GeoCam

EARTH SCIENCES ALUMNI MAGAZINE

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NEWS

London Underground air polluted with small magnetic particles

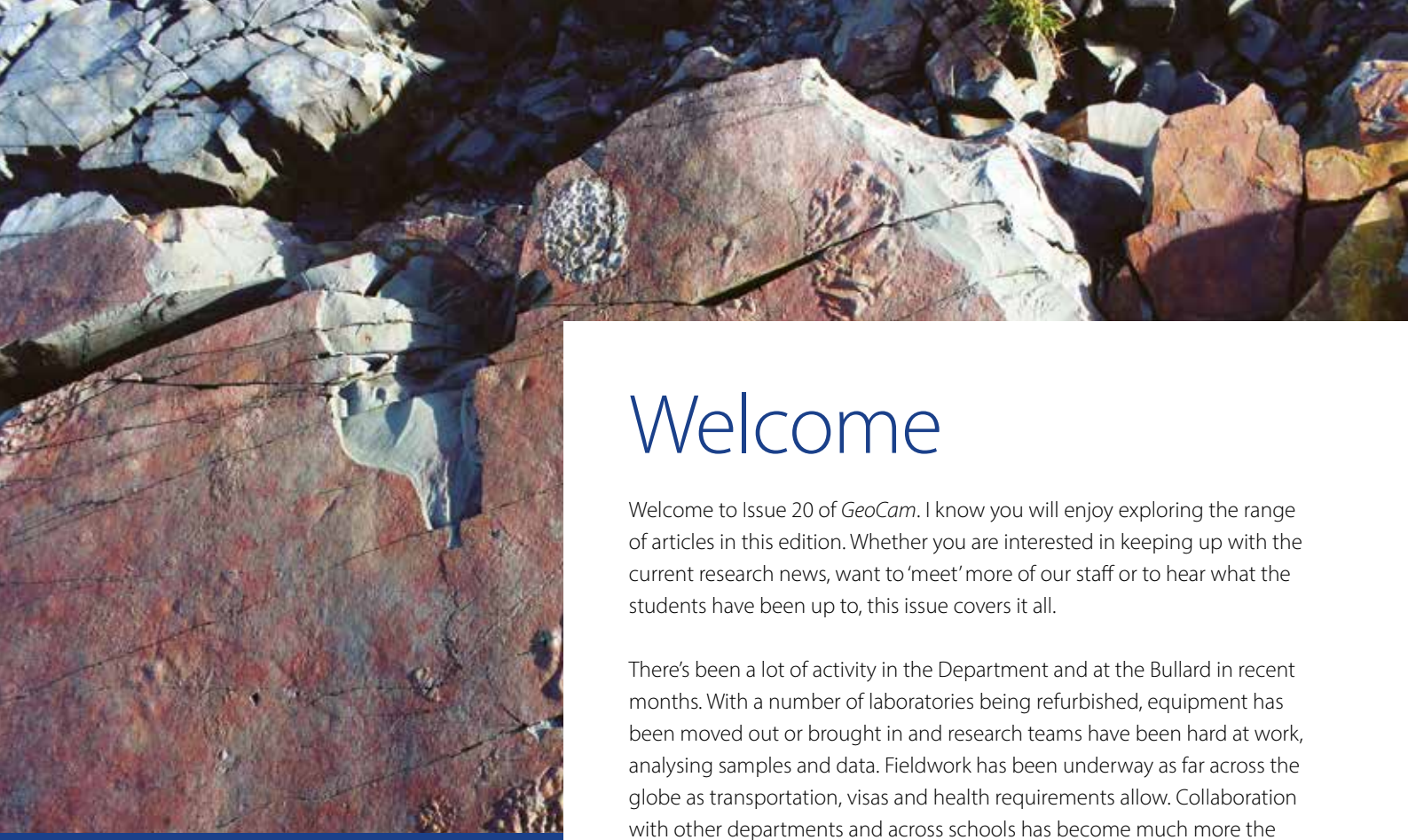
FEATURE

In Conversation with Alex Liu

RESEARCH

Mineral Resources for the Energy Transition

UNIVERSITY OF CAMBRIDGE



IN THIS ISSUE

Cover Image: Mount Kinabalu, Borneo

Welcome

Welcome to Issue 20 of *GeoCam*. I know you will enjoy exploring the range of articles in this edition. Whether you are interested in keeping up with the current research news, want to 'meet' more of our staff or to hear what the students have been up to, this issue covers it all.

There's been a lot of activity in the Department and at the Bullard in recent months. With a number of laboratories being refurbished, equipment has been moved out or brought in and research teams have been hard at work, analysing samples and data. Fieldwork has been underway as far across the globe as transportation, visas and health requirements allow. Collaboration with other departments and across schools has become much more the norm for research being undertaken in a range of areas as well.

The end of the summer was also an end of an era for two of our most well-known staff. James Jackson and Andy Buckley both retired in September 2022. Other news on who has joined and who has left is included in the Geological Record pages herein and it is all part of the life of an organisation to welcome and farewell individuals but it would be fair to say that Andy and James have made unique contributions that have touched the lives of a huge number of people who have come through the doors.

Outreach has become a buzz-word in academic institutions. Often it is about creating connections with local communities; allowing potential future students the chance to experience what a course has to offer; helping primary schools enrich the education they offer. For us it includes reaching out to our Alumni to maintain the relationship built in your time here. As well as GeoCam, we have a termly e-newsletter, an alumni LinkedIn group and department Instagram and Twitter accounts for you to follow. If you haven't yet perused the many articles on our Blog, I recommend enjoying the diverse content shared there. If you find yourself able to join us, the Alumni Day is a face to face chance to reconnect – with staff and student volunteers as well as your peers. I wish you a happy and healthy 2023. We hope to see you soon,

Richard Harrison, Head of Department

CARA HANMAN,
ALUMNI COORDINATOR

The building's carvings

Every alumnus can remember the majestic purple Weald brick and Clipsham limestone of the downtown building but have you ever studied the many carvings that decorate the exterior?

When scaffolding was erected recently for maintenance work, the intrepid Andrew Stephenson took the chance to get some close up images that sparked my interest in things I think are hidden in plain sight: the c120 year old decorations not seen in detail by anyone without a scaffold since they were installed.

The building was designed by T G Jackson in 1892 to house a working museum and be a focus for University teaching and research. Built between 1899 and 1904, the Sedgwick Memorial Museum cost nearly £40,000, funded by an appeal, managed by Sedgwick's successor Professor Thomas McKenny Hughes, that ran 'for a generation'.

T G Jackson's autobiography notes that the carvings are by London-based architectural sculptors and ornamentalists Farmer and Brindley. The column capitals offer eye catching carvings – there are flowers, the heads of musk sheep, pterodactyls (my personal favourite) and what might be a fawn's head nestled amongst the more typical flourishes of scrolls and leaves. The bears and bison at the museum steps, an iguanodon and sloth supporting the University arms and the woolly mammoth to the left of the Downing Street entrance make up the welcoming party to anyone entering the building.

It proved difficult to uncover information in the archives about the carvings but former Museum Director Dave Norman was able to help with the research: '*The stonework chosen has significance. And the pairing of the ground sloth & Iguanodon over the entrance on Downing St is clearly related to the early exhibits (there is a huge ground sloth pelvis and hind limb that used to be on display in the Cockerell Building and the Iguanodon came across from Zoology "on loan" in the 1890s).*'

The discovery doesn't stop there. Just below the eaves of the North Wing, are a number of evenly spaced college coats of arms. On the south facing side of the North Wing are Trinity, Downing, Sidney Sussex, Emmanuel, Magdalene, Christ's and St John's. The north facing side bears the arms of St Catharine's, Peterhouse, Clare, Pembroke, Gonville and Caius, Trinity Hall, Queens', King's, Corpus Christi and Jesus colleges.

The suspicion that these shields represented the colleges that donated to the building appeal was hard to verify. However, Dave once again came to the rescue, confirming '*Yes, the shields were of the donors to the memorial fund...*' In Douglas Palmer's biography of Professor McKenny Hughes for the Geological Society, he notes that a Dr C Darwin contributed 15 guineas to the building appeal managed by the professor, which makes me curious about who else donated. Perhaps finding the list of donors will uncover another Hidden Department story…

The carvings of an iguanodon and ground sloth either side of the University coat of arms over the Downing Street entrance to the Department.

RESEARCH NEWS

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FOSSIL OVERTURNS MORE THAN A CENTURY OF KNOWLEDGE ABOUT THE ORIGIN OF MODERN BIRDS

© DR DANIEL FIELD

The Cambridge research team.

Fossilised fragments of a skeleton, hidden within a rock the size of a grapefruit, have helped upend one of the longest-standing assumptions about the origins of modern birds.

Researchers from the University of Cambridge and the Natuurhistorisch Museum Maastricht found that one of the key skull features that characterises 99% of modern birds – a mobile beak – evolved before the mass extinction event that killed all large dinosaurs, 66 million years ago.

This finding also suggests that the skulls of ostriches, emus and their relatives evolved 'backwards', reverting to a more primitive condition after modern birds arose.

Read more: http://bit.ly/3ISyf9G

NORTHERN BORNEO'S TECTONIC HISTORY AND UNUSUAL LANDFORMS EXAMINED WITH SEISMIC DATA

Northern Borneo is dotted with puzzling landforms that can't be explained by typical plate tectonic processes. One example is Mount Kinabalu – in the Malaysian state of Sabah in northern Borneo – an anomalous granite mountain which towers at twice the height of all other peaks in the country.

"We wanted to know how strange surface features like Mount Kinabalu got there," said Cambridge Earth Sciences' Nick Rawlinson. Back in 2018, Rawlinson and researchers from Cambridge, the University of Aberdeen, Universiti Malaysia Sabah, and the Malaysian Meteorology Department deployed a network of seismic stations across the region.

After nearly two years of data collection, the researchers have created a seismic profile – effectively a slice through the Earth showing the structure of the crust and mantle beneath northern Borneo. The results, which Rawlinson will be presenting at this year's AGU Annual Fall Meeting, show how northern Borneo's landforms are related to processes happening deep in the convecting mantle.

Read more: http://bit.ly/3XjbYGp

© N RAWLINSON

SCIENTISTS MAP DEEP WATERS IN THE NORDIC SEAS

© CHRISTINA LARKIN

A new study involving Cambridge earth scientists, published in the journal Nature Geoscience, is helping us understand the mechanisms linking the oceans with the climate system.

"The extent to which ocean circulation can be impacted by the changing climate is of key importance to society..." said lead-author of the study Christina Larkin, who was a PhD student at Cambridge Earth Sciences when she conducted the research.

For decades, scientists have theorised as to how the shifting ice cover impacted ocean circulation. A leading idea is that deep water formation in the North Atlantic shifted south to warmer climes during the last ice age, but other studies found contrasting evidence. This new research is the first to map out deep water movements in the Arctic in unprecedented detail, meaning the debate can finally be re-addressed.

Read more: http://bit.ly/3WjGe2u

UNEARTHING THE REASONS WHY SOME ANCIENT ROCKY CRATONS OUTLIVE OTHERS

Looking around us, from the mountains of the Himalayas to the bottom of the ocean, many rocks are no more than a few hundred million years old. But some areas of Earth's surface have remained virtually untouched for 3 billion years. These resilient cratons are located within continental interiors, set back from plate boundaries.

Research conducted by Charlotte Jackson, previously a PhD student in the Department of Earth Sciences – measured water and fluorine in rocks from the roots of the ancient Kaapvaal craton in southern Africa.

© C JACKSON/S GIBSON

Mantle xenolith containing orthopyroxenes which have been sheared.

According to Professor Sally Gibson, "Charlotte's detailed and data-driven approach has been crucial to unravelling the controls on craton stability."

Read more: http://bit.ly/3WmwSmK

© LONDON UNDERGROUND STOCK IMAGE

LONDON UNDERGROUND POLLUTED WITH MAGNETIC PARTICLES SMALL ENOUGH TO ENTER HUMAN BLOODSTREAM

The London Underground is polluted with ultrafine metallic particles small enough to end up in the human bloodstream, according to University of Cambridge researchers. These particles are so small that they are likely being underestimated in surveys of pollution in the world's oldest metro system.

The researchers carried out a new type of pollution analysis, using magnetism to study dust samples from Underground ticket halls, platforms and operator cabins.

The team found that the samples contained high levels of a type of iron oxide called maghemite. Since it takes time for iron to oxidise into maghemite, the results suggest that pollution particles are suspended for long periods, due to poor ventilation throughout the Underground, particularly on station platforms.

Some of the particles are as small as five nanometres in diameter: small enough to be inhaled and end up in the bloodstream, but too small to be captured by typical methods of pollution monitoring. However, it is not clear whether these particles pose a health risk.

Other studies have looked at overall pollution levels on the Underground and the associated health risks, but this is the first time that the size and type of particles has been analysed in detail. The researchers suggest that periodic removal of dust from Underground tunnels, as well as magnetic monitoring of pollution levels, could improve air quality throughout the network. Their results are reported in the journal Scientific Reports.

Read more: http://bit.ly/3GLggPJ

DR JUDITH BUNBURY, GEOARCHAEOLOGIST AND TEACHING ASSOCIATE

A DAY IN THE FIELD **EGYPTIAN GEOARCHAEOLOGY**

Just before dawn, I wake with chattering teeth to hear the welcome sound of the chef putting on the kettle. The coldest moment, when you are in the desert under canvas, is half an hour before dawn, when the temperature can dip below zero.

Ruins of the Roman town at Umm el-Dabadeb, Kharga Basin.

Camping in the Kharga Basin.

Geology underground in the Valley of the Kings.

Time to get up! I wriggle around, dressing inside my sleeping bag and, as the kettle boils, emerge from my tent as other shadowy figures, all in coats, hats and gloves also hatch, each from their own chrysalis. The first cup of tea is restorative and the second a treat, as we eat a camp breakfast, fried egg, fried dates and lightly toasted flatbread.

MY WORK AS A GEOARCHAEOLOGIST TAKES ME DOWN TOMBS AND WATER TUNNELS, UP MOUNTAINS, ACROSS DRIED UP LAKEBEDS AND OVER SAND DUNES IN THE DESERT. AT OTHER TIMES, I SPEND A WEEK IN THE NILE VALLEY, SHADED BY PALM TREES, DRILLING THE NILE SEDIMENTS. SOMETIMES WE CAMP, AT OTHER TIMES RENT A DIG-HOUSE.

The teams can be large and include all types of specialists, those who can magically read hieroglyphics off a rock-face or the prints of disease in ancient bones. My role is to record and interpret the sedimentary and environmental records and identify the type and source of stone artefacts. It is a privilege to work alongside such a variety of experts and fascinating to hear, day-by-day what they are discovering as we piece together the past.

While the archaeologists examine in minute detail the interior of ancient buildings, they determine who lived there, what they ate and their trading and diplomatic contacts. Sometimes they find the letters they wrote or the stories that they read. My personal favourite is a complaint about a missing item of laundry from around 1200 BC. Out in the field, I concentrate on the environment around the site, discovering where the springs and pools, wells, quarries and even rubbish dumps were. Using the hand auger, we can sample the past, with the average metre of sediment equivalent to a thousand years of history. Compiling the evidence, we create a 4D model of the landscape history of Egypt. On the millennial timescale, we see the Nile snaking across the valley floor, large lakes shrinking into mud-pans and the green realm of the Early Holocene Sahara turning into one of the world's largest deserts.

Our unexpected result is that, during the Late Bronze Age (c. 1500–1300 BC), leading up to the time of Tutankamun, Egypt enjoyed a further wet period. During this time, wells and waterholes in the desert refilled and ancient explorers set out, travelling from oasis to oasis, building as they went and setting up water-stations along the caravan routes. As the desert dried out again, the people departed until another wet-period, in the Graeco-Roman Era (c 300 BC – 300 AD), when the same routes and wells came back into use.

In our time, climate change has started to bring rains back to Egypt. The once rare rainstorms have become regular features of the Egyptian winter and pools have started to reform. However, climate sceptics challenge our interpretation and offer alternative explanations. What we interpret as springs in the desert from which people collected water, they interpret as shrines to which people brought water. In our 2022 season, we set out to break the deadlock and decide whether they were really springs and whether we can expect them to reform if the rains continue.

In the spring season of 2022, we headed out into the desert, to a site we know as 'Jeddah' to explore abandoned churches and monasteries and look for evidence of former springs. Beside a cleft in the rock, we found hundreds of wasp nests and a now-dry reservoir. These wasps had travelled 14km from the cultivation of the Nile Valley before stopping to build their nests. Feeding on nectar, they carry balls of wet mud to a sheltered crevice where they fill a mud cell with paralysed grubs and insects, accompanied by an egg. When the egg hatches, it eats the larder, kindly left by its parent, and eventually breaks out of the cell to fly on the wind to a new site. They are the perfect indicator of a wet micro-habitat, and the nests are over the top of the Roman plaster, making it unlikely that they were dependent upon water, delivered by zealous monks tending a shrine.

By mid-morning, the desert is getting hot, we find a handy shadow and stop for 'second breakfast', a brew of porridge or noodles and a cup of 'wadi tea', made by shaking a teabag in hot water from a flask. The break is welcome and comes around the time we need to turn towards basecamp, all archaeologists must be off the desert by 2pm. Back at base, dig lunch starts with a rehydrating soup and is followed by a chance to plot up and consolidate our notes. Don't tell the Director, but I often sneak in a crafty nap after my morning on the hoof!

CHARLES D. BEARD, POSTDOCTORAL RESEARCH ASSOCIATE

MINERAL RESOURCES FOR **THE ENERGY TRANSITION**

The rollout of renewable energy generation and electrified transport infrastructure requires mining of a range of raw materials, many of which have historically low demand. Can a process-based understanding of the formation of these critical geological resources help us to efficiently locate them, and to extract from them with minimal environmental impact?

Above left: Banded carbonatite, Tundulu complex, Chilwa Alkaline Province, Namibia. The vast majority of active REE mines target deposits associated with carbonatite, where carbonate minerals dominate over silicates. Carbonatites are thought to exsolve from alkaline-silicate melts during cooling and crystallisation.

Above right: Drill core from the Catalão II Nb-P deposit, Alto Paranaíba Igneous Province, Brazil.

The biggest challenge that society faces today is, of course, climate change. Over the last 20 years, use of "green" technologies, including solar, wind power, and electric vehicles, has grown massively. The good news is that this growth has driven down cost so that renewables are now comparable with, or often cheaper than, fossil-based options. The adoption of renewable technologies is climbing sharply but globally in 2020 usage was still less than 10%. Building clean energy and transport infrastructure requires materials; a greater diversity of materials than fossil-fuel-based counterparts. Realising a low-carbon future will therefore be very mineral intensive and will require much geological expertise.

The raw materials that we need to support the energy transition include both well-established commodities such as copper, and

Geologists stop for a shady lunch at the Amis Gorge, Brandberg Complex, Damaraland Alkaline Province, Namibia.

materials that society has not mined in significant amounts before. The motors that drive EVs and the generators in wind turbines use high-strength REE-Fe-B magnets. Solar uses Ga, In, Te, and Se; minor metals that have not been produced in significant amounts in the past. Battery storage requires Li, Co, graphite, Ni, and Mn. Connecting it all, the electrical grid uses Cu, Zn, Ag and more. All are essential ingredients for the energy transition. Some are termed 'critical' because there are concerns around security of supply and where they are being mined at the moment.

Recycling will be really important and by the end of this century we may be approaching something that looks close to a circular economy. But right now almost every EV ever made is still on the road. Every wind turbine is still spinning away. There's almost nothing to recycle. And on top of that no process is 100% efficient, so we will always loose some material in manufacture and use, however hard we try. The shift in material demand is so large that an "optimistic" industry forecast is that, by 2040, we may get no more than 10% of our energy-critical materials from recycling. So we obviously need to mine primary geological resources. The good news is that many energy-critical materials have low historical demand. Because society hasn't yet looked very hard, there are likely to be many near-surface deposits to find. Geologists are now exploring in a wide range of environments and there's lots to learn!

In Cambridge, Owen Weller, Carrie Soderman and I are focussed on alkaline igneous rocks and their contained deposits of REE and HFSE. The REE are critical for manufacture of magnets, high-performance optics, and catalysts, and the HFSE are mostly used in high-performance alloys, abrasives, medical devices and nuclear reactor control rods. Our work examines the processes by which alkaline magmatic systems form, and seeks to quantify the processes that lead to the concentration and mineralisation of their contained metals, or to the formation of barren systems.

We use a "mineral systems" approach, tracing the path of metals from source rocks where they reside in low concentrations prior to deposit formation. A carrier for the metal, perhaps a silicate melt, hydrothermal fluid or brine is important, as is a geodynamic trigger that provides the energy kick that sets the system into motion. Once the metal is mobile, it needs a path to travel through; such as a dyke or vein system. Then the metal must be concentrated, and deposited in a trap, usually by crystallisation from a fluid or melt. Finally, the freshly-formed mineral deposit must be preserved. If erosion has washed the metals away, or sedimentation buried it beyond the depths accessible by mining then it is of no use to us. If any of these six 'critical processes' has not occurred, there is no mineral deposit. Best to move on and look elsewhere.

A process-based understanding is useful to streamline exploration, first looking at the continental-scale, then using progressively higher-resolution and more specialised geological techniques to zoom in. The ultimate aim is to streamline exploration for high-grade deposits of critical raw materials, from which extraction can yield the greatest amount of metal for the smallest environmental impact and energy use. The easier and cheaper it is to find deposits of materials critical for renewable energy technologies, the faster society can move away from fossil fuels.

Left: Brian Harland on the 1957 Arran trip.

Above: The 1950 group on top of Goat Fell. Perce Allen is second from the right (in RAF jacket, under the hammer), Margaret Sudbury seated to the left.

Right: A 1957 group listens to Brian Harland (standing second left). Norman Hughes is at far right. Location unknown.

NIGEL WOODCOCK, DOUGLAS PALMER AND SANDRA FRESHNEY SEARCH THE ARCHIVES FOR ANSWERS

THE ARRAN FIELD COURSE: when and how did it start?

Many of us reading this will share memories of the first-year Geology/Earth Sciences field course to the Isle of Arran. Whether the week was one of enjoyable sunshine or endured rain and wind, few people will have forgotten the Arran experience. Memories may even include some geology! After all, the island claims to have a greater variety of geology than any other comparable area in Britain.

But when and how did this field trip originate? Departmental memory suggests a date sometime after World War II (1939–45), but when? Our research trail began with the field trip journals of the Sedgwick Club. Before the war, department field trips did not extend much beyond Cambridge. Because of this deficit, the Sedgwick Club had the long tradition of the Easter field trip. They even ran trips during the war (1940, 1942, and 1945) and annually from 1947 to at least 1958. These trips were regarded as extra-curricular and certainly not examinable. Moreover, they were mainly for elected members of the Sedgwick Club, mostly Part II students. Neither the journals nor the club minutes mention an Arran trip for IA students.

Our trail continued with the Arran journal kept by Brian Harland between 1952 and 1966. Brian is often credited with developing or even starting the Arran course, and he certainly organised and taught on it for over 30 years. Brian was a Geology undergraduate in Cambridge from 1935 to 1938. His PhD work was curtailed by the start of World War II in 1939. A Quaker conscientious objector, he spent the war years with the Friends Service Council running a Department of Geology in what became Chengdu Technology University. After the war, in 1946, he joined the teaching staff in the Cambridge department.

Perhaps the start of his Arran journal in 1952 marks the start of the IA Arran trip? Certainly Brian's 80 quarto pages of detailed field notes in 1952 imply his first experience of Arran rocks. He includes a typed and cyclostyled information sheet issued to students. "*This field-class is an integral part of the course of study for the Natural Sciences Tripos. It is not an extra*" emphasises the sheet, suggesting that the course was relatively new. However, the advice that "*[students] formerly … obtained railway fares and a substantial part of their maintenance expenses from their grant-giving authority*" implies that the course had run before 1952. But the most unexpected feature of that sheet is the concluding signature: not of W.B. Harland, but of P. Allen.

Percival (Perce) Allen joined the department teaching staff with Brian in 1946, following a B.Sc and a PhD at Reading University and RAF service in their Photographic Interpretation Unit. Perce evidently ran an Arran trip in 1951, but apparently without Brian's involvement. Brian's assiduous notetaking in April 1952 was probably because Perce Allan had already been offered the chair of Geology in the Reading department, which he took up in the October.

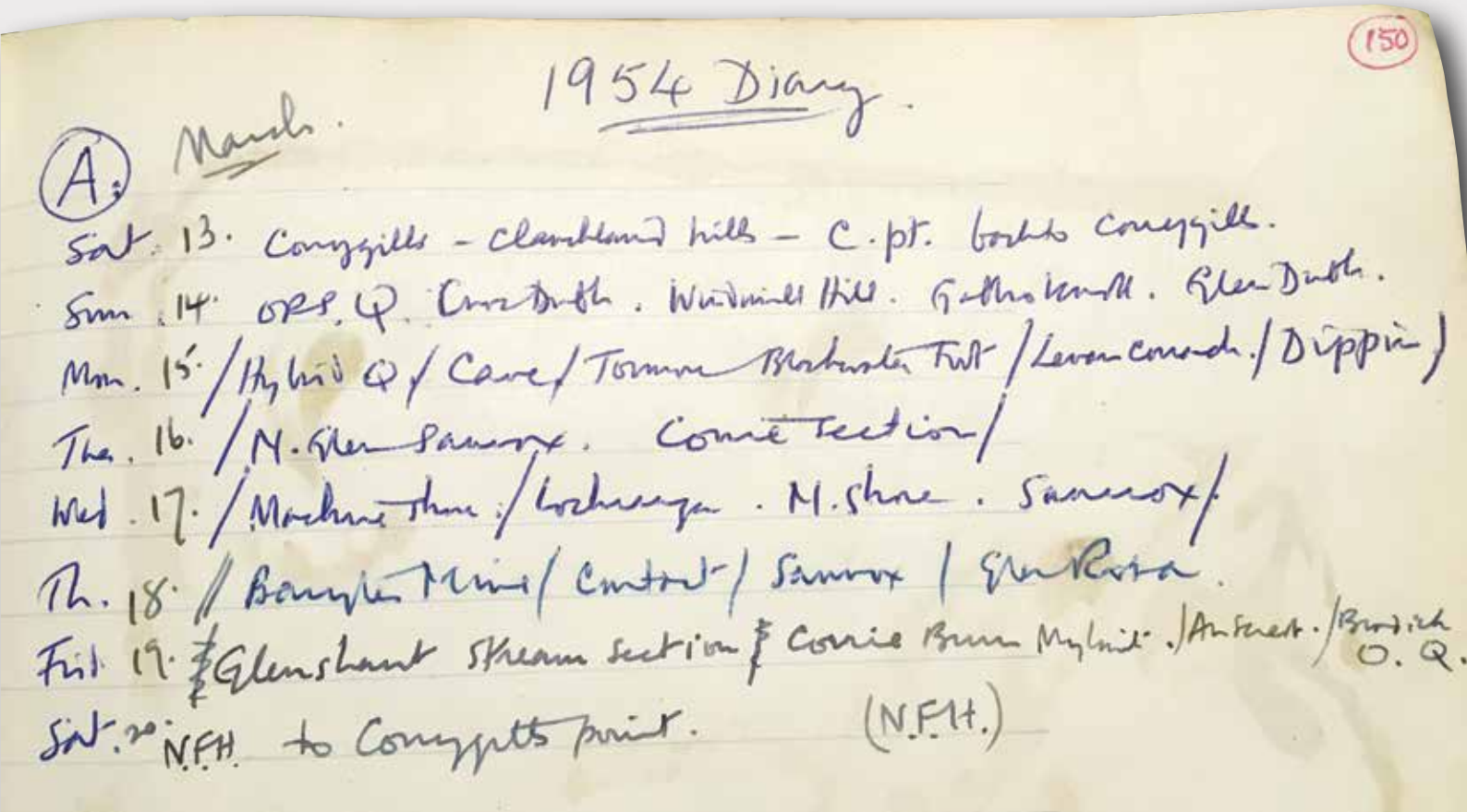
No sooner had we inferred that an Arran course ran in 1951 than a third archive moved the dial back another year, to 1950. The material was donated by Margaret Sudbury (née Walker), a Geology undergraduate then postgraduate from 1949 to 1955. Margaret kept two information sheets from the 1950 course and a set of photos showing that Perce Allen was leading the trip of about 10 students, assisted by Sedgwick Museum curator Bertie Brighton. Currently this provides the earliest evidence for the departmental Arran trip, but who knows what other archival evidence awaits discovery.

What then of Brian Harland's contribution to the development of the trip? Whilst he didn't originate the Arran course, he was largely responsible for developing the itineraries still used today and for the scientific underpinning that makes the course so valuable and enjoyable.

In 1953, Brian led two successive student parties, apparently without any other help. He still made nearly 60 pages of notes, defining the field days so familiar to the present day. By 1954 the itinerary had further evolved when Brian was joined by the newly appointed Norman Hughes. After 1954, Brian's journal contains mostly staff and student lists and administrative details, a valuable record nevertheless. A later generation of field leaders appear progressively: Colin Forbes and John Hudson in 1958, Peter Friend in 1959 and Alan Smith in 1964. Fortunately some amusing snippets survive amongst the routine lists. Brian kept some of the handover notes from one week's party to the next. Writing to Norman Hughes in 1959, Brian observed that "*Party A was half prima donna talented geologists and half dead tail, and tended to disintegrate slightly, but there was a lot of good geology done*."

I trust that no-one reading this from 1959 Party A was in its dead tail!

Below: The evolving daily itineraries in their 1954 state.



Sunset over a quiver tree forest, southern Namibia.

IN CONVERSATION WITH Alex Liu

Dr Alex Liu joined the Department of Earth Sciences in 2016 and is an Associate Professor in Palaeobiology and a Fellow of Girton College. He reflects on his work with Erin Martin-Jones.

You study Ediacaran fossils, why are they significant?

Ediacaran macrofossils range between 579 and 539 million years in age, and include the first examples of large, complex organisms we have in the fossil record. At this time, just before the start of the Cambrian, we see the first possible animals, as well as evidence for the impact they had on sediments and environments.

This is a key transition in Earth's history, yet we still have so many unanswered questions, including why animals evolved at this particular time, and what sort of animals the fossils are actually recording. Answering these questions is a major part of what motivates me and my research.

What have been your stand-out fossil-finds?

One of the stand-outs was work in 2011 on strange Ediacaran fossils that look like pizzas: hundreds of them, reaching up to half a metre wide and all different in shape and internal structure. No one knew what they were at the time, but my suggestion that they record the decayed remnants of animals preserved on the seabed has so far stood the test of time.

More recently, working with colleagues in Oxford, we found thin 'strings' on bedding planes joining organisms of the same species – we think these are like the reproductive runners or stolons connecting strawberry plants. Quite often it's the traces of movement these animals left behind, or the way they interacted as a community, that I find the most fascinating aspects of studying life at this time.

Dr William McMahon and an oryx amongst the sand dunes of Sossusvlei, Namibia.

Our fieldwork campsite on Ferryland Head, eastern Newfoundland, August 2022.

What are your research group up to?

Our aim is to understand how and when the Ediacaran biota evolved, and whether they impacted the planet. We're a team with diverse backgrounds, including sedimentologists, geochemists and zoologists. Some are working on the discovery and taxonomy of these fossils, others are trying to pin down the chemical and physical conditions of the environments the organisms lived in.

Have you always been into fossils?

Definitely when I was a lot younger – my Mum has drawings of dinosaurs and fossils I did when I was about five – but my interest in them waned in school and it wasn't until University applications that I discovered Earth Sciences. I studied at Oxford, where my favourite topics were geochemistry and palaeontology – I couldn't choose between the two, so I chose a fourth year project that combined both. Palaeontology won out, and I ended up staying at Oxford for a PhD on Ediacaran fossils. It was a particularly inspiring lecturer – Martin Brasier, a leader in Precambrian palaeontology – who encouraged me to take that path and, after a postdoc at Girton College, Cambridge, I moved to Bristol for a research fellowship before returning to Cambridge as a lecturer.

Where in the world has your work taken you, so far?

The opportunity for discovery is a major bonus of my research – when out in the field, I'm reminded how lucky I am that fossil-hunting in beautiful places is part of my job!

Probably the most geologically incredible place I've been is the Ediacara Hills in southern Australia – a well-known Ediacaran site where almost every rock you turn over contains a fossil. Unexpected cultural highlights have been on the White Sea coast of Russia, where we drove past Russia's main nuclear submarine base; and in Brazil in 2016 where I witnessed political protests as the President was impeached.

What about your Leverhulme project?

Our current project is looking at the sedimentary environments in which Ediacaran fossils are found, to determine how environmental conditions control the types of fossils and styles of fossil preservation we see in global Ediacaran sites. We're specifically asking whether there was a mass extinction at the end of the Ediacaran. With sedimentary geologists Brennan O'Connell and Will McMahon, and PhD students Cat Boddy and Phil Vixseboxse, I have been working in Namibia and Newfoundland in the past year to gather data that should bring us closer to an accurate record of changing Ediacaran diversity through time.

Is it true you're known for your sense of humour?

It's fair to say I try not to take myself too seriously! Last year I had some fun in running two back-to-back races over a weekend – the 10km Cambridge Town and Gown, then the Cambridge Half Marathon – in an inflatable T. rex costume to raise funds for a new book trolley and teaching resources in the Sedgwick Museum. I seemed to be popular with children lining the route! I also play the trombone – the most entertaining musical instrument in my view – in the Girton Fellows and Students Brass Band, and the College orchestra.

RICHARD HUGHES

Life After Cambridge Earth Sciences

I began my PhD at Cambridge in 1980 after completing a geology BSc at the University of Wales, Cardiff. Earth sciences at Cambridge is something of a family affair. It's there that I met my wife Catherine who was studying for her PhD in mineral physics. More recently our daughter Ella graduated from Cambridge with a Natural Sciences BA and Earth Sciences MSci in 2019.

After completing my PhD I joined the British Geological Survey where I enjoyed a very varied career of over 20 years. My time living and working in South America was a highlight: I was one of a British-Ecuadorian team which completed the first systematic geological and geochemical mapping of the entire Cordillera Occidental of the Andes, from Peru in the south to Colombia in the north. I later worked on several international development projects in various parts of Africa, and ended my BGS career as Director of Information with responsibility for digital data-sets, analogue collections and IT infrastructure.

In 2013 I joined The Coal Authority, a public body that carries out essential work in managing the UK's very substantial, hazardous legacy of mining. Around this time I also made a return to learning at the University of Cambridge, completing the 'Advanced Leadership Programme' at the Judge Business School.

When the role of Executive Secretary at the Geological Society was advertised in late 2016 it seemed like the opportunity to put into practice much of what I'd learned in earlier roles. The Society had been through some difficult times, modernisation was long overdue, and membership numbers were in decline.

A major highlight of the past 5 years at the Geological Society was a transformative strategic review completed in late 2020 which, amongst other things, has brought new science focus. Other successes include the stabilisation of membership numbers, the roll-out of a new membership model, the launch of a new open access journal, and observer status at COP26 which enabled us to advocate for the essential role of the Earth sciences in achieving net zero.

The past five years have certainly been unpredictable but big strides forward have been made and there's no doubt that the Geological Society is in a stronger position to respond to the many challenges that lie ahead

I retired from the Geological Society at the end of October 2022 and, as I look back on my career, I can't help but conclude that I've been hugely privileged and fortunate. My time at Cambridge was a stepping stone to an immensely varied and fulfilling career that I could only have dreamt of when I stepped through the door of the Downing Street site for the first time so many years ago.

Richard climbing Eryri (Snowdonia), in Wales.

AMY FOLKHARD, SEDGWICK CLUB PRESIDENT

A Year in the Life of The Sedgwick Club: Recovering from COVID

The handover meeting between my first Sedgwick Club committee (I was social secretary) and our predecessors, in early April 2020, was held over Zoom. By that point, having been in lockdown for a couple of weeks, we were all familiar with the app from Zoom quizzes with our respective friend groups, an apparently universal experience.

The shape that the next year would take, though, was unformed and unpredictable. The mapping project in Peru that my group had spent the year planning was still pencilled in my diary for September, our contingency plan (the Lake District), which was later also cancelled, was still viewed then only as an absolute last resort.

Two years and one pandemic later, as newly elected President, I found myself one term away from being the only member of the undergraduate body with any memory of the pre-COVID days (a quirk of having intermitted part-way through my third year – my original peers were all about to graduate). The Sedgwick Club had very successfully weathered the COVID years – credit for this goes to emeritus talks officers James Craig and Eloise Matthews in particular. While these talks, our fortnightly board games nights, and annual events still worked online, our members' ability to form friendships across different year groups had taken a beating. First on the new committee's agenda, then, was to continue the work of the 2021–22 committee in helping to re-establish the department's reputation among undergraduates as home to one of the tightest-knit student communities in the university.

A donation of funds from the department (thank you, Owen Weller!) helped. My committee used our portion of the money to throw an extra-extravagant garden party in June, hiring sumo suits for attendees to wrestle in and a set from one of Cambridge's most beloved live bands. (The garden party's atmosphere got stellar reviews from the band themselves, especially once we'd fed them strawberries and cream.) We were lucky in September that around twice as many 1Bs as usual decided to take Earth Sciences, and were very excited to take them on their first Magical Mystery Tour at the end of January. Alongside this, Lent term will see us consolidate our post-pandemic relationship with other student geological societies, with the return of the Geovarsity football match against the other place and, if all goes well, students from multiple other universities presenting posters at our annual conference in March.

On a more serious note, the time away from usual routine created by the lockdowns has allowed recent committees to spend time reflecting on the Sedgwick Club's values and putting a new emphasis on inclusivity and environmental accountability. Although surviving the pandemic required a lot of creative thinking from committee members, the chance to tweak our approach to the year's events with these goals in mind has been invaluable, and the sense of community among the undergraduate student body is, I think, beginning to resemble its old self.

Left: One of the many chicken fights at the 2022 Summer Garden Party.

Below: Current members at the 2022 Christmas Ceilidh – the ceilidh band member taking this photo had just told us all to say 'G5a', the iconic Shap Granite specimen number she'd remembered from the previous year.

ISOBEL ROWELL, POST-DOCTORAL RESEARCHER

WACSWAIN:
WArm Climate Stability of the West Antarctic during the last INterglacial – catchy!

Drill tent at Skytrain Ice Rise.

This project aims to constrain estimates of how and when the West Antarctic Ice Sheet (WAIS) retreated during the Last Interglacial (LIG), 130 to 115 thousand years ago. Evidence suggests that sea level during the LIG peaked at between 6 and 9 m higher than present, a range necessitating at least some contribution from Antarctic Ice Sheet retreat, the WAIS being the most likely candidate. Antarctic temperatures during this time period were in line with projections for the year 2100. These figures warn of the potential for significant future sea level rise resulting from anthropogenic climate change. Retreat of WAIS glaciers, such as Pine Island and Thwaites, is underway and identified as a "tipping point" which could bring about irreversible WAIS collapse. But "between 6 and 9 metres" is a substantial range, and there is a need to fine-tune this important estimate. WACSWAIN aims to achieve this by drilling ice cores at WAIS locations expected to have survived the LIG. The chemical records of these cores might tell us what happened during that time.

Two fieldwork campaigns were carried out (Figure 1), firstly at Skytrain Ice Rise in 2018/19 when a 651 m ice core was successfully drilled in a single season. The following year, a drilling campaign on Sherman Island obtained ice samples to 323 m depth, which you can read about in a series of blogs on the department website. I was pleased to lead the analysis of the Sherman Island core which, although it doesn't cover as much time as we would like, does provide a unique record of the last millennium in this very sensitive region of the WAIS.

The first stage of any ice core interpretation is establishing an "age scale" – essentially assigning an age to each depth point throughout the core. We used multiple methods, including "annual layer counting" and identifying well-dated events such as abrupt changes in methane concentration and the Laschamps Event at 42 ka, among many others. We can conclude that the Skytrain core does contain the Last Interglacial – an exciting result!

We are now interpreting the well-dated records of stable water isotopes, chemical species and other measurements including total air content. Comparing these datasets together, it should be possible for us to interpret, at least qualitatively, historical changes in temperature and elevation at the site. This could allow us to piece together what happened to the WAIS and Ronne Ice Shelf surrounding Skytrain Ice Rise. Using this approach, we are already reaching some interesting conclusions about an intriguing change in conditions during the early Holocene.

The Skytrain Ice Rise core is the longest from the WAIS and has the potential to dramatically aid our understanding of at least the last 130 ka of this important region of Antarctica. We hope to publish more exciting data and results in the coming months, so be sure to watch this space!

Read the full blog on our website:
https://bit.ly/3wx8mEY

A map of the WACSWAIN ice core drilling sites in the West Antarctic Ice Sheet.

Catch up with the Sedgwick Museum

LIZ HIDE, DIRECTOR, SEDGWICK MUSEUM OF EARTH SCIENCES

© COLLECTIONS MIGRATION TEAM

Some of the rock samples in the Museum's collections.

For decades, one of the most important petrological collections in the world has been tucked away in an old WWII building in west Cambridge, where it's been challenging to look after and study. Comprising about 160,000 rock specimens and more than 200,000 thin sections, the collection assembled by Alfred Harker in the late nineteenth century has global coverage, with specimens from 124 countries and more than 100 volcanic islands including Pitcairn and Tristan da Cunha.

This outstanding collection finally has a fitting home, in the Sedgwick Museum's new Collections Research Centre, on the Department's Madingley Rise site. Although the pandemic has disrupted our plans in recent years, we have now moved the majority of the collections, including the Harker Collection, into the new facility. We aim to complete the move this year.

As you can imagine, moving c.150 tonnes of rocks is no trivial task. Our small, energetic team is led by Collections Manager, Dan Pemberton and supported by Helen Devereux. It's physically hard work, made more complicated by occasional potentially hazardous minerals, which require particular care and treatment. Each drawer has been cleaned, photographed, weighed and documented before being packed and moved onto racking in the new building. Once there, it's available to researchers and students, and in future we will also host specimen images online.

Our aim is that these collections can be actively and frequently used for research and teaching. Fieldwork will always be important but the pandemic, and growing climate concerns, has highlighted the potential of the Museum's collections to initiate and support research. Pre-fieldwork study of collection material means that precious fieldwork time can be spent more efficiently. In projects where travel isn't possible or advisable, study of material in the collections may replace fieldwork altogether. We are keen to work with researchers to develop this sustainable approach, and are seeking funding for a new post to manage the Centre, coordinate access to and promote the use of the collections. We'll also be developing opportunities for volunteers to be part of the collections team.

Meanwhile we're delighted to have the Museum gallery busy with visitors again, after a year when visitor numbers were still short of pre-pandemic levels. We're working hard to make people feel at home again in the Museum, with our staff, volunteers and students running public rock and fossil handling sessions. Thanks to the Friends of the Sedgwick Museum, we hosted four students on summer placements for a wider range of museum roles.

Throughout the Museum, we've created ways for people to get involved with our work, and to find new ways for people to use, experience and enjoy our amazing collections.

Awards

Professor Mike Bickle won the Geological Society's Murchison Medal at the Society's awards presentation on President's Day in June 2022.

Dr Simon Matthews won the Geological Society's Murchison Fund award at the Society's awards presentation on President's Day in June 2022.

Many congratulations to **Sasha Turchyn** on her promotion to Professor (Grade 12) and to **Neil Davies**, **Emilie Ringe**, **John Rudge** and **Ed Tipper** for their promotions to Professor (Grade 11) in this year's Academic Career Pathways exercise. All richly deserved, and a great endorsement of their research, teaching and service contributions to the Department, University, and beyond, over the years.

Department Alumnus, **Professor Richard Fortey**, a long term palaeontologist at the Natural History Museum, author of nine books and television presenter, has been awarded an OBE for services to palaeontology and geology in the 2023 New Year Honours list.

Top to bottom: 1. Emilie Ringe, 2. Professor Richard Fortey, 3. Edward Tipper, 4. Sasha Turchyn and 5. Dr Simon Matthews.

The Geological Record

Student Prizes

Nominations

James Craig (St Catharine's) was nominated for the BSRG Award Sedimentology.

A British Geophysical Association prize nomination went to **Amber Parsons** (Jesus).

Mineralogical Society undergraduate award included nominee **Ambre Brabant** (Pembroke).

James Craig (St Catharine's) was nominated for the Winifred Georgina Holgate Pollard Memorial Prize.

Awarded

The Harkness Scholarship was awarded to **James Craig** (St Catharine's).

Rebecca Sheng (Fitzwilliam) received the Palaeontological Association Undergraduate Prize.

Ambre Brabant (Pembroke) was awarded the Wiltshire Prize.

New Staff

Ali Mashayek

Sharon Shadrokh

Kathryn Shaw

Charlie Beard

Alison Cook has joined as Business and Operations Manager

Ali Mashayek is our new Associate Professor of Climate Modelling

Adriano Gualandi has joined as Associate Professor in Geophysics

Charlie Beard joins as a member of Research staff working with Owen Weller

Luke Rochford has joined Iris in the microanalysis suite as a technical officer.

Simon Frostick and **Sharon Shadrokh** are both returners to the Department, joining us once again to ensure our IT works smoothly in spite of all we do to it.

Gloria Irmin, **Alaaedin Zydan**, **Cesar Hernandez Baeza** and **Mirko Eguren Schreier** have joined as cleaners.

Adam Osmond has joined as a Workshop Technician, Downing Site, working with Chris Parish

Robert Seidel is working as Collections Assistant (Mineralogy and Petrology) for the Museum, Forbes Building, working with Dan Pemberton

Kathryn Shaw and **Simon Matthews** have joined as Research Associates, Downing Site, working with Helen Williams.

Ruth Noble is our new DTP Administrator.

Retirements

Dr Andy Buckley retired as Department Administrator at the end of September 2022.

Professor James Jackson began his retirement in September 2022.

You can read more about Andy and James' careers here:
http://bit.ly/3kIs6ms

Leavers

Giulio Lampronti, Technical Officer in the microanalysis suite, left in August 2022.

A welcome return to **MAPPING PROJECTS**

Ballycastle, Northern Ireland

Joseph Brabin, Amy McMahon, Jessica Humphries, Runzhe "Rocky" Yu, and Yizhe "Matthew" Lou

Ballycastle, a small town on County Antrim's northern coast, has a rich history. Having first been put on the map for its industry – which included coal mining, salt-panning, and glass-making, all largely developed by Col. Hugh Boyd (1690–1765) – Ballycastle is now a favoured holiday destination. A stone's throw from Giant's Causeway, littered with druid artefacts, and the grounds of the Battle of Glentaisie, there is no shortage of things to satisfy the curious. Aside from the famous columnar joints, the region boasts much to entertain the geologist: enough to attract our group to Ballycastle between July and September 2022 for our third-year mapping projects.

The geology of the area is extremely diverse and helpfully familiar from the IA Arran field course. The basement rocks (deposited in the Neoproterozoic and early Cambrian) belong to the Grampian Terrane and are members of the Dalradian Supergroup. In our area, they included quartz-mica schists and psammites.

The next oldest rocks are of Carboniferous age and represent a variety of environments. The limestone, chock-full as it is with crinoids and brachiopods, is clearly of marine origin, whereas cross-bedded sandstones record a fluvio-deltaic setting; the famous coal seams illustrate when relative sea level was lower and plants could dominate the system. Much to our delight, we found a two metre long plant fossil exposed on the coast.

Except for a small exposure of Triassic sediment at Murlough Bay (where part of Game of Thrones was filmed), there is no surviving stratigraphy between the Carboniferous and the Cretaceous Chalk. This Chalk forms much of the coastline to the east of Ballycastle and contains large belemnites.

Perhaps the most remarkable lithologies in the area are the Paleogene igneous rocks. These include the Antrim Lava Series, extrusive rocks that cap the Chalk around Kinbane. More impressive still are the intrusions. A tremendous dolerite sill forms at the 200 metre high Fair Head; the sheer columnar-jointed face is a favoured destination for abseilers. Between Fair Head and Ballycastle, numerous dykes (such as the "North Star" and "Carrickmore" Dykes named after adjacent collieries) jut out from the cliffs and into the sea. Igneous activity stemmed from the opening of the North Atlantic and the passage of Northern Ireland over the Iceland plume in the Earth's mantle.

The Ballycastle area's impressive range of geology is well exposed on the coast but less so inland. Nevertheless, we were happy with the map that we could make. Let's hope that the examiners are equally satisfied!

Joe with Schist.

Amy lies beside a carboniferous plant fossil.

The view west to Ballycastle.

Intrepid mappers, Lucy, Ollie, Liam and Daniel.

Unravelling the geological history of the Quaggas Berg

Liam Holland, Daniel Clarke, Lucy Hyde and Ollie Ross

We travelled to South Africa for our undergraduate mapping project, focussing on the sedimentary rocks and deformation of part of the Cape Fold Belt. We based ourselves in the wine-renowned Breede valley, at a hospitable farm with ostriches, bees, sheep and lots of dogs. Our mapping area in the Quaggas Berg nature reserve had never been mapped at 1:10000 scale. The terrain was difficult but not impossible, and with so much exposure and some excellent geology we couldn't have wished for a better area.

The five mapping units, all from the lower Witteberg Group (Upper Devonian) were characterised by marine and lagoonal sediments. The metamorphic grade was low so there were lots of Zoophycos trace fossils and Lycopod fossils, as well as cross bedding, hummocky cross-stratification and wave ripple lamination. However, the outstanding features of the area were the many incredible folds, exposed in three dimensions. These folds took up a large proportion of our time but hopefully the data we collected will help other researchers understand better how the Cape Fold Belt formed.

We also discovered some rock art at two locations, which were added to a database of such art in South Africa. The art depicts people and animals. However, the elephants are peculiarly double ended, a discovery that might be archaeologically special.

During our time away, we also had plenty of excursions, including a safari, whale watching, and four days hiking … that's what you really need after 28 days of mapping! From a campsite in the Cederberg our amazing hikes took us to see the Maltese Cross, cave art, and the Wolfberg arch and accompanying cracks. These were incredible places, and seeing the geology and pseudo-karstic weathering there was really a treat, definitely recommended for future mappers. We then headed for Cape Town, where we climbed Table Mountain, and went to the botanic gardens. The views from Table Mountain were incredible, and we even had a cheeky swim at the top. None of us were eaten by baboons, snakes, or insects, so that's a win for us.

Stunning terrain in which to work – including far-reaching views from Table Mountain and folded sedimentary rocks.

Make a world of difference in Earth Sciences

Donations from our alumni are increasingly important in adding value to our students' experience of Earth Sciences, whether through teaching or through research as a Part II or III undergraduate or post grad.

There are four ways that you can allocate your gift:

- The **Earth Sciences Fieldwork Fund** helps maintain the Department's strong commitment to field teaching as a vital way of bringing lecture and practical material to life. Boosting fieldwork provision for all students who have missed field courses due to Covid restrictions will involve extra costs, which the fund can help with.
- The **Earth Sciences Student Support Fund** helps individual students struggling with the extra costs of doing an Earth Sciences degree. Our aim is for nobody to be disadvantaged because they can't afford a field course fee, or the cost of a laptop for remote learning for instance.
- The **Sedgwick Museum of Earth Sciences Fund** helps the Museum to care for and share its internationally important collections. The Museum continued to provide access to its collections for researchers and students throughout the pandemic, while its targeted school and public programmes encourage the next generation of Earth Scientists.
- The **Earth Sciences General Fund** is unrestricted in its use. It can help to support all urgent or unexpected needs within the Department, which include topping up partially-funded postgraduate studentships, helping with travel to research labs, with new initiatives for lab equipment, and adding cameras to microscopes to allow socially-distanced teaching.

You can donate online at **philanthropy.cam.ac.uk/give-to-cambridge/earth-sciences** or fill out the Donation Form inserted with this GeoCam.

For further information about donating to Earth Sciences or guidance on how to leave a gift, please do contact us.

Cara Hanman
alumni@esc.cam.ac.uk

Jasmine Aslan
Associate Director of Physical Sciences
jasmine.aslan@admin.cam.ac.uk

Students, staff and demonstrators enjoying a very sunny April 2022 Arran Fieldtrip.

Thank you to our donors 2021–2022

We wish to thank alumni and friends who have generously made donations to the Department over the last year. Every effort has been made to ensure this list is accurate; do contact us if you believe we have made an omission.

We would also like to thank all those who made a gift to the Department anonymously.

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For further information about the impact of a legacy and guidance on how to leave a gift to the Department of Earth Sciences please do contact us:

Cara Hanman, Alumni Co-ordinator
Department of Earth Sciences
E: alumni@esc.cam.ac.uk

Jasmine Aslan, Associate Director of Physical Sciences
University of Cambridge Development and Alumni Relations
E: jasmine.aslan@admin.cam.ac.uk

Dr Auriol Rae demonstrating for students on the April 2022 Arran fieldtrip.