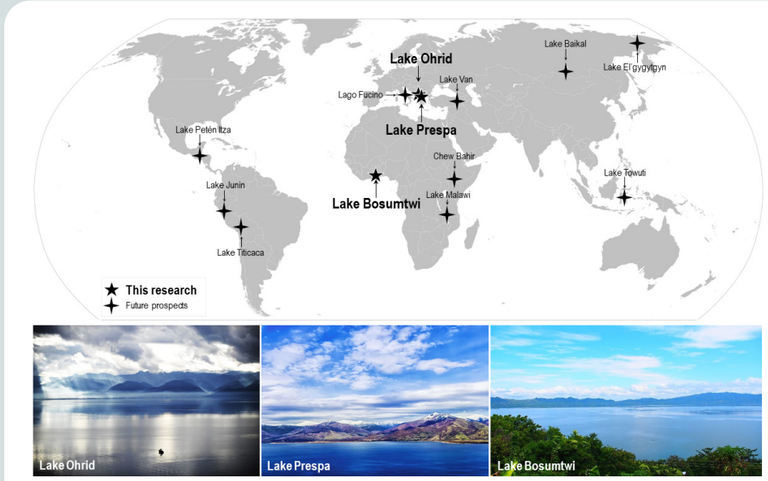



***Figure 1:*** *Map showing the locations of lakes selected for this research (black stars, bold labels; images also shown), alongside prospective targets for future research (black crosses). (Image Credits: Lake Ohrid (Getty Images), Lake Bosumtwi (Visit Ghana), Lake Prespa. (Konstantinos_K, iStock.com).*

The sediments deposited in lake basins pose a solution to both of these problems, and hence a crucial source of information on Hg cycle behavior deep into the past. Over many thousands of years, tiny particles, dead organisms, and chemical materials are transported to, and deposited in, these basins, creating distinct layers that each represent a snapshot of environmental conditions at the time of deposition. Long lake-sediment cores can be extracted by drilling, combined to create long composite sediment successions, and used to investigate records of the environmental history of the basin, the climate changes it has experienced, and the responses of elemental cycles to these changes[3].

Our research sought to answer the question: *what environmental factors had the most significant influence on the global biogeochemical cycle of Hg over millennia*? We selected three lake sediment successions for analysis: Lake Ohrid (Macedonia/Albania), Lake Prespa (Greece), and Lake Bosumtwi (Ghana) (Figure 1). All are >1 million years old, yet differ in terms of their size, chemistry, and hydrology: factors that could each influence how they record Hg cycle changes. Concentrations of Hg were measured by atomic absorption spectrometry* (Figure 2), and the timing of distinct Hg anomalies to the timing of major environmental changes recorded in these lakes by synchronous changes in sediment structure, organic and inorganic geochemistry.

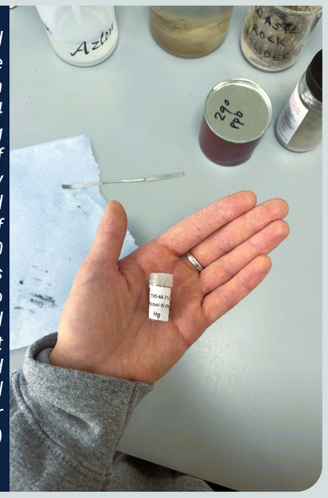


***Figure 2:*** *One of 694 powdered sediment samples from Lake Ohrid analysed in this study, each taken at regular intervals of 64 centimetres, and representing an average time resolution of ~2,000 years. Approximately 0.5 g per sample was delivered to our lab at the University of Oxford, from which ~39 to 340 mg was weighed into glass measuring boats and heated to ~700°C. This heating volatilized and oxidized the Hg present in the sediment, which could then be measured by spectral absorption to give us a value for the total Hg concentration (HgT) of the sample.*

Over ~2000 measurements revealed changes in the Hg cycle were effectively recorded in lakes Bosumtwi, Prespa, and Ohrid over multiple millennia, and often corresponded to major climate transitions. However, the timing of the largest Hg signals clearly differed between the three lakes, suggesting they were produced by different processes. For example, the highest Hg concentrations in Lake Bosumtwi correspond to the African Humid Period (~14,000 to 4,000 years ago) when the climate was drastically wetter than it is today[4]. Whereas, lakes Prespa and Ohrid record distinct Hg cycle changes linked to shifts in local vegetation, erosion, and glacial activity[5], and these links remain present in Lake Ohrid as far back as ~1.36 million years ago – when the lake itself formed[6] (Figure 3).

**These findings are important because they:**

i. Demonstrate that climate change is capable of altering processes important to the terrestrial Hg cycle, and with sufficient magnitude to leave measurable traces in the sedimentary record.
ii. Underscore how sedimentary Hg could elucidate how the Earth system has interacted through time.
iii. Reveal a close correspondence between long-term Hg cycling and the biosphere (e.g., vegetation, soils).
iv. Imply that both natural and human-driven climate change could leave a lasting imprint on the terrestrial Hg cycle.

Looking to the future, there are several intriguing avenues for more work in this field. For example, identifying the processes that could dictate a lake's sensitivity to natural Hg cycle alterations, through use of advanced geochemistry, statistical models, and grain size modelling. Acquisition of Hg data from other ancient lake sediment cores (Figure 1) will also help us to identify key similarities and/or differences in Hg signals between different lake types (e.g., deep vs shallow, and 'open' vs 'closed'), and allow us to explore how the global Hg cycle responded to major climate transitions even deeper in Earth's past[7].

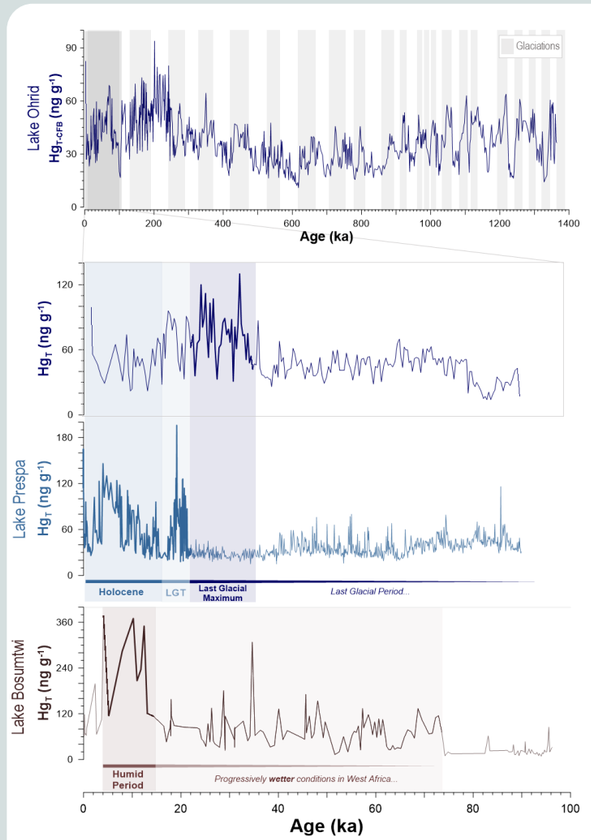



***Figure 3:*** *A comparison of total Hg concentrations (HgT) measured in the sediments of lakes Prespa, Ohrid, and Bosumtwi, with key transitions/events relevant to each core labelled. Ages are presented in 'ka', which refers to kiloyears before present (1950 CE). 'Glaciations' are colder intervals in Earth's history characterized by the expansion of ice sheets and glaciers, a reduction in sea levels, and higher atmospheric dust loading.*

This research was made possible through the funding of the European Research Council Consolidator Grant 'V-ECHO' (ERC-2018-COG-8187 17-V-ECHO) awarded to Tamsin Mather in 2018. This project has given me opportunities I could never have dreamed of, and the opportunity to work with a selection of incredible scientists: from my supervisory team (Tamsin Mather, David Pyle, Stuart Robinson) to colleagues (Joost Frieling, Isabel Fendley). I extend my deepest thanks to them for putting so much trust in me, inspiring me, and showing me what it truly means to be world-class. Sincere thanks also go to the Oxford Earth Science Accounts and Postgraduate Admin Teams, Steve Wyatt, Jeannette Stimpson, and all members of the Oxford Volcanology research group.

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# NEW KIDS ON THE ROCK

## INTRODUCING THE NEW APPOINTMENTS IN OXFORD EARTH SCIENCES

### Stacy Carolin
Laboratory Manager in Isotope Geochemistry

Stacy re-joins the department after 10 years of postdoctoral research experience in isotope geochemistry, beginning in our own Earth Sciences department, followed by contracts at the University of Innsbruck Institute of Geology, University of Cambridge Earth Sciences, and University of Oxford School of Archaeological Sciences. Stacy now manages the Metal Free Labs and the two multi-collector ICP-MS instruments, working with students, postdocs, and faculty on a broad range of research topics ranging from chemical weathering to volcanic tracers to natural resources.

### Emily Donald
Geofacilities Lab Manager

Emily joined the Department in June 2024 as manager of the Geofacilities SRF. She has a background in Commercial Thin section preparation within a UKAS accredited laboratory, with experience in a diverse range of materials (concretes and ceramics to natural stone). She undertook her studies at the University of Plymouth and has a particular fondness of Foraminifera, as well as the dark art of thin section preparation. She is always honoured to be the first person to see a multitude of minerals and fossils in thin section before handing them over to their owners.

### Hannah Lingard
Head of Administration and Finance (Maternity Cover)

Hannah joins the department from Oxford Physics where she led a highly respected team of Research Facilitators. She will spend just over a year with us as Head of Administration and Finance, ensuring that professional services support is of the highest level so that the Department can continue its mission to provide a fantastic education in Earth Sciences and carry out world leading research. Her background is originally in Chemistry (with an MSci from Cambridge and DPhil from Oxford) and she's worked in research support at Oxford since 2012. She's really enjoying combining her experience in Chemistry and Physics to help her to understand the amazing science going on here and looks forward to meeting alumni and hearing about their exciting journeys after their time here, whether in Earth Sciences or other fields.

### Matthew Kemp
Outreach and Communications Assistant (Maternity Cover)

Matthew started as the maternity cover for the Outreach and Communications Assistant in October 2024 after submitting his DPhil thesis. In this role he helps Dr Charlie Rex with the outreach, communications, events and alumni strategies for the department. During his DPhil in Oxford he took a holistic approach to plate reconstruction by combining seismological deep mantle images alongside surface geological studies, with a focus on Alaska. He previously obtained an MSci from Cambridge with a project on deep Earth seismology underneath Hawaii.

Throughout his studies he has been a keen science communicator, running outreach events, producing documentaries, and writing and performing musical comedy about science. As one half of "Geologise Theatre" he has written and performed musicals about science for young people and is currently touring a climate change show and workshop across the UK alongside his department work.

### Harish Kumar K S
Postdoctoral Researcher

Harish Kumar is a Postdoctoral Researcher currently working with Prof. Heather Bouman on the NERC-funded Integrating Drivers of Atlantic Productivity (IDAPro) project. This research focuses on estimating phytoplankton productivity in the subpolar North Atlantic at multiple scales using both in-situ and satellite data. He completed his doctoral thesis, titled "Modelling of Sea Surface Solar Irradiance, Primary Productivity (PP), and Biogeochemical (BGC) Properties with Relevance to Optical Remote Sensing," under the guidance of Prof. Shanmugam at the Ocean Optics and Imaging Laboratory, IIT Madras, India. His expertise lies in examining biases and uncertainties in existing algorithms and models, and in developing advanced methods for estimating satellite-based PAR, PP, and BGC products. Additionally, he has investigated climate-driven perturbations, such as El Niño and La Niña, in both regional and global oceanic waters.

### Alasdair Knight
Postdoctoral Research Assistant in Biogeochemistry

Alasdair recently completed his PhD at the University of Cambridge, where he explored how ion-exchange reactions between water and minerals affect chemical weathering rates and the carbon cycle. His research combined field studies in Nepal, laboratory experiments, and the use of barium stable isotopes. He joins the department as a post-doctoral research associate (PDRA), focusing on the positive feedback mechanisms between oxidative weathering, greenhouse gas release, and deglaciation. This research will involve fieldwork in substantially colder temperatures than Nepal, with a planned field trip to Svalbard this summer. His work contributes to the Accelerated Carbon Dioxide Release from Sedimentary Rocks in a Warming World project, led by Bob Hilton in collaboration with Julie Cosmidis and Laura Stevens.

### Virginia Ettwein
Geofacilities Technician

Virginia joined the department at the tail end of December 2024. A palaeoclimatologist/palaeoceanographer by training, she received her PhD from UCL where she used oxygen isotopes and biomarker analyses from deep sea sediments to investigate the role of polar temperature gradient-driven variations in the South American Summer Monsoon in modulating global climate since the Last Glacial Maximum. She also holds an MSc in Quaternary Science from Royal Holloway specialising in micropalaeontology, and a BSc in Geography from UCL. Her career has spanned working in US National labs, private consultancy and industry. She previously worked with the department from 2019 to 2022 developing an archive for student project materials and is excited to return to support the Geofacilities team in a much wider capacity.

### Luca Stigliano
Postdoctoral Research Assistant in Microbial Biomineralization

Luca recently completed his PhD at ISTerre, focusing on mineral (bio) weathering and investigating traces of microbial life preserved on altered mineral surfaces. He holds a BSc and MSc in Energy Engineering from Politecnico di Milano. Luca has joined Oxford Earth Sciences as part of BioFacts, a 5-year ERC/UKRI-funded project aimed at understanding the biomolecular and genetic controls of microbial biomineralization. His current research uses high-throughput Raman spectromicroscopy to explore the role of organic molecules in shaping the unique properties of minerals formed by microbes.

### Piyush Sriwastava
Postdoctoral Research Assistant at the Museum of Natural History

Piyush is a post-doctoral researcher working with Dr Ross Anderson at the Museum of Natural History. He completed his PhD at IIT Bombay, India, where he investigated the mechanism of clay nucleation and its crystallisation pathways during basalt alteration, under biotic and abiotic conditions. Now in his role at the Museum, he is investigating clay and biomolecule interactions from the perspective of preservation of soft tissues and bio-mineralisation. He aims to experimentally investigate the impact of biomolecules on mineral equilibria in sediment pore fluid and vice-versa, which he hopes can shed light on some basic questions about the record of the origin and evolution of life.

*This year the department was also joined by ...*

***Professor Oleg Melnik*** *- Royal Society Visiting Fellow*
***Maria Olguin*** *- Postdoctoral Research Assistant in Volcanic Fluid Geochemistry*
***Catherine Harrison*** *- Postdoctoral Researcher*
***Chloe French*** *- HR Apprentice*
***Louise Wright*** *- EA to the Head of Department and PA to the Head of Administration and Finance (Secondment Cover)*
***Jack Turner*** *- Facilities Assistant*
***Jason Terry*** *- Postdoctoral Research Assistant*
***Jonathan Dolinschi*** *- Postdoctoral Research Assistant*
***Calum Braham*** *- Postdoctoral Researcher*
***Zhengxuan Li*** *- ERC Research assistant*
***Hanwen Zhang*** *- Postdoctoral Research Assistant*
***Xuan Cao*** *- Postdoctoral Research Assistant in Aqueous Geochemistry and Sedimentary Processes*
***Shijia Peng*** *- Newton International Fellow*
***Estelle Ledoux*** *- Postdoctoral Researcher*

# VOLATILE VOLCANOES, FANTASTIC FOSSILS AND PHENOMENAL PLANETS: 365 DAYS OF EARTH SCIENCES OUTREACH AND PUBLIC ENGAGEMENT

DR CHARLIE REX, OUTREACH AND COMMUNICATIONS MANAGER

Earth Science Outreach and Public Engagement have gone from strength to strength in the past year. As a department we worked with over 3000 school-age students from across the country and participated in 8 public engagement events, none of which would have been possible without the support of 44 amazing undergraduate, postgraduate and staff volunteers from the Department!

*Our volunteers at the Brookes Science Bazaar.*

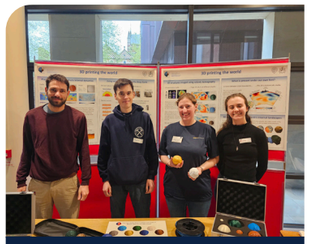
A major goal for the Outreach Team this year was to raise the profile of our subject among prospective students. We partnered with ten different Oxford colleges to deliver *academic taster sessions* to groups from state schools across the UK. These sessions form part of a day of activities designed to give students a flavour of what it is like to study at Oxford. During our sessions, students are given an overview of the undergraduate course before they examine some of our favourite rocks and fossils. As a group, they then participate in some experiments to investigate the difference between effusive and explosive volcanic eruptions.

*Evidence boxes for our new Climate Detectives recruits.*

Volcanoes were also a theme of one of our contributions to the *Oxford Brookes Science Bazaar* in Spring. Attracting over 7000 visitors, the Bazaar is a fantastic opportunity for us to engage local families with the geosciences, and this year we took three activities – based around fossils, volcanoes and planets – to showcase our subject. We were thrilled that our volcanoes stall was presented with the "Most Engaging Activity" award by the Oxford Brookes Pro Vice-Chancellor for Research and Global Partnerships.

Also recognised this year with a nomination for a prestigious Vice Chancellor's Award was *Sensing Volcanoes*, the interactive exhibit led by Professor David Pyle, which ran at the Royal Society Summer Exhibition in Summer 2023. David and his team were nominated in the Research Engagement category. You can find out more about Sensing Volcanoes in the Spring 2023 Issue of this publication.

In April, we launched *two brand new school-based workshops* – Fantastic Fossils (designed by DPhil student Stephanie Lechki) and Climate Detectives – and ran these with a number of classes in local primary schools. Fantastic Fossils was a huge hit with some Year 6 children in September, particularly when we discussed the idea of birds actually being dinosaurs (you can imagine the reactions!). For the older students, our climate workshop gives "new recruits" to the "Climate Detectives Agency" the task of interpreting proxies from within a sediment core, complete with tiny model diatoms, foraminifera and ice rafted debris.

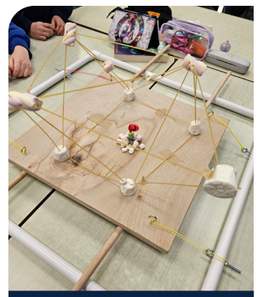


*Volunteers at the Earth Day Event in April.*

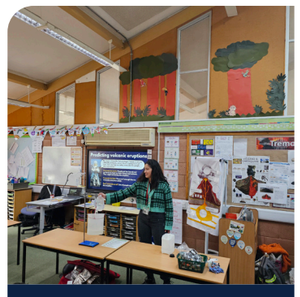
*A solar system of planets, designed by Year 1 students at a local primary school.*

Our new event for 2024 was the Oxplore Festival, which took place in Bodmin, Cornwall across two days in July. Oxplore has, until recently, been an online resource, allowing students to delve deeper into big questions such as "is a robot a person?" and "should everyone speak the same language?". This year, the University launched the Oxplore Festival, a two-day celebration of curiosity and exploration for Year 7 and 8 students from across Cornwall. Volunteers from the Department ran a series of workshops about planetary science, and showcased our earthquake simulators as part of an exhibition. We're excited to be taking part in the festival again in 2025 when it heads to Bradford!

If you are interested in learning more about outreach and public engagement, including how you can support our initiatives, please contact Charlie at outreach@earth.ox.ac.uk.



*Testing the stability of a structure made from marshmallows and spaghetti on a shake table.*



*DPhil student Sofia demonstrating the difficulty in predicting volcanic eruptions using party poppers.*



UPDATES FROM

# OUGS

## OXFORD UNIVERSITY GEOLOGICAL SOCIETY (FORMERLY GEOLSOC)

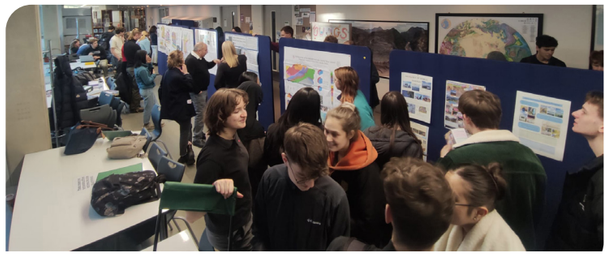
ZOE GUY, 4TH YEAR UNDERGRADUATE (2024/25 PRESIDENT)

OUGS is the student-run society predominantly for Earth Sciences undergraduates, and this year we are bigger and better than ever, with record high engagement and new memberships. This year OUGS is focusing on strengthening our community and diversifying our events, but don't worry, we still host many of the classic OUGS events, including as Rocktails and GeoVarsity! We aim to provide academic, career and social opportunities for all our members. Here are some of our recent highlights!

## MAPPING CONFERENCE A HUGE SUCCESS!

The OUGS Mapping Conference saw the Department atrium transformed into a showcase of mapping projects, with around 20 poster boards on display, library material for perusal, informational brochures and even brownies! All four year groups were invited, and each gained something different from the conference, ranging from location ideas to layout tips. The Conference also generated discussion about how the mapping project is financed. The feedback for this event was extremely positive, and many older years (myself included!) wished they had the opportunity to present their maps too. The Mapping Conference also allowed professors and postgrads to reminisce on their mapping projects and see what their teaching helps us to achieve.

OUGS also hosted two talks during Michaelmas term. One was focused on the project options and the other on how to write the project. These were incredibly well attended and addressed the uncertainty often felt by members before they embark on the next stage of their coursework.



## OUR ARTISTIC SIDE

OUGS frequently hosts pottery painting, crocheting and screen-printing nights for members to de-stress. Check out our pots and newly designed field trip post cards!


## ROCKTAILS

Our termly party "Rocktails" (creatively named many years ago as a mash up of rock and cocktails) is still very much alive and well. It is our most popular event of the term for good reason! The most recent Rocktails event had the theme 'Velociwranglers' (cowboy dinosaurs) but over the years we have had costume themes such as 'Rockstars' and 'Geologists Under the Sea'.

## 2023/24 OUGS

### FIELD TRIPS

OUGS organise a field trip within the UK every year for its members, which has been kindly sponsored by Viridien for the past three years. In 2023 we went to Dudley, followed by Derbyshire in 2024. The next trip will be in Hilary Term 2025. It's a great opportunity for the year groups to get to know each other, spend time in nature, and is enjoyed by all. In the past we have visited outcrops, collected samples, listened to the talks on the geological history of the area, and stopped off at gift shops!

Summer Dinner this year moved away from the iconic Wig and Pen to the stunning Isis Farmhouse for a formal evening of cocktails, speeches and fond farewells to finalists.

We also hosted a summer BBQ for all our members at the Exeter.


OUGS FC played against the postgrads (culminating in a sad 3-4 loss for OUGS!). We also hosted Cambridge Earth Scientists for the annual GeoVarsity.

# ALUMNI EVENTS

## LOBANOV-ROSTOVSKY LECTURE IN PLANETARY GEOLOGY

We were delighted to welcome Dr Vlada Stamenkovic, Senior Director of Space Resources at Blue Origin, to deliver the Lobanov-Rostovsky Lecture in November. Dr Stamenkovic presented fascinating insights into the technologies in development at Blue Origin Space, including prospecting for reserves on the Moon, and learning how to transform lunar regolith into solar panels. His talk, which took place in the Museum of Natural History, was attended by a large audience and inspired some fascinating discussion. The Lobanov-Rostovsky Lecture was inaugurated in 2013 in recognition of the support given by Mr Nikita Lobanov-Rostovsky (BA Geology, Christ Church 1955) to the Department. This annual public lecture examines the fundamental questions of the origin of planets, formation and deformation, and geology on a global scale.

*Professor Don Porcelli, Dr Vlada Stamenkovic, Mr Nikita Lobanov-Rostovsky and Professor Mike Kendall at the 2024 Lecture.*

## CAREERS FAIR

The Department would like to express our sincere thanks to the many alumni who attended the Earth Sciences Careers Fair in November. Our current undergraduate and graduate students thoroughly enjoyed hearing about the various career paths represented on the day. This was the largest event in recent history, with 15 companies in attendance. A number of our company representatives also offered short talks in the Seminar Rooms throughout the afternoon, and shared insights into their current roles and career history. The Careers Fair will return in Autumn 2025 – if you would like to attend as a representative please email alumni@earth.ox.ac.uk.

## FINALS PARTY

Finals Party, which takes place annually at the end of Trinity Term, is an opportunity to celebrate our most recent graduates and to recognise the hard work of individuals with prizes across a variety of categories. A number of our alumni and their employers kindly sponsor these awards, and we were grateful that many of them were able to join us on the day to present them to the recipients. A huge thank you to these individuals for their generosity. The afternoon ended with a BBQ on the roof terrace and a toast to the class of 2024! If you are interested in sponsoring a prize this year please email alumni@earth.ox.ac.uk.

*The 2024 winners with some of our prize sponsors.*



# ALUMNI NEWS

## NEW ZEALAND AWARD FOR ALUMNUS

Dan Bassett, who completed his DPhil in the Department of Earth Sciences back in 2014, supervised by Professor Tony Watts, was recently awarded the McKay Hammer by the Geoscience Society of New Zealand. The McKay Hammer is the oldest and most prestigious award made by the Society and recognises the person who has made the most meritorious contribution to Geology in the previous three calendar years. Dan's award recognises a sustained body of work that has significantly advanced our understanding of subduction zone structure and processes. Dan has led research on Hikurangi Margin crustal structure and the relationship between forearc structure and shallow megathrust slip behaviour. At the same time Dan has collaborated with others on broader questions of intraplate volcanism and subduction zone slip behaviour. Congratulations Dan!

*Dan Bassett accepting the "Golden Rock-Hammer".*

## ALUMNUS REPRESENTS GEOSCIENCE IN GLOBAL YOUNG SCIENTISTS SUMMIT

Earthquakes took a spotlight at the Global Young Scientists Summit (GYSS) at the National University of Singapore with John Dale Dianala (JD to most), who studied for his DPhil at the Department of Earth Sciences and St Cross College with Professors Richard Walker and Barry Parsons from 2017-2021. With over 340 participants in life sciences, biomedicine, physical sciences, and engineering from around the world, JD was 1 of 16 selected to take the stage and pitch his research on using satellite radar to understand the earthquake cycle, featuring work from his DPhil and upcoming projects at the University of the Philippines where he is now Assistant Professor.

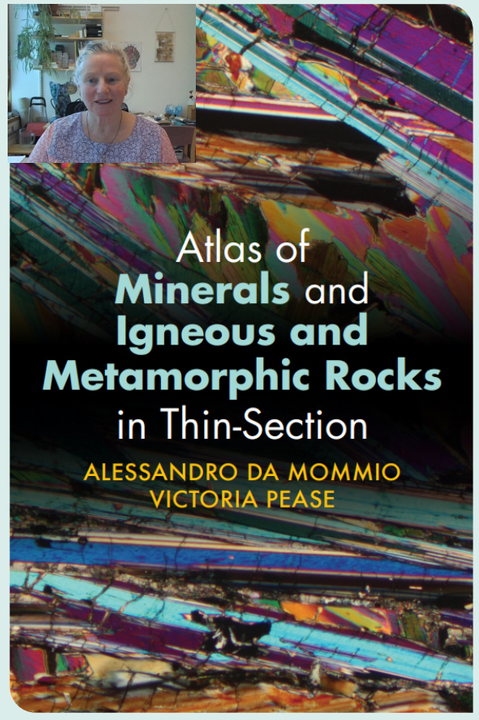
Organized by the National Research Foundation (NRF) Singapore, GYSS brought together Nobel Laureates and eminent scientists with young researchers in one venue from 6-10 January 2025, with plenary talks and panel discussions on the role of science in global issues like sustainability, human wellbeing, and artificial intelligence.



*Image Credit: GYSS.*

## NEW THIN-SECTION ATLAS FROM ALUMNUS

Victoria Pease, Professor of Tectonics & Magmatism at Stockholm University and Oxford Earth Sciences Alumnus, has co-written CUP's *"Atlas of Minerals and Igneous and Metamorphic Rocks in Thin-section"* which will be published in June. Here is a snippet of the blurb: "[This book]... provides the geology student and geoscientist with a stunning new color atlas of the main rock-forming minerals, as well as igneous and metamorphic rocks in thin-section. Chapter 1 highlights the distinctive characteristics used to identify different minerals ... following chapters describe rock textures and types, ... [and] also includes insights into how information from thin-sections can be studied using modern analytical methods. ... This Atlas is an indispensable reference textbook for all facilities that use a petrographic microscope, for professional geoscientists, and as an aid for any student studying minerals and rocks."



ALUMNI REPORTS

# NORTHUMBRIAN EARTH OUTREACH

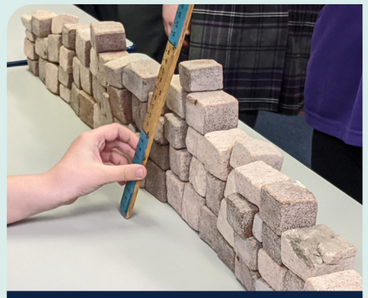
**IAN KILLE (MATRICULATION 1978) GIVES AN ACCOUNT OF HIS WORK WITH NORTHUMBRIAN EARTH AND VARIOUS OUTREACH PROJECTS THAT HAVE TAKEN PLACE IN NORTHUMBERLAND...**

Hadrian's Wall was not a work place I'd have envisaged when researching the Isle of Mull igneous complex after graduating. Decades of work in telecoms followed the research, then an escape back to Geology. In 2008 I set up Northumbrian Earth from my new home in Northumberland; its aim, to provide opportunities for the local community and visitors to explore the geodiversity of the area, by running events, setting up partnerships and taking on contracts.

The most recent contract was as Community Geologist for the Hadrian's Wall Community Archaeology Project managed out of Newcastle University by Professor Rob Collins. This gave an opportunity to work with the Wall's many communities and deliver a mass-science project that combined archaeological and geological techniques. We explored the geological setting of the Wall, what the Wall is made of (spoilers, its sandstone!), Wall-stone sources and Wall-stone reuse in post-Roman constructions. It was satisfying to see people being inspired by geodiversity and to leave a legacy of publications, including an academic monograph "The Fabric of the Frontier" that shows the value of interdisciplinary work.

*Alfie's thank you card, All Saints Morpeth.*

Now I am in the final throes of re-editing a book, "Berwick Coast Rocks!" for its 2nd edition. Its aim, and that of its earlier partner "Northumberland Coast Rocks!", was to offer easy ways to explore the geology of the coast in a format that could be slipped into a pocket. The books grew from a project I ran, supported by the Northumberland Coast ANOB working with the Alnwick U3A. One of the group, Helen Page, inspired by the geology, decided to write a book. This became two, and with lottery funding we ran outreach programmes to local communities, including schools, to launch each book. Both books, now handed to me, are useful partners to the regular geodiversity walks I run encouraging people to explore our beautiful coastline.



*All Saints Morpeth Hadrian's Wall Workshop.*

*Geodiversity Walk at Cocklawburn Beach Northumberland.*

ALUMNI REPORTS

# OxPAN ALUMNI NETWORK

**ANNA RUFAS (MATRICULATION 2016) INTRODUCES A NEW ALUMNI NETWORK WHICH CONNECTS LGBTQ+ GRADUATES**

A new initiative aimed at connecting, empowering and celebrating an estimated 35,000 LGBTQ+ Oxford graduates around the world was launched in the summer of 2024. Founded by former Jesus College alumnus Christer Holloman, the Oxford Pride Alumni Network (OxPAN) is designed to foster a global community of alumni.

Since its launch, OxPAN has established regional committees in London, Washington, New York and Oxford. The Oxford chapter has already held two successful gatherings, in November 2024 and February 2025. As the network grows, OxPAN aims to engage the Oxford LGBTQ+ research community, with a particular focus on increasing representation of women, who are currently underrepresented in the group's events.

OxPAN represents an important step in acknowledging the contributions of LGBTQ+ alumni to the University, providing graduates with access to a supportive global network, and helping to shape Oxford's future.

To learn more and join the network, visit the OxPAN website: https://oxfordpridealumni.org



ALUMNI REPORTS

# INVESTIGATING THE GEOLOGICAL POTENTIAL FOR BIOENERGY WITH CARBON CAPTURE AND STORAGE (BECCS) IN BRAZIL

**RAPHAEL PIETZSCH (MATRICULATION 2018) FROM PETROBRAS RESEARCH CENTRE, RIO DE JANEIRO, OUTLINES THE WORK GOING INTO BECCS IN BRAZIL**

According to the IPCC (2022), pathways to limit global warming to 2°C rely heavily on $CO_2$ removal methods like reforestation and BECCS (bioenergy with carbon capture and storage). BECCS is seen as a promising option in some countries, including Brazil, but its technical and financial feasibility remain unproven. Brazil is the fifth largest country by area, seventh largest by population, and seventh largest $CO_2$ emitter in the world (IEA 2023). However, Brazil's electricity generation and total $CO_2$ emissions have very different profiles from most countries (Figure 1) - the energy sector is one of the least carbon-intensive in the world, with renewables accounting for 87.5% of the share of power generation (IEA 2023). The country's climate and geography support a thriving agro-industrial sector, including biofuel production from sugarcane. These characteristics make Brazil a promising candidate for integrating biofuel production with $CO_2$ sequestration in deep saline aquifers.

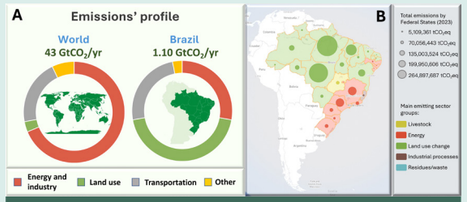



*Figure 1: Distribution of the main sources of $CO_2$ emissions. (A) World and Brazil. (B) Profile of the main sources of $CO_2$ emissions of each Brazilian State, model GTP (global temperature change potential). Sources: IEA and SEEG.*

Linking these two could help us achieve negative emissions, because photosynthesis produces biomass that is converted into biofuel. The $CO_2$ emitted during fermentation can be captured with high purity, and can then be compressed, transported, and injected (geology helping!) into deep saline aquifers unsuitable for other uses. To this end, we are investigating the subsurface geology of the Palaeozoic Paraná Basin (Figures 2 and 3), which has a theoretical capacity to store 462 Gt $CO_2$ in saline aquifers alone (Ketzer et al. 2016). Injection rates also matter and could range from <100–250 Mt $CO_2$/yr (Lap et al. 2023), but field tests are lacking, and several factors may influence actual rates. For instance, a single company that operates four plants in the State of São Paulo can process 24 million tonnes of sugarcane per harvest/year. Conservatively, direct emissions from fermentation alone (roughly, 1 tonne sugarcane to 10–80 litres of ethanol, and 6.37 kg $CO_2$ per tonne of ethanol) likely release between 1200–9650 tonnes $CO_2$/harvest, which could be tapped directly.

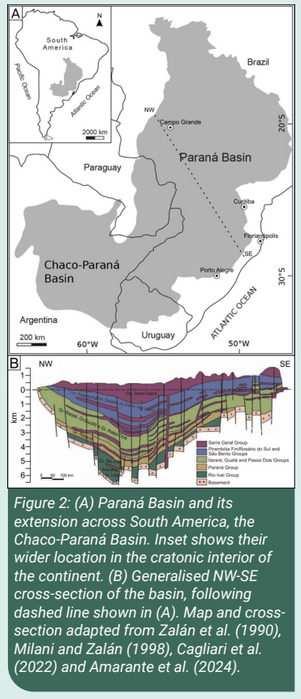



*Figure 2: (A) Paraná Basin and its extension across South America, the Chaco-Paraná Basin. Inset shows their wider location in the cratonic interior of the continent. (B) Generalised NW-SE cross-section of the basin, following dashed line shown in (A). Map and cross-section adapted from Zalán et al. (1990), Milani and Zalán (1998), Cagliari et al. (2022) and Amarante et al. (2024).*

The Paraná Basin lies beneath Brazil's industrialised southeast, near major $CO_2$ emitters like oil refineries and biofuel plants. Its Permian units are ideal for supercritical $CO_2$ storage, enhancing storage and injection efficiency. The basin is also capped by the Serra Geral Group flood basalts (Figure 2B), posing an additional challenge for seismic acquisition, with poor subsurface imaging. Still, they could facilitate in-situ mineralisation, which is the focus of parallel research. The basin also hosts the Guarani Aquifer, the second largest in the world, and as a critical freshwater resource it must remain protected.

*Figure 3: Field trip in the southern winter (early August 2024), to review the stratigraphic, sedimentologic and structural relations of the Paraná Basin in outcrops along its eastern border (west of Curitiba, shown in Figure 2). In the background, red fluvio-glacial sandstones of the Permian Itararé Group can be seen. Image credit: Mirella Antonio.*

We see here several challenges of a technical nature to safely store $CO_2$ in this basin. Furthermore, regulatory and commercial frameworks are under construction, complicating immediate implementation. These factors are demanding a fast-paced debate, requiring collaboration among scientists, policymakers, and society. Regarding the geological challenges specifically, nearly all related disciplines are necessary here, such as stratigraphy, structural geology, geomechanics, geophysics and geochemistry, entailing core and formation water sampling, and subsurface geological modelling. We are currently in the early stages of this endeavour, and are hoping to provide robust geological data to support safe $CO_2$ storage in the basin, advancing sustainable climate solutions.

*With thanks for the author acknowledges the financial support of Petrobras and the partnership with the Brazilian Geological Survey (SGB), in particular the willingness of geologists Rodrigo Adorno, Oderson Souza Filho, Almerio França, Junia Casagrande, Saulo Bortolini, Filipe Lira, the hydrogeologist Roberto Kirchheim, and managers Claudio Ziglio, Anelise Souza, Igor Viegas and Ygor Rocha to dive deep (literally) in this project.*

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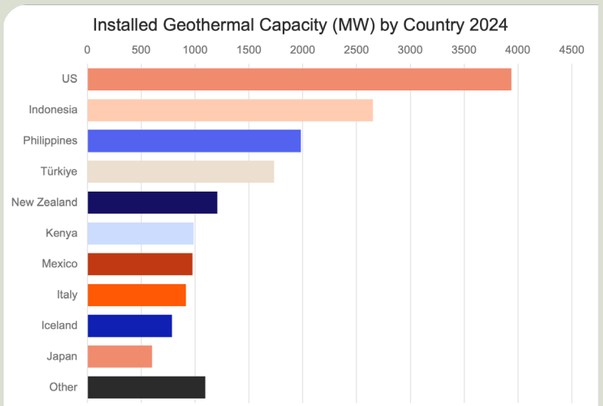
ALUMNI REPORTS

# "GOING UNDERGROUND"

**JONATHAN VERLANDER (MATRICULATION 1989) GIVES US A RUN-DOWN OF GEOTHERMAL ENERGY'S HISTORY AND POTENTIAL FUTURE...**

As the world grapples with the challenge of providing affordable and low carbon energy to an ever-growing population, part of the solution could be literally under our noses. Well, under our feet to be precise.

Geothermal energy is a natural, renewable source of energy that can be utilized for direct uses, such as heating, cooking or bathing, and also to generate electrical power, with the emission of few greenhouse gases. Our use of geothermal energy goes back thousands of years, but commercial geothermalpower generation began a little over a hundred years ago at a plant at Larderello, Italy in 1913. Now the world's largest geothermal plant complex is at The Geysers, north of San Francisco, which came online in the 1960s and currently generates around 800 MW of power from 13 power plants supplied by the steam from over 300 wells.




*Data Credit: ThinkGeoEnergy.*

Geothermal power has historically relied on identifying areas of the earth's crust that have elevated geothermal gradients (often plate boundaries or other active tectonic zones) thereby creating resources of hot water or steam at commercially viable depths. The water or steam flows (or is pumped) via wells to a power plant, and then, once cooled, is reinjected into the reservoir by way of another set of wells, thereby maintaining pressure and volume in the reservoir. In some counties, such as Iceland, the produced water may be used in a district heating system after it has passed through the power plant, and there is interest currently in also extracting minerals (particularly lithium) from the produced water.

As well as providing low carbon power, another attraction of geothermal plants is that they can operate 24/7, providing reliable baseload power regardless of weather conditions, unlike wind and solar.

In the last five years, two new types of geothermal technology have been developed by researchers and industry working together:

- Enhanced or Engineered Geothermal Systems ("EGS") share many technologies with the oil and gas industry, specifically horizontal wells and the hydraulic stimulation ("fracking") of low permeability basement lithologies. Water is injected into this artificial fracture network from the surface, thereby setting up a circulation of the water between the injection wells and associated production wells. Some notable EGS projects are the Utah FORGE project (US Department of Energy), Fervo Energy's Cape Station project, and the Haute-Some project in Switzerland.
- Advanced Geothermal Systems ("AGS") aim to create a similar circulation of fluid from hot rocks at depth to power generation facilities at the surface. However, in these systems the fluid is contained within a closed system, with no physical interaction with the rock at depth. Heat transfer is thereby via conduction, rather than convection as in the case of conventional geothermal techniques and EGS, and because the fluid does not leave the system, it is possible to utilize fluids other than water, such as super critical carbon dioxide, which has superior conductive properties. Some examples of AGS or closed loop projects are Eavor's projects in Canada and Germany, and GreenFire Energy's Greenloop project in California.

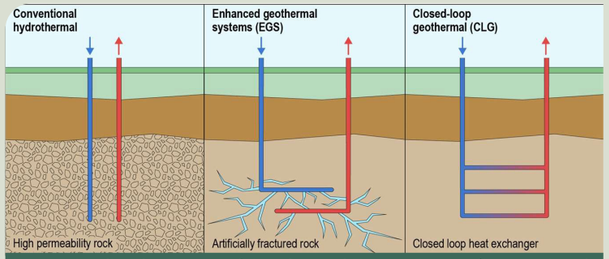



*Image Credit: The Future of Geothermal Energy Report (International Energy Agency, 2024).*

New technologies, like EGS and AGS, have the potential to expand the development of geothermal projects to regions of the earth where they have been previously uneconomic or impractical. Currently, geothermal meets less than 1% of global energy needs, but a review of the future potential of geothermal by the International Energy Agency in 2024 presented a roadmap to how continued technology improvements, coupled with reductions in project costs, could meet up to 15% of global energy needs by 2050.

To fulfil the potential of geothermal energy, it will require ongoing collaboration within the geothermal industry, coupled with the continued transfer of existing technology from the oil and gas industry, and the development of new technologies by research and innovation organizations.

The challenge of providing energy to meet the future needs of the earth's population will not be met by a single technology, but geothermal – driven by Earth Scientists at its core – has the potential to play a significant role in meeting this challenge.

*Jon is the Head of Investment Evaluation at Baseload Capital, a geothermal investor and project developer with assets in Japan, Taiwan, Iceland and the US. He completed his bachelor's degree and doctorate at the department in the last century.*



ALUMNI REPORTS

# BOULBY MINE EXCURSION - 1ST NOVEMBER 2024

**EDWARD FOLLOWS (MATRICULATION 1983) TAKES US ON A JOURNEY DEEP INTO THE BOULBY MINE...**

Four energy industry geoscientists visited the Boulby Mine on the 1st November 2024 guided by Tom Edwards, Chief Geologist. Our geological agenda unfortunately left no time to visit the Boulby Underground (dark matter research) Laboratory. After the site and underground safety briefings, kitted out in shorts, we descended to pit bottom.

The Boulby mine, located on Cleveland Way coastal footpath, nestles into the Jurassic above Staithes fishing village. The mine is currently extracting polyhalite (Potassium Calcium Magnesium Sulphate), which is used as a fertiliser. Polyhalite, a pseudomorph of anhydrite, formed in the English Zechstein Cycle EZ2 Fordon Evaporite Formation. Historically the mine focused on the Boulby Potash Member in the shallower EZ3 cycle. A switch to the deeper Potassium source eliminated the potash processing to achieve a more economic, lower carbon product.

*Huddled around a carnallite sample – like the Arkenstone from Tolkien's Hobbit.*

To reach the polyhalite, the operator, ICL, cut an inclined ramp; the road walls allowed us to examine a transect from basal EZ3 into EZ2. Several highlights included: a bright orange carnallite layer in the anhydrite; the Brotherton dolomite (a Plattendolomit equivalent); pronounced ripples on a drift ceiling further down the EZ3/EZ2 boundary; and the Fordon Halite member.

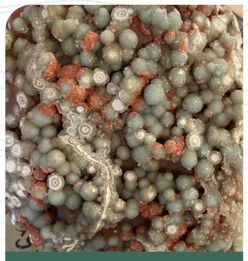
*The visitors in front of the toothed rotating drum that extracts the polyhalite.*

We examined an active face in the polyhalite workings, northeast of the mine shafts, some 6 km offshore at a depth of 1.5 km. The excavator is a rotating drum with tungsten carbide teeth that breaks up the mineral which is then fed away with rotors. A shuttle car carries the freshly excavated material to a long-range conveyor. Predrill and remote-controlled excavation of the polyhalite surfaces help make the extraction safer. Once we had retreated to a safe distance, the miners returned, and we were treated to noisy extraction action.

Horizontal exploratory drilling is critical for the longevity of the mine; wells are continuously cored using reverse circulation to assist retrieval of cores from up to 3 km away. With sidetracks, these wells reach up to 9 km total length. The core-based chemical analysis is imperative for the mine to monitor contaminant halite in the polyhalite. Typical hydrocarbon industry data contrasts with that of the mine data with respect to the scales and orientation of greatest data density. The positioning and correlation challenges are common to both industries, as is uncertainty management, particularly for prediction of resource volume recoveries.

Apart from the physical re-alignment of the mining machinery to manage fault offsets, faults appear to impact the broad-scale thickness variations of the polyhalite. A bespoke offshore 3D seismic survey has been a predictive help. Faults also conduct fluids that impact Potassium grades, developing exotic minerals like boracite. Tom showed us an impressive colour array of hydrocarbon fluids collected from seeps through faults in the salts.

*Side wall through the polyhalite – bedding clearest at base along with rock bolts and survey markers. White marks are machine scratches. Geological hammer for scale.*



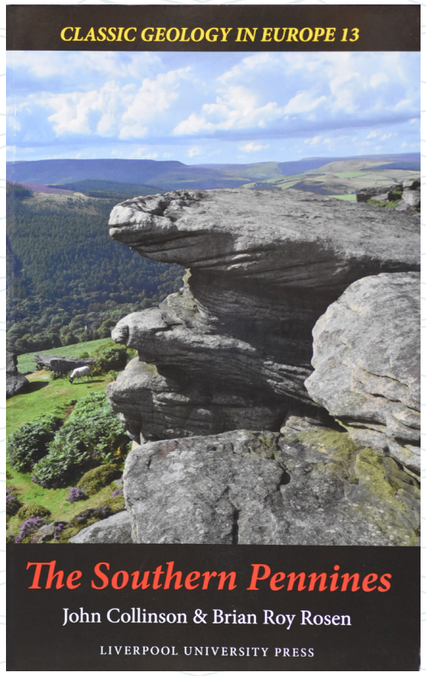
*Boracite $Mg_3B_7O_{13}Cl$ is a fault-associated mineral.*

The visitor group is appreciative of the care and attention shown by Boulby mine geologists Dogan, Ali, Elan and particularly Tom. Thanks to Tamara Geshtamov who organised the GESGB interfaces with our host ICL to make such a fantastic visit possible.

*This is a modified version of an article in the December issue of GESHB Magazine by Edward Follows (Worc, 83), Silvan Hoth and Thomas Edwards, with thanks to Luke Davies, and Paul Brockbank.*

# NEW BOOK ON 'THE SOUTHERN PENNINES' FROM ALUMNI

*Bill Groves, Brian Rosen and John Collinson at an exposure of aeolian lamination and cross bedding in the Permian Bridgnorth Sandstone near Bridgnorth during a geo-picnic in 2010. (Image Credit: Jill Darrell).*




In October 2024 Liverpool University Press published a new geological guide to 'The Southern Pennines' written by two alumni, John Collinson and Brian Rosen, who started their geological journeys in 1961 when they joined the Department of Geology and Mineralogy (as it then was) as undergraduates. Both drew inspiration and an enthusiasm for sedimentary processes and environments from Harold Reading's teaching. John continued in Oxford to work on the Namurian of the Pennines under Harold's supervision whilst Brian went to King's College, London to work on modern corals and reefs of the Seychelles. Throughout their divergent careers, they kept in touch, and when John decided to try to bring together his experience of the Millstone Grit of the Southern Pennines as a coherent publication, it was natural to ask Brian to contribute an account of the Dinantian limestones of the Derbyshire White Peak, where his knowledge of the area and his experience of ancient and modern corals and reefs could bring fresh eyes to these sediments.

This cooperation also came about because both had, over the years, maintained their undergraduate friendship with the late Bill Groves who had spent his career teaching geology at schools in the Black Country with great enthusiasm for field work. The three of us met regularly for geo-picnics held where interesting geology was combined with a visit to a strategically located hostelry. The book is dedicated to the memory of both Harold and Bill.

The guide explores the field geology of the Pennines between the southern Yorkshire Dales and the southern edge of the Derbyshire Peak District. The guide is written and illustrated at a technical level but should appeal to visitors to the area, especially those with an existing interest in Geology.

The guide treats mainly sedimentary rocks of Carboniferous age, discussing their evolving mosaic of structural settings and depositional environments. Dinantian limestones were deposited in tropical conditions on shallow carbonate platforms, on flanking ramps and in deeper basins. Mud mounds ('reefs') of many sizes were built by microbial activity on and around platforms. The basin-floor topography of platforms and basins was eliminated throughout the Namurian by the advance of large deltas that deposited a thick, cyclic succession of sandstones, mudstones and siltstones, the Millstone Grit, creating the alluvial plain on which Westphalian Coal Measures were deposited.

Introductory chapters explain the tectonic, stratigraphic and environmental factors that controlled sedimentation, later deformation and mineralisation. The interaction of on-going tectonic activity, changing sediment supply and fluctuating sea level, due to southern hemisphere glaciation, determined the stratigraphy and the evolving palaeogeography. The field guide proper describes localities that illustrate this evolution. Organised in six chapters, individual localities are described and illustrated, some grouped into geo-walks and geo-biking itineraries.

The book has a retail price of £29.99 and may be obtained through the Liverpool University Press website with a 20% discount.





# ROS WADDAMS
## 1952-2024

*Ros on Oslofjord, 1971.*

On Ros Waddams (St Hilda's, 1970) the mantle of cheerleader of our year settled easily. One of 3 women in an intake of 25, she always seemed bright-eyed, positive and energetic, and courteous in the way her infectious grin and ready laugh treated everyone equally. In later decades she became the glue which held many of us together as alumni. She died in January 2024, peacefully, a few days after a sudden stroke, in Oslo, where she had lived and worked for many years.

Vivid memories are of Ros on field trips: at Easter '71 late night swimming on the beach in Arran, in the summer of '71 among seven of our year on Harold Reading's annual expeditions to the late Precambrian in Finnmark, in '72 walking for three hours across Mull on a moonless night after a Ceilidh, and, less than three months before Finals, her boisterous 21st birthday party at the family home in Batcombe, Somerset.

A professional geologist for some 40 years, at the same time she brought up her children, Saul and Lynnea, in Texas with her first husband, geologist Marc Edwards (Oxford PhD, 1970s). She moved to Norway and lived in the Oslo area with her second husband David Worsley, another geologist. Her photographs, of Libya, East Timor and elsewhere were exhibited, and she began to write passionately on conservation, urging the need not just to bemoan climate change but to adapt to it. In parenthesis she spent harrowing weeks volunteering with UNHCR in a camp for boat refugees on the Greek island of Chios. Throughout her life Ros was driven by a natural and deep humanity. We miss her.

*Text and photo by Oxford undergraduate friends of Ros: Richard Gozney (Teddy Hall, 1970), Richard Miller (Teddy Hall, 1970) and Roger Suthren (St Peters, 1970).*

# A SUBJECT AS OLD AS TIME, EARTH SCIENCES ENDURES...

## AND EVOLVES...

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