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NEWS
RESPONDING TO VOLCANIC CRISES IN THE CARIBBEAN

FEATURE
MAGMA TAKES THE LONG WAY AROUND

REPORT
HOUDINI GASES UNCHAINED – HIDDEN HELIUM GAS FIELDS

WELCOME

TO THE OXFORD EARTH SCIENCES ALUMNI MAGAZINE

MIKE KENDALL - HEAD OF DEPARTMENT

Dear Alumni,

We are already one term down on this academic year and we're off to a great start. It is always exciting to welcome a new cohort of undergraduate and postgraduate students at the start of each year and even better to see how they have quickly become an integral part of the department by this term.

This year, we also welcomed a new member of Faculty. Luke Parry is a paleobiologist whose research looks at the 'Cambrian Explosion', a geologically brief interval during which all of the major groups of animals first appear in the fossil record. Luke's position is an APTF appointment, where he is a tutor at St. Edmund Hall. He currently holds a NERC Independent Research Fellowship. Luke will play a central role in our enhanced collaboration with the Natural History Museum, which makes Oxford a world leading centre for paleobiology.

As well as new students, we also have new Departmental initiatives. Funding from the Oxford Martin School has led to a new research program exploring critical metals and geothermal energy. Led by the Department, this interdisciplinary effort unites researchers from Earth Sciences, Economics, the Smith School of Enterprise and the Environment, Chemistry, and the Faculties of History and Law. Numerous other initiatives are in development, including programmes on natural hazards, water quality and ocean health. These are ambitious programmes where our Department is playing leadership roles.

In the last academic year, we celebrated many achievements, including the first alumni dinner since the pandemic. Our teaching was recognised with MPLS awards presented to Ally Morton-Haywood and Tamara King. Richard Walker received a well-deserved MPLS impact award for his contributions to earthquake resilience in Asia. Heather Bouman, Stuart Robinson, and Erin Saupe have been promoted to the position of Professor by the University's Recognition of Distinction panel.

On the environmental side, we received a Gold Green Impact Award for our building. I am also pleased that staff led a submission to the LEAF programme for eight labs as well as the workshop. The labs received the LEAF gold award and the workshop received the LEAF bronze award.

We continue to do well in producing world-leading research and gaining grant income to support our research. Many members of Faculty were recognised through awards and accolades, including Richard Palin who was awarded the Max Hey Medal from Mineralogical Society and Ros Rickaby who received the Science Innovation Award of the European Association of Geochemistry.

As we look ahead, I am optimistic about the opportunities and achievements awaiting us.

IN THIS ISSUE

CONTENTS

A Crack in Time' by Chia-Hsin (Wendy) Tsai.

This photograph, taken during an undergraduate field course at the Corinth Canal in Greece, was the Earth Science winner in the national Royal Society Publishing Photo Competition in 2023. The image depicts a typical outcrop, showcasing normal faults within an extensional tectonic setting – alongside a surveyor as the perfect scale bar. The Corinth Canal sits in the centre of the neotectonic depression and cuts through numerous normal faults. These faults displaced the Middle to Late Pleistocene lacustrine and marine stratigraphy with evident sedimentary structures.

HOUDINI GASES UNCHAINED
HIDDEN HELIUM GAS FIELDS

SARAH HILTON

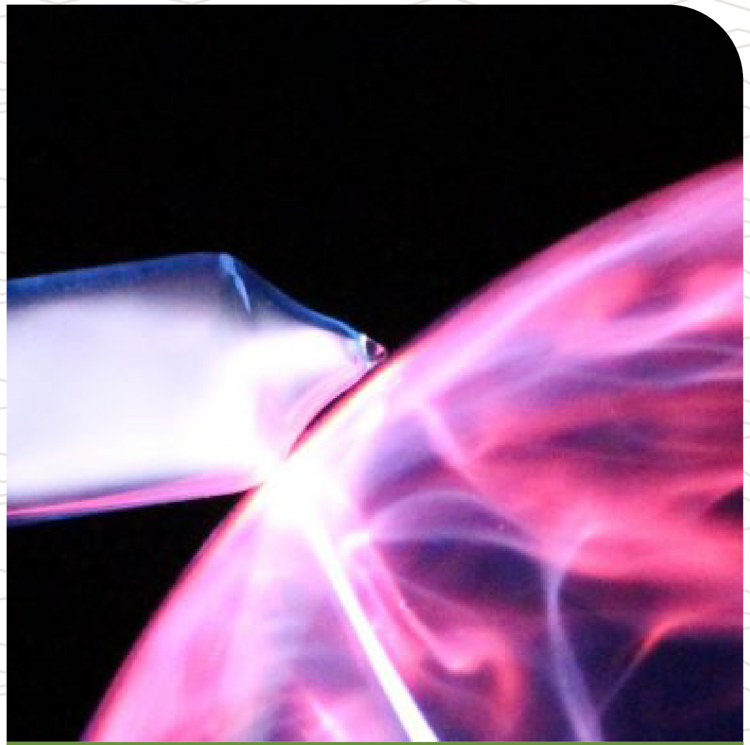
Helium and hydrogen gases are essential for medicine, high-tech industries, fertiliser for food security and a future net-zero society. Their production today is however chained to a large carbon footprint while, additionally, helium supply is in crisis. Together, these reasons mean that identifying alternative, carbon-free sources of natural helium has become critically important.

The challenge is that these lightest of gases easily escape from geological reservoirs given enough time. They are both escape artists. Houdini gases. Research led by Oxford Earth Sciences could help overturn the current supply crisis of helium without the large carbon footprint. This study proposes a new model to account for the existence of previously unexplained helium-rich reservoirs. The research defines a new concept in gas field formation and identifies the geological settings that these Houdini gases can be found and tapped without emmitting carbon dioxide.

Helium has been produced to date as a rare minor gas separated during the production of methane or carbon dioxide natural gas fields. Helium is a $6 billion market essential for the operation of MRI scanners, computer chips and fibre optic manufacture as well as state of the art nuclear and cryogenic applications. A limited nodal supply chain compounded by a planned Russian supply of >30% of the global market has resulted in today's helium supply to many users being turned off.

Hydrogen is used to create fertiliser and in the hydrogenation of compounds essential for the food, petrochemical and pharmaceutical industries. The global hydrogen market today is $135 billion. Greater than 99% of today's hydrogen is produced by splitting off hydrogen from coal and natural gas (methane), and this alone accounts for 2.3% of global CO_2 emissions. To supply the energy needs of a net-zero society, hydrogen demand could increase the annual hydrogen market to between $700-$1000 billion – but only if the hydrogen comes from non-CO_2 emitting processes.

Helium is generated naturally over hundreds of millions of years in the continental crust by the decay of uranium and thorium found at very low levels in almost all rocks. The helium generated continually escapes because of its small atomic size and high diffusivity. Think of a helium filled balloon a few days after the party. When the helium reaches shallower levels of the crust, by itself it would be at concentrations so low that it would be dissolved in the water found in the rock's pore spaces. Under these circumstances the helium continues to diffuse through the water in the interconnected pore space towards the Earth's surface, where it either joins with hydrocarbon (methane) or carbon dioxide gases or reaches the atmosphere. Once in the air, because it is so light, helium escapes to space – another Houdini act.



Helium is a gas vital for MRI scanners and high tech industry – which is suffering from severe supply issues. Now research has identified a new concept in helium gas field formation that will help secure this rare gas for society. Here a tube of helium is seen glowing in the presence of a plasma ball. *CREDIT: Oliver Warr – University of Ottawa; AEL AMS Laboratory*

This new research by scientists from the Universities of Oxford, Toronto and Durham however also considers nitrogen. Nitrogen is released from the deep crust along with helium. The authors identify the geological circumstances where the concentration of nitrogen can be high enough to create gas bubbles in the rock pore space. Such a process can take hundreds of millions of years, but when it happens the associated helium escapes from the water into the gas bubbles. The bubbles rise, because of buoyancy, towards the surface until they hit a rock type, or 'seal', that doesn't allow the bubbles through (low permeability). The helium-rich gas bubbles collect beneath the seal and, the research shows, can form a substantial gas field when the overlying geological structures have the right shape (typically like an inverted bowl). These nitrogen and helium-rich gases contain no methane or carbon dioxide – and helium production is thus unchained from a carbon footprint. This new concept in gas field formation informs discovery of the locations, and gas compositions where such resources might be exploited.

Dr Anran Cheng, lead author of the study, says 'The high diffusivity of helium and the long timescales it takes to accumulate enough gas means that we must view the entire geological system as a dynamic process. This perspective helps identify the environments that slow the gases down enough to accumulate commercial amounts, rather than expecting all the gas generated to be geologically trapped'.
The radioactivity that generates helium also splits water to form hydrogen. In addition, hydrogen is also generated in large quantities when water reacts with common iron-rich rocks. Prof Chris Ballentine, co-author, notes 'The elephant in the room is hydrogen. The amount of hydrogen generated by the continental crust over the last 1 billion years (half the average age of continental crust) would power society's energy needs for over 100,000 years.' Prof Barbara Sherwood Lollar, co-author, tempers this by adding 'Much of this hydrogen has escaped, been chemically reacted or used up by subsurface microbes – but we know from studying the gas in deep locations in the subsurface around the world that some of this hydrogen is indeed stored underground in significant quantities'. Prof Jon Gluyas, co-author, states that, 'This new understanding of helium accumulation provides us with the critical start of a recipe to identify where significant amounts of geological hydrogen, as well as helium, might still be found.'

This work was funded by the China Scholarship Council, the UKRI Oil and Gas DTP, The University of Oxford Dept of Earth Sciences, NSERC and CIFAR (Canadian Institute for Advanced Research).
You can find the full paper at https://doi.org/10.1038/s41586-022-05659-0

Dr Anran Cheng (lead author) and Professor Chris Ballentine preparing equipment for measurement of helium isotopes in geological samples.
Photo credit: Sarah Hilton

RESPONDING TO VOLCANIC CRISES IN THE CARIBBEAN

PROFESSOR DAVID PYLE

Natural hazards research offers a rich, dynamic and interdisciplinary environment, where the challenges are not only to understand the physical processes driving the hazards – like volcanic eruptions and earthquakes – but also to use that new knowledge and understanding to mitigate future disasters. For the past 12 years, I have been working on interdisciplinary projects with colleagues from University of the West Indies and UEA on the volcanoes of the Eastern Caribbean to that end; most notably on Montserrat and St Vincent. Our work culminated this year in a portable and interactive exhibit, which we ran first at the Royal Society Summer Sciences exhibition in July 2023.

The steaming summit of the Soufriere Hills Volcano, Montserrat, March 2023.
Photo Credit: David Pyle

Volcanoes have many features that may mean that we can detect and diagnose activity long enough before it happens that we can take protective measures. We generally know where volcanoes are before they start to erupt; we can investigate their past behaviours, and install monitoring systems to track signs of unrest – which can usually be heard, felt and smelt – before an eruption begins. Communities living on volcanoes often have cultural memories of what happened during past eruptions, and of the warning signs that have preceded eruptions. These stories complement geological information we can retrieve from the deposits of past eruptions, and often fill gaps in the official records and correspondence that we might find in archives. For these reasons, a growing area of volcanic research involves community engagement. Not only is this a way of accessing and validating local knowledge, but it also empowers the people who live on volcanoes in their roles as custodians of the environment, to memorialise the past, and to imagine futures co-existing with the volcano.

'Metamorphosis of Hope' mural painted at the Montserrat Secondary School, May 2023.
Photo credit: Karen Pascal, Montserrat Volcano Observatory.

One place where we have been working recently is on the island of Montserrat. Montserrat has a dark history of colonial settlement and enslavement. It is also a volcanic island, but one which had not erupted in historical times until 1995. Over the past 18 months, we have been working with the Montserrat Volcano Observatory and with archives on Montserrat, and in the UK and USA. Our deep-dive into the archives reveals new stories of the scientific and political responses to a volcano-seismic crisis that troubled the island for four years in the 1930s, damaging buildings and causing anxiety across the island. There was no eruption, but instruments brought in by visiting scientists from Martinique and Britain to monitor these events helped to establish the first volcano observatory on Montserrat. This was run by staff from the agricultural station until 1946, when the last instruments were relocated to St Vincent. Our archive work has uncovered the names, and responsibilities, of the Montserratians who were involved in the response; the internal arguments among the British scientists, about whether there was actually a volcano there, or not; and arguments among government officials, over whose responsibility it was for managing the crisis, and whether or not it might make sense to build a regional monitoring network across the Eastern Caribbean. It took two further volcano-seismic crises, on St Vincent and then St Kitts and Nevis, before the first steps were taken to establish a regional Seismic Research Centre at the University of the West Indies.

In 1989, Hurricane Hugo laid waste to the capital, Plymouth and, at least in popular retelling, took with it the only copy of a 1986 report on the volcano threat to the island. Plymouth was rebuilt, with a new hospital, secondary school and jetty, in the shadow of Chance's Peak mountain. In July 1995, a crater behind Chance's Peak burst into life; and by April 1996, Plymouth and the whole of the southern Montserrat had been abandoned under the threat from the growing Soufrière Hills volcano. The eruption reached a tragic climax in June 1997 with the deaths of 19 people within the exclusion zone. Eruptions continued on and off until 2010, and the volcano today still remains restless, looming ominously over the buried city of Plymouth, with much of the island still out of bounds. But where the island was once grey, it is now increasingly green; and the subterranean geothermal bounty of the island could help transform the island's economy.

We shared the stories from the archives with an afterschool programme, developed by MVO at the Montserrat Secondary School – to engage the students with the recent history of the island and its volcano. The students then worked with artists from The Goodness Tour to create the first of a series of community murals which celebrate the new volcanic history of the island, its cultural heritage, and tropical riches.

These same stories also formed the backdrop for our exhibit – which explores how people sense, and make sense of volcanoes; and how we make decisions in the face of uncertainty. This year we have run the exhibition in London, Oxford and Norwich; and our ambition is to take the exhibition to Montserrat, to mark the 30th anniversary of the start of the Soufrière Hills eruption, in 2025.

Link to the project: *https://curatingcrises.omeka.net*

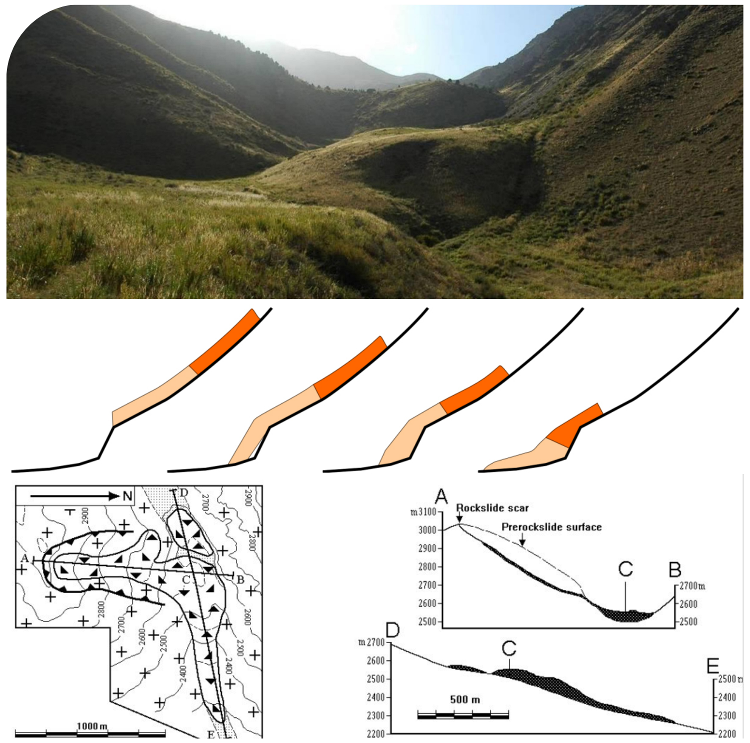
This work has been funded over the past 2 years by NERC, AHRC, the Royal Society and the University of Oxford GCRF and Newton Fund Consolidation Account (GNCA).

Some of the 'Sensing Volcanoes' team at the Royal Society, London, in July 2023. They are standing on the digital 'imaginarium', which we use to role-play a scenario around an emerging volcanic crisis on a small island. L-R: Sofia Della Sala (Oxford), Steph Batten (Royal Holloway), Conor Rutland (UEA), Michal Camejo (Oxford) and Beitris Morrison Evans (Oxford). *Photo credit: Sarah Hilton.*

KYRGYZSTAN ROCKSLIDES AND RELATED PHENOMENA

SECOND YEARS: CHARLES WALLACE AND ANDRAS CSEREP

In the summer of 2022, after the first year of our studies, we travelled to Kyrgyzstan and participated in the ICL Summer School on Rockslides and Related Phenomena run by Dr. Alexander Strom. The objective of this summer school was to learn about the various types of bedrock slide morphologies, with focus put on their internal structures and methods used for their identification. This is deemed to be of essential importance as hazardous natural phenomena endangers the livelihoods of people living in mountainous regions throughout Central Asia. This is further made apparent by the failures of up to billions of cubic metres of bedrock wreaking havoc with a 5-10 km runout distance away from the headscarp and the longer lasting effects of valley inundation with subsequent outburst flooding. One example of such an event was the 1786 Kangding-Luding earthquake in China that triggered the Dadu rockslide which formed a dam, resulting in outburst flooding that killed 100,000 people downstream, being the most disastrous rockslide catastrophe in recorded history (Dai & Lee, 2011).



An example of a rock avalanche we observed was The Northern Karakungey rock avalanche with a 10 million cubic metre volume. It's a jumping type rock avalanche with a compact body at the foot of the headscarp. Additionally, there are convex slopes and a long elongated avalanche part downstream. The main rock avalanche body jumped from a 200m shelf dividing into a rock avalanche downstream with a more broken up internal structure and a smaller separate deposit upstream acting as a dam past the ridge at the top left of the image. The graphic in the middle represents the standard jumping avalanche morphological shape but in real life these rock avalanches are complex and fail in a multitude of ways as shown in the bottom part of the image. Hence, it is essential to observe rockslides in detail. (Strom & Abdrakhmatov, 2022)

Cold river running from the mountains which you have to wash in at the Kokomeren River Basin camp.

A photo of a mound of rocks in a jigsaw pattern called a molard. It has been theorised that the rocks were ejected from the rock avalanche which is apparent by the structure of the molard. Nearer the centre of the structure, the rock fragments are smaller, possibly indicating the root of the feature. Understanding structures like these can tell us more about the internal flow and mechanics of the rock avalanche.

The reason we carried out this summer school in the Kokomeren River Basin in central Kyrgyzstan is due to the numerous rockslides and rock avalanches with various morphological types present (primary, jumping and secondary rock avalanches). The arid climate was favourable for their exposure and the region exhibits an expressive neotectonic structure with many active faults and surface ruptures, emphasising the link between tectonic activity and rock avalanches. This was done in collaboration with a variety of professionals in private, public and academic sectors representing Slovenia, Russia, Uzbekistan, Kyrgyzstan, Kazakhstan, India and Japan. The summer school was supported by the JCS Hydroproject Institute, Institute of National Academy of Sciences of Kyrgyz Republic, International Consortium of Landslides and UNESCO.

A typical day in the school started with the sound of Dr Strom's "GOOOD MOOORNING UNITED KINGDOM' at 6:30 as we struggled to leave the warmth of the sleeping bag and emerge into the almost freezing air temperatures. Luckily, there was a breakfast of hot porridge and Tandyr nan bread waiting for us kindly prepared for us by the two cooks, Ainagul and Kamila, who had been up even earlier. Straight after, we left for the various rock avalanches all crammed into an old soviet UAZ minivan. Dr Strom guided us around the various features of each slope failure, explaining how different types can be interpreted from their morphological and internal characteristics.

The large scale prehistoric landslides and surface ruptures we climbed and observed can be treated as evidence for strong earthquakes in the past and more recent history. Observing these hazards in the past can be useful when looking at future large scale intraplate earthquakes within Central Asia.

Caption: The cooks, Ainagul and Kamila, preparing dinner for us at the campsite. We ate a small packed lunch in the field, a meal of watermelon and plov in the afternoon and a soup ,such as lagman, with bread in the evening. *Photo credit: Ulzhan Aldabergen*

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Strom, A.L. & Abdrakhmatov, K.E. 2022, "Rockslides and rock avalanches in the Kokomeren River Basin (Central Tien Shan)" in the ICL Summer School on Rockslides and Related Phenomena Guidebook.

MAGMA TAKES THE LONG WAY AROUND

STEPHEN HICKS

Magma takes the long way round – A new study in Science Advances shows how molten rock from Earth's mantle, which eventually erupts, does not always take the shortest, most direct path available to reach volcanoes at the surface. These new insights help us to inform what drives the type and rate of volcanic eruptions and the make-up of erupted magma.

The published paper results from an international collaboration between scientists from the United Kingdom, the United States, Germany, and Trinidad and has involved Oxford Earth Scientists Prof. Mike Kendall and Prof. Jon Blundy.

When two titanic tectonic plates collide, one plate can sink (subduct) beneath the other, plunging into Earth's mantle. These subduction zones are responsible for some of Earth's most hazardous earthquakes and volcanic eruptions. However, it remains poorly understood how magma forms originally and what controls the exact position of volcanoes on top of the overlying plate.

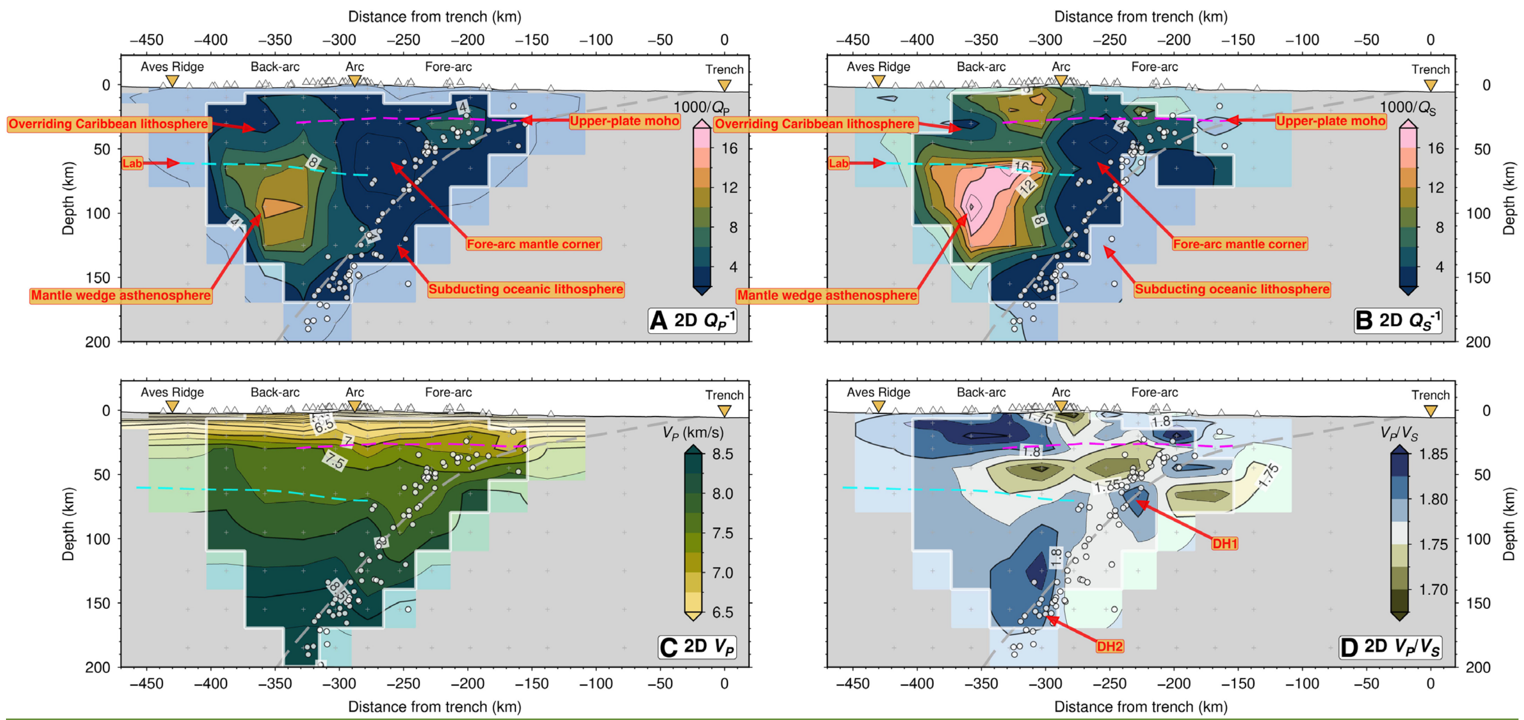
Lead author, Stephen Hicks, said, "Scientific views in this much-debated subject have traditionally fallen into two tribes. Some believe the subducting plate mostly controls where the volcanoes are, and some think the overlying plate plays the biggest role. But in our study, we show that the interplay of these two driving forces over 100s of millions of years is key to controlling where eruptions occur today".

Subducting oceanic plates act as giant reservoirs, transporting water into the deep Earth. These fluids enter the plate through fractures and faults formed during its birth (at mid-ocean ridges) and where it later bends beneath Earth's deep ocean trenches. Water gets locked into fractures and bound into minerals within the plate.

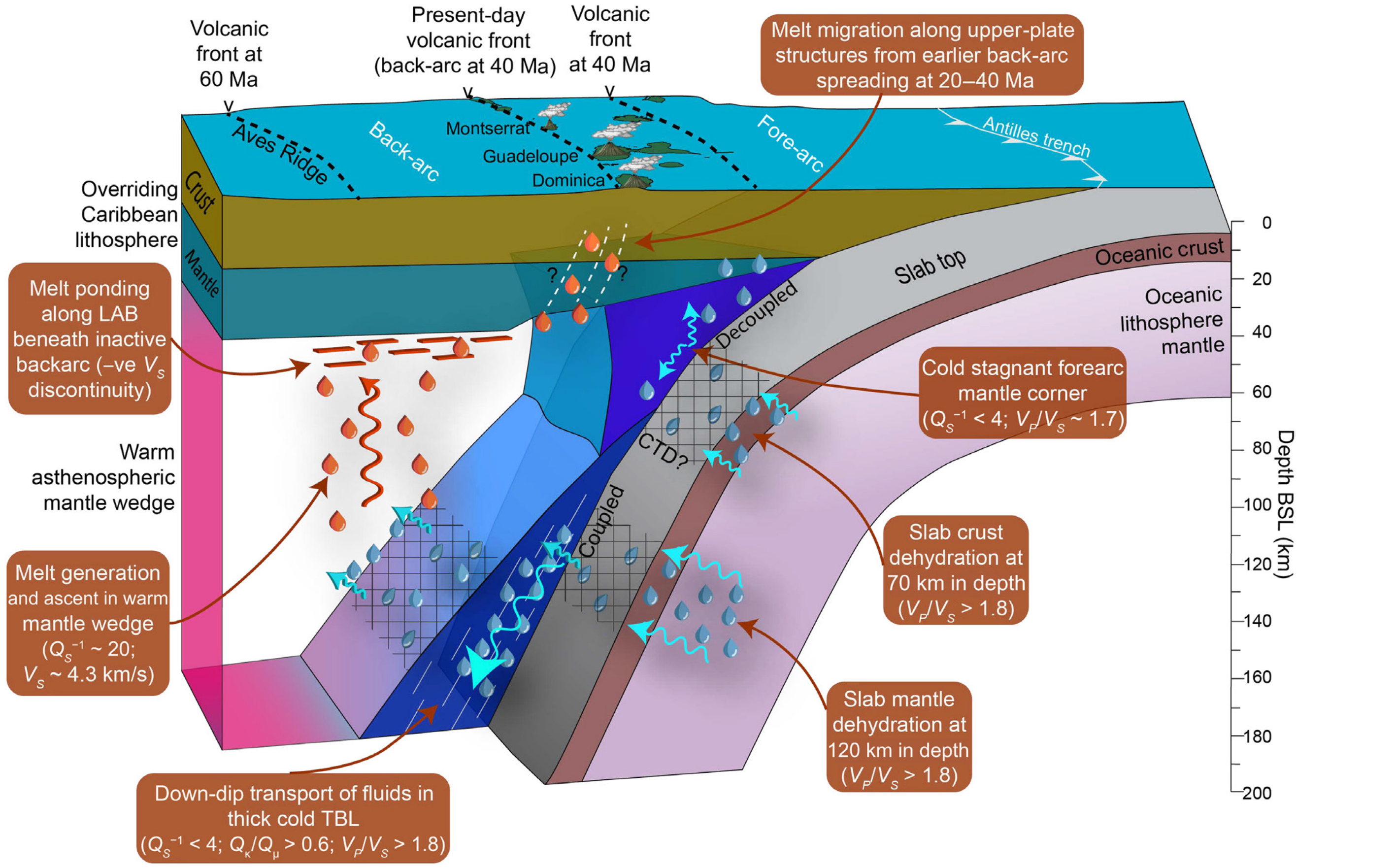
Subducting plates are subjected to high pressures and temperatures as they plunge to to 10s-100s of kilometres in depth. These extreme conditions cause the locked-in water (and other volatile elements) to be driven off. These fluids, which melt the warm mantle above, are the key ingredient of magma that eventually erupts around volcanic arcs at the edges of Earth's oceans (such as the Pacific Ring of Fire). Yet the pathways that fluids and melt take deep within the Earth, from the subducting plate to the volcanic arc, cannot be directly seen nor easily inferred from what is erupted.

When seismic energy from earthquakes travels through different materials, the waves either slow down or speed up. Along with these speed changes, the energy of waves is also absorbed (attenuated). Hot and molten rock is particularly attenuating: it zaps energy from seismic waves as they travel through it.

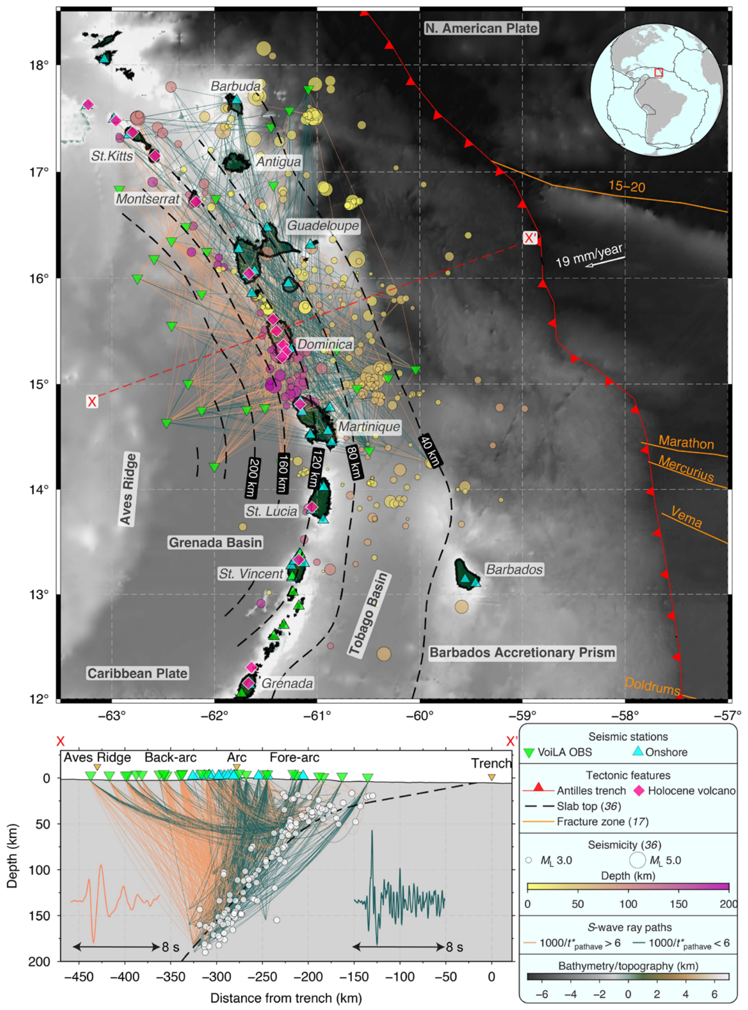
The study used earthquakes to map seismic attenuation in 3D, similar to how a CT scan maps the internal structure of our bodies. As part of a multi-million-pound Natural Environment Research Council (NERC) funded project, the researchers collected seismic data from a subduction zone in the Eastern Caribbean that resulted in the Lesser Antilles' volcanic islands.



Cross sections through the 3D models. *Image credit: Hicks et al., Sci. Adv. 9, eadd2143 (2023)*



Schematic view of dehydration and melting processes in the mantle wedge beneath the Lesser Antilles Arc (LAA) based on our combined interpretation of seismic attenuation and velocities. *Image credit: Hicks et al., Sci. Adv. 9, eadd2143 (2023)*



*Seismotectonic context of the Lesser Antilles arc, with S-wave ray-path coverage and path-averaged t*S results. Image credit: Hicks et al., Sci. Adv. 9, eadd2143 (2023)*

Stephen Hicks said, "Our knowledge of fluid and melt pathways has traditionally been focussed on subduction zones around the Pacific. We decided to study the subduction of the Atlantic instead because the oceanic plate there was formed much more slowly, and it subducts more slowly than the Pacific. We felt these more extreme conditions would make fluid and melt pathways more imagable using seismic waves. Hicks continues, "Because many subduction zones lie underwater, rather than land, we needed to deploy ocean-bottom seismometers to build an accurate 3-D picture of the subsurface". Unusually, the study found that the zone of strongest seismic attenuation at depth was laterally offset from beneath the volcanoes. These images led the authors to conclude that once water is expelled from the subducting plate, it is carried further downwards, leading to mantle melting behind the volcanic front. Melt then ponds at the base of the overriding plate before it is likely transported laterally back toward the volcanic arc.

The research paper can be found at: http://dx.doi.org/10.1126/sciadv.add2143

This news article was written by lead author Stephen Hicks (who conducted the research whilst at Imperial but who is now at UCL) and is shared with permission.

SAMPLE COLLECTION FROM DEEPEST, DARKEST PERU

CHEMICAL WEATHERING FROM THE ANDES TO THE AMAZON

VICTORIA ALCOCK AND LEWIS COLLINS (DPHIL STUDENTS)

The confluence of the Tambopata and Malinowski rivers within the Tambopata National Reserve in the Madre de Dios region.

The Amazon River basin is a critical component of one of the most important ecosystems on planet Earth and is an area of huge research and conservation interest across a wide range of scientific fields. It covers 6.1 million square kilometres, and part includes the world's longest mountain range, the Andes, the world's largest rainforest, the Amazon, which produces 20% of the oxygen in our atmosphere, and is home to an estimated 10% of the species on the planet.

For both of our DPhils we are investigating a range of chemical weathering processes and their impact on the transport of trace elements, the short- and long-term carbon cycles, and the effect of human activity on these processes. The Amazon basin has been the subject of much research in the past in this field, as the river system channels more rainfall than any other, seeing around 20% of the world's freshwater runoff, and moves an estimated billion tonnes of suspended sediment each year. This summer we had the opportunity to spend six weeks in south-eastern Peru, to collect samples in both previously studied and new regions of this amazing landscape.

Chemical weathering of silicate rocks has long been considered to act as a long-term CO_2 sink and a source of nutrients to the oceans, and accurately quantifying these weathering fluxes remains a key area of interest. However, recent research has uncovered further complexity in how these reactions move carbon and trace metals, spurring novel new lines of scientific investigation. Examples include how processes such as oxidative weathering of organic carbon and sulfide minerals can lead to weathering acting as a net CO_2 source, and how weathering reactions can concentrate and isotopically fractionate trace elements. Many of these trace elements are of critical importance to our lives, and finding new and sustainable sources of them, such as deposits produced by weathering, will play a key role in the transition to a greener technological world.

Deforestation, mining, and anthropogenic climate change are already having a huge impact on the overall carbon budget of the Amazon, which holds 150-200 billion tonnes of carbon in the forests and soils. It is already estimated to have emitted 13% more CO_2 than it sequestered over the past 20 years, and human destruction continues at an ever-accelerating pace. Around 10% of the total deforestation of the Amazon is now thought to be the direct result of mining related activity, which primarily focuses on the extraction of gold. This human activity changes both the chemical composition of the water through addition of mercury, and the physical properties of the sediments in the river system, by re-introducing fine-grained sediment and secondary phases which had previously been deposited.

Heavily deforested and mined land near the town of Alto Libertad in the Madre de Dios region. Isolated shrubs in the foreground on land that previously would have resembled the dense forest in the distance.

Chemical weathering processes can be investigated using laboratory measurements of the concentrations and isotopic compositions of elements in novel isotope systems, on samples of fresh bedrock, weathered rocks and minerals, and the waters they have interacted with. Our DPhil projects focus on the use of lithium and the trace element rhenium as tracers of different weathering processes. Lithium can be used to investigate the processes which occur during weathering on the scale of individual mineral surfaces to understand silicate weathering fluxes, and how secondary minerals concentrate

Confluence of the Inambari and San Gaban rivers showing the huge difference in sediment loads being transported along parallel paths from the Andes down to the floodplain. Mixing continues for several hundred metres around the bend.

and isotopically fractionate trace elements in the environment. Rhenium is a proxy for oxidation of fossil organic carbon, and can be used to track how this carbon-releasing reaction is controlled by environmental variables such as erosion. Together these proxies will allow us to investigate both silicate and oxidative weathering on the same samples in the same system, giving us a more complete view of both the key chemical processes and our impact on them.

We began our Peruvian adventure by collecting samples with another group based in the heavily mining affected areas of rainforest on the Amazon floodplain, where we were able to see first hand the damage caused by artisanal mining. While beautiful in its own way, the stark contrast between the open, sandy dunes with man-made mining ponds, and the pristine rainforest, served as a constant reminder of the consequences of our actions on the planet.

Taking in the tourist experience in Machu Picchu, the lost city of the Incas.

This section of our trip was sadly cut short by rumours of a second round of national strikes and road closures. Access to the main interoceanic highway was essential to our goal of sampling a transect from the floodplain to the high Andes, in two previously unsampled river sections. We quickly adjusted our plans and set off, using this road to follow the Inambari river and several of its tributaries. The carefully planned route took us through both shale and granite dominated catchments in the Madre de Dios, Puno, and Cusco regions of Peru, with sampling locations comprising major road bridges, riverbanks, rockfall deposits and soil profiles. Setting off early and working day and night enabled us to still collect a wide range of samples spanning fresh bedrock, weathered rock surfaces, water samples, suspended sediments and weathered secondary mineral deposits, albeit at the expense of our rest days!

The final sample location, water and rock samples, and our high tech equipment!

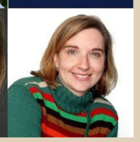
Owing to the huge volumes of water we needed to collect to obtain enough rhenium for isotopic analysis, and the need to use a long field column chromatography method to pre-concentrate the samples, we unfortunately ended up having to spend two weeks in Cusco at the end of our trip. This left us no choice but to see some of the world's most famous tourist sites while we waited for the samples to process. We left the columns running for as long as we could and explored the capital of the Incan empire and surrounding landscapes, with favourite sites including Humantay Lake, Saqsaywaman, and, of course, Machu Picchu.

Our final challenge was flying home with 25kg of samples and 45kg of equipment, ideally without anything being opened or thrown out along the way. While arguing in Spanish with Peruvian customs was not fun, it was much easier than the Spanish-Portuguese conversation in Sao Paolo! In spite of all this, our samples arrived safely back in London, and now wait in the Department for analysis in the labs in the new year!

FOR THE RECORD

RECENT AWARDS

Congratulations to Oxford Earth Sciences faculty member Dr Richard Palin for being awarded the Max Hey Medal of the Mineralogical Society for 2023. Dr Palin's research involves field- and laboratory-based studies combining metamorphic geology, isotope geochronology, geochemistry, and thermodynamic phase equilibrium modelling, which are used to investigate the evolution of the lithosphere in space and time. Recently completed projects have considered the physico-chemical effects of fluid–rock and melt–rock interactions in different geological environments (e.g. devolatilization in subduction zones and hydration of middle-/lower-continental crust), and comparative studies of the early Earth with other rocky bodies in our solar system, with a view to quantifying the extent of secular change in metamorphic processes and products though geological time. He has participated in numerous multidisciplinary and international collaborations during his career, and has published 78 papers on these themes, including contributions in Nature, Nature Geoscience, Nature Communications, and Geology.



Congratulations to Oxford Earth Sciences faculty members Heather Bouman, Stuart Robinson and Erin Saupe who have been promoted to Professor by the University's Recognition of Distinction panel. Heather is now Professor of Biogeochemistry and remains Supernumerary Fellow in Biogeochemistry at St Johns, Oxford. Her research investigates the diversity and physiology of marine phytoplankton single-celled organisms over a range of marine ecosystems, from the poles to the tropics, combining field observations with satellite remote sensing to improve knowledge of the factors governing the taxonomic structure and biogeochemical function of phytoplankon communities. Stuart is now Professor of Sedimentology and Stratigraphy and remains Tutorial Fellow at St Anne's, Oxford. His research focuses on the study of past environments, past climates and the impacts of major environmental change. In particular, how components of the Earth system (e.g. climate, carbon cycling, oceanography) have operated in the geological past, with a particular interest in periods of extreme greenhouse warmth, such as the Mesozoic Era and early Cenozoic. Erin is now Professor of Palaeobiology. Her research investigates the interactions between life and environments over geological time scales addressing fundamental questions on the origin, maintenance, and conservation of biological diversity. More specifically, integrating biological data with information from the fossil record to elucidate the controls on community and species' responses to environmental change across various spatial and temporal scales.

Many congratulations to Professor Ros Rickaby who has been named the recipient of the 2023 Science Innovation Award medal by the European Association of Geochemistry. Ros is a marine biogeochemist, her overarching theme is to use the past co-evolution of life, environmental chemistry, and Earth's climate to inform predictions of future change. Ros has pioneered an interdisciplinary blend of biology and chemistry to define the evolving role of the mineralising phytoplankton, in driving climate.

A paper published in 2021 with postgraduate student Odysseus Archontikis as first author has received the Tyge Christensen Prize this year. Awarded to Odysseus Archontikis and co-author Jeremy Young for their paper "A reappraisal of the taxonomy and biodiversity of the extant coccolithophore genus *Palusphaera* (Rhabdosphaeraceae, Prymnesiophyceae)." In this study, the authors clarified species-level diversity of the coccolithophore genus *Palusphaera*. Prior to this study, there was only one formally described species in the genus, *P. vandelii*. Based on examination of material collected during numerous research cruises, the authors raise the number of described morphospecies to four: *P. vandelii*, *P. probertii sp. nov.*, *P. crosiae sp. nov.* and *P. bownii sp. nov.* The results are based on the meticulous analyses of scanning electron microscope (SEM) images which revealed subtle but consistent differences among the species related to the structure and shape of the coccoliths and spines.

Congratulations to Dr Ross Anderson who has been awarded a Royal Society University Research Fellowship, one of 5 across the MPLS division.

The evolution of complex life like animals and plants transformed our planet and its ecosystems, but the early stages of this revolution remain poorly understood. The biggest barrier to our understanding is the rarity of early fossils. Looking for these key evolutionary markers is like looking for needles in a very large haystack. The Royal Society Research Fellowship will enable Ross the time to get to grips with how early fossils were preserved, helping him to pinpoint the right rocks to find them and inform an ambitious fieldwork programme. Ultimately the fellowship will enable him to address the tempo of the early evolution of complex life and how it was associated with environmental change.

It is with great pleasure that we announce 2 members of our department have won awards in the MPLS divisional Teaching Awards scheme. The scheme celebrates success and recognises and rewards excellence in innovative teaching practice. Congratulations to both Tamarah King and Ally Morton-Haywood who were nominated for these awards by both students and staff of the department.

Earthquake geologist, Tamarah King, received 11 nominations through the MPLS nomination process, plus two additional nominations in letters sent directly to the Associate Head of Division (Education). These recommendations came from both faculty members and undergraduate students and all recognised Tamarah's enormous efforts in classroom, tutorials and field teaching this year.

Alexandra is a graduate student and early-career teacher. She received two nominations from undergraduate students for contributions to demonstrating in their first-year palaeontology classes. Alexandra has a personal, inclusive and positive approach to demonstrating. This was recognised in the nominations, where students commented on the additional steps she took to support them, on top of her already outstanding demonstrator ability.

Congratulations to Dr Laura Stevens, who has been awarded a 2024 Arne Richter Award for Outstanding Early Career Scientists. Each year the European Geosciences Union (EGU) recognises an outstanding early career scientist in each of its disciplinary Divisions. Of these, four of the awardees are selected for the union-wide Arne Richter Award, recognising particularly outstanding achievements across all fields of geoscience. The awards are presented annually at the EGU General Assembly. Dr Stevens' research is in the field of ice-sheet dynamics, and how ice-sheet melting can drive changes in ice-sheet flow. Their work on ice-sheet dynamics in Greenland and Antarctica is vital for an improved understanding of global ice volumes, the vulnerability of these ice masses, and their effects on sea level. Before taking up their post in Oxford, Laura earned a PhD in Geophysics in the MIT/Woods Hole Oceanographic Institution Joint Program and a BA in Geosciences at Wellesley College, both in Massachusetts, USA. Their most recent work, published in the journal Nature Communications, examined observations of supraglacial lake drainage at Helheim Glacier, an outlet glacier of the Greenland Ice Sheet, and determined that the highly efficient subglacial drainage system resulted in a limited effect on the rate of discharge.

Our congratulations go to Professor Richard Walker on being awarded this years MPLS Social Impact Award. The awards celebrate the work of MPLS researchers who have made significant contributions to the economy or wider society at large, through their research. Working with colleagues in the UK and overseas, Professor Richard Walker's research group have devoted the last two decades to improving understanding of large earthquakes in continental interiors, with a particular focus on central Asia, where long recurrence times between seismic events mean that such risks are rarely on the minds or in the cultural memories of local communities and civic leaders. By utilising historic records from past disasters and a pristine landscape where earthquake ruptures have been preserved into the prehistoric period, the team have been able to map where active faults lie and analyse the types, sizes, and intervals between large earthquakes along them. These datasets have been used to develop officially recognised hazard maps that are now relied on for future planning decisions around urban expansion and future infrastructure development.

Many congratulations to Oxford Earth Sciences Head of Department, Professor John-Michael Kendall, is the recipient of the 2024 Gold Medal for Geophysics from the Royal Astronomical Society (RAS), which he was awarded for his outstanding work in the field of solid earth geophysics. Professor Kendall was presented with this award in light of his important contributions to the field of seismology (the study of earthquakes and seismic waves in the Earth's interior) and for his support of the next generation of seismic researchers. His work spans the full breadth of the discipline, from placing constraints on structures at the base of the Earth's mantle, to setting standards in seismic monitoring in industrial applications. Mike's research covers both pure and applied seismology and involves a range of geological settings. His current research reflects his keen interest in addressing the world's energy demands including sustainable natural resources. Recent research projects involve the search for geothermal energy and critical minerals held in volcanic brines. He also actively works on seismic methods for monitoring the geologic storage of CO2 as a means of reducing greenhouse gas emissions.

Professor Mike Kendall has also been elected a fellow of the Royal Society of Canada for his outstanding contributions to science. Already elected a fellow of the Royal Society here in the UK in 2019, Mike has this year been elected as a fellow of the Royal Society of Canada, in the Academy of Science. Mike says of the award, 'As a Canadian, this award means a lot to me. I benefitted greatly from the Canadian education system, which encourages students in all fields and is still one of the best in the world. I am fortunate that I still get to do research in exciting parts of Canada.' Leading seismic field experiments in geologic settings ranging from the Canadian Arctic to Ethiopia, Mike has made pioneering contributions to the study of the structure and dynamics of the Earth's interior, with a focus on seismic anisotropy. Congratulations to Mike for both of these awards!'

NEW KIDS ON THE ROCK

INTRODUCING THE NEW APPOINTMENTS IN OXFORD EARTH SCIENCES

Marina Flores
Research Assistant

Marina is an Environmental Geologist and Hydrogeologist with five years' experience working in Engineering and Environmental consultancy. She joined Oxford Earth Sciences as a Research Assistant to work on a project that seeks to repurpose Oil & Gas datasets to identify ultra-deep aquifers. She has carried out data analysis using geospatial analysis (GIS) and machine learning. Ultra-deep aquifers are located in unconventional groundwater settings and mapping them could contribute to identify alternative sources of fresh water. This would be of importance to arid or drought-stricken areas around the world to alleviate water scarcity.

Dr Malini Kallingal
Postdoctoral Research Assistant in Blue Carbon Security at CO_2 Storage Sites

Malini has joined us from Defence Bioengineering and Electromedical Laboratory (DEBEL) – Defence Research and Development Organization (DRDO), Ministry of Defence, Bangalore, India where she did her Ph.D. in Chemistry. Her research mainly focused on the preparation, characterization and functional studies of modified activated carbons for the capture of CO_2 from confined environment. Here, she will be working in the Agile project (Carbon Capture and Sequestration) focusing on generating maximum estimates of blue carbon at risk of disturbance across the Endurance site from compiled data of particulate organic carbon (POC) and accumulation rate in sediments from BGS and oil industry repositories. She will estimate rates of loss of carbon and therefore Corg remineralisation by performing CO_2 bubbling experiments.

Dr Zheyu Tian (Jerry)
Departmental Safety Officer & Chemical Safety Officer

Dr Zheyu Tian (Jerry) has recently joined Oxford Earth Sciences from the Earth Sciences Department at University College London, where he earned his PhD in Sedimentary and Isotope Geochemistry. His previous work focuses on biogeochemical cycles, developing and refining existing geochemical methods, understanding the weathering and oxygenation history, and the relationship with tectonic movements and life evolution through crucial junctures in Earth history (mainly PreCambrian). Holding a doctorate in geochemistry equips him with a profound understanding of the necessity for laboratory experiments in Earth Sciences. In his role as the Departmental Safety Officer & Chemical Safety Officer at our department, Jerry's responsibilities encompass managing and overseeing the safe handling, storage, and disposal of hazardous chemicals in our Department. Providing safety guidance, support and maintaining a secure working environment to all levels in the wet chemistry lab.

Dr Charlie Rex
Outreach and Communications Manager

Charlie joins Oxford Earth Sciences from the University of Glasgow, where she recently defended her PhD thesis on the East Asian Monsoon in Japan and how it behaved during recent periods of deglaciation. Her research focussed on developing isotope-based monsoon reconstructions using the varved sediments of Lake Suigetsu, and the utilisation of contemporary isotope monitoring and luminescence techniques to support the creation of these records. Charlie holds a BSc in Chemistry and Earth Sciences from Durham University, and a MSc(Res) in Polar and Alpine Change from the University of Sheffield. She is thrilled to be here coordinating the department's outreach programme, communications and events, and looks forward to meeting many of our alumni in the coming weeks and months.

Hilde Cronwright
Laboratory Technician (RIV-ESCAPE)

Hilde has joined the Oxford Earth Science department to provide analytical, technical and administrative support to the team working on the RIV-ESCAPE project under Professor Bob Hilton. She holds BSc Honours degrees in both Geology and Chemistry. Her working experience includes 10 years as Laboratory Manager in the ISO17025 accredited Diamond Exploration Laboratory at The MSA Group, an international geological consulting company based in Johannesburg, South Africa. Prior to that she had a 13-year career as Analytical Scientist at the Council for Geoscience (Geological Survey of South Africa) in Pretoria, specialising in the analysis of geological samples for large-scale regional geochemical exploration projects and environmental applications. She has a keen interest in method development, implementing quality control procedures and project management.

Dr Jimmy Moneron
Post-doctoral researcher in carbon storage risk assessment

Jimmy just finished his Ph.D. in Jerusalem where he worked on the fascinating Messinian Salinity Crisis in a Marie Curie fellowship called SaltGiant. Prior to that, he did his BSc and MSc (in geology-related fields) in Norway (Tromsø, Bergen) and France (Dijon, Paris).
Jimmy is now working in Oxford as part of the Agile Initiative, a NERC-funded project, which is a multidisciplinary network focused on CO_2 storage in the 'Endurance site' located offshore UK. Jimmy's current research especially focuses on analyzing faults above salt-cored anticlines and assessing risks related to potential CO_2 leakage after injection. He also works on the Permian's Zechstein salt, where he analyses maps of different stratigraphic levels within that salt layer.

Dr Leonardo Mena-Rivera
Postgraduate Research Assistant in Biogeochemistry

Leo joins the University of Oxford from the School of Chemistry of National University of Costa Rica. Prior to that, he completed a PhD in Chemistry at the University of Bristol. His research focuses on understanding the key processes involved in the transport, reactivity and preservation of organic matter in freshwater ecosystems, using a combination of mass spectrometry, compound-specific stable isotopes and amplicon sequencing approaches. He has also been involved in multiple initiatives regarding integrated water resources management.
Photo: Leonardo Mena-Rivera

This year the department was also joined by ...
***Joseph Asplet** – Postdoctoral Research Assistant in Induced Seismicity and Seismic Imaging*
***Monika Rusiecka** – Postdoctoral Research Assistant in Experimental Petrology*
***Deze Liu** – Postdoctoral Research Assistant in Experimental Petrology*
***Lauren Gorovjsky** – Postdoctoral Research Assistant in Experimental Petrology*
***Rita Kounoudis** – Postdoctoral Research Assistant in Seismology*
***Jason Dowsing** – Building and Facilities Technician*
***Nadia Santodomingo** – Departmental Lecturer in Palaeontology*

THANK YOU!

A SELECTION OF THANK YOU MESSAGES FROM STUDENTS TO ALUMNI

In first year all our Earth Science students are given a field kit which enables them to complete their work while out in the field. The supply of this kit is entirely funded by alumni donations. This year some of our students wanted to say thank you to you, our alumni, for supporting this initiative

I am a 3rd year student, and I was looking through our online resources that I should inform my 1st year mentees about, when I came across a document detailing the cost of all our field kit. I had never stopped to think how lucky we are to have this provided from department right at the beginning of the degree since it has proved invaluable, through our field courses and definitely our mapping project! I wanted to extend my thanks, for myself and the whole undergraduate body, for the provision of our field kit!




Dear All Alumni,
I am Adriana Karim, an current fresher at Oxford University reading Earth Sciences. I am writing to you to express my heartfelt gratitude for sponsoring the equipment needed for future field trips. The attached document is a thank you card that I designed as a token of appreciation. I am fully aware that it is not much compared to the kind donations you have given but I believe this is the least I can do.
Thank you,
Adriana Karim

Dear department alumni,
I am Xuanxiao Wang, a first year Earth Sciences student. Thank you very much for providing the valuable equipment to help us carry out the field study. I appreciate all of your support greatly.
Sincerely,
Xuanxiao

ISLAY REUNION

JOHN THOMPSON

In June, fifteen past students of Earth Science ("Geology") at Oxford (Matriculation 1973) gathered on the Isle of Islay for a fifty-year reunion – a concept that made all the attendees collectively nervous. We were joined by nine partners who provided a welcome diversion from excessive reminiscing and geotalk.

The opportunity to meet on Islay was exciting especially given the local expertise provide by one of the past students – David Webster. David spends a substantial amount of time on the island and has co-authored two excellent field guides on Islay, Jura and Colonsay (details below). These provided context and details for field visits over the weekend. Of course, the nature of Islay, the beautiful beaches, and nine excellent distilleries added to the appeal.

The geology of Islay is remarkably diverse and significantly different from other Hebridean islands in the region. We visited areas in the southwestern, southern, and eastern parts of the island. Highlights included the ~1,950-1,780 Ma Rhinns Complex – gneissic

gabbro and syenite that was metamorphosed at ~1.710 Ma, the unconformably overlying Dalradian Groups - featuring evidence for a snowball earth (Port Askaig Tillite) and well-preserved stromatolites in the overlying Bonahaven Dolomite, and the "billion-year gap" (the unconformity) that separates these two contrasting sequences. We also inspected a wide variety of intrusions, mostly dykes and sills representing diverse ages and rock types – late Neoproterozoic, Silurian, Permo-Carboniferous, and Tertiary – that reflect rift-extensional and arc-compressional tectonic events over more than 600 My. There was more than enough to satisfy the geological specialities in the group and interesting geological anecdotes, locations, and natural history for the non-geologists. A visit to an active archaeological dig on a Mesolithic-Neolithic site was a fascinating bonus.

Islay is well known for magnificent distilleries. We visited two and saw the other seven, learnt about whisky making, the source of barley and water, and some of the related myths. A few drams were tasted during the visits and well into the evening in the Port Charlotte Hotel, the base for our visit. We were a vibrant but well-behaved group, and everybody was up on-time and raring to go each day. That was not necessarily the case 47-50 years ago!

It was a wonderful weekend where we discovered that the group was as eclectic as ever but excellent company. A vote of thanks goes to our Islay hosts, David and Isobel, and to James Macdonald and others who helped to galvanize us into action. Plans are afoot for another gathering in a new location – to be determined.

Check out the two guide books by David Webster, Roger Anderton and Alasdair Skelton: A Guide to the Geology of Islay (3rd edition 2021) and A Guide to the Geology of Islay, Jura and Colonsay Volume II (2021), published by Ringwood Publishing: www.ringwoodpublishing.com

Photo credit: John Thompson

A RETURN TO HORTON-IN-RIBBLESDALE: FIFTY YEARS SINCE OUR MAPPING TRAINING

ROBERT GATLIFF

The Class of 1972 has had several large get-togethers, including visits to Cambridge, Oxford, The Alps, and last year a 50-year reunion in The Pyrenees. I don't know the usual percentage of students that continue as geologists but in our year, it is probably more than 75%, and those that have taken different paths still have their geological enthusiasm.

In June a smaller group decided to participate on a shorter field trip to Ribblesdale and adjacent valleys, led by one of our own, Andy Johnson, who has developed an interest in the area through training University of Derby students. Andy put together a brilliant weekend, meeting at The Crown in Horton where we all stayed in 1973. Keith O'Nions, supported by Adrian Bath led the Easter 1973 field trip; two terms into our degree course, our first week-long field trip, and straight into field mapping. Looking at my field notebook, we certainly worked hard taking dips and strikes, cleavage measurements and logging many sections in great detail around the Crag Hill anticline. I remember an article in the press reported a "group of schoolboys" trespassing on the railway and inadvertently stopping a train! More likely an undergraduate fumbling a coin out of his pocket to place on the track.

Archaeology or Geology? The team at Holmes' Erratic

The first day was a walk around Horton looking at the Ingletonian, remembering Keith talking about his first radiometric dating in the area. Andy had approached the landowner for access to some outcrops of the Silurian sequence but access was denied. A few sheep seem a poor reason to stop visitors entering a field…it wouldn't happen in Scotland!

Day 2 was based on the Ingleton waterfalls trail. There is a one-way system in operation but the geological story works better in reverse, with superb outcrops of Carboniferous Limestone and the Ingletonian. Later we drove up Kingsdale seeing glacial features. On Sunday morning we visited Norber near Austwick. Norber is well worth the climb. On the way up there is a lovely outcrop of the Carboniferous-Ordovician unconformity – not so good as on previous visits, like so many classic geological outcrops, soil and plant growth are degrading them! At the top is a large cluster of erratics.

Andy has theories about the Norber erratics (Why are they there? Are they really glacial erratics?) Intriguingly, there are huge blocks in a boulder bed about 10 m above the unconformity of the same composition and size as the cluster of erratics. Maybe there is a link to the erosion of stacks along a complex shoreline.

Cheese tasting at Courtyard Dairy

Members of the Class of 1972 re-convened with partners at the site of their first undergraduate field trip in April 1973 at the Horton in Ribblesdale inlier Yorkshire. The trip was lead by Andy Johnson (Keble: facing to the right).

At the top we agreed a revised interpretation of a classic figure in Arthur Holmes' Principles of Physical Geology (Fig. 494, page 659 in my thick red 2nd edition) - no longer geological but archaeological.

We finished the trip at the Courtyard Dairy just outside Austwick with a splendid cheese tasting. A short but excellent reunion.

The Austwick 'erratics' a famous group of Silurian greywackes found resting on Carboniferous Limestone provoked much discussion. The much-photographed boulder in the picture (Holmes: Principles of Physical Geology 2nd edn., p 659) has clearly been propped up by "Austwick man" and is not, or is not solely, resting on an undissolved pedestal of karstified limestone.

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

AND EVOLVES...

LEGACY GIFTS HELP ENSURE OUR DEPARTMENT DOES BOTH

FIND OUT MORE HERE:
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To learn more about the impact a gift in your will could have, or to find out how to remember the Department's work in your bequest, please contact:

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