Department of Earth Sciences
Graduates Newsletter
2016

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Welcome to our new Head of Department, Dave Mattey

Dave Mattey joined us in the early days of the Department to build our analytical geochemical capabilities, both in teaching and research. Initially, he was was focused on improving techniques in mass spectrometry but he has subsequently broadened his interests. In the mid-nineties he introduced a new undergraduate course on planetary geology to take advantage of all the new data coming from NASA, learning the subject together with the students as he taught it. Later, he took advantage of Ted Rose's knowledge of the caves under Gibraltar to launch new research into using speleothems to measure climate change involving monitoring cave environments in France, India and the tropical Pacific. Dave is not afraid to take on new ventures and his experience will certainly feature in his new job as HOD.

Farewell to Pete Burgess as Head of Department

It is with sadness that we say farewell to Pete Burgess, pictured above in his natural habitat of microbial carbonates. Pete left us once before, then returned, but sadly this departure may be different since he takes up a new Chair in Sedimentology at Liverpool. Pete's experience in industry, knowledge of petroleum geology and expertise in clastic and carbonate sedimentology has been a huge contribution to the Department. Above all, Pete is passionate about teaching and field geology and has played a leading role in some of our big undergraduate and MSc fieldtrips. It is alleged (by a structural geologist) that he has been the only

geoscientist who has dared to explain the delights of microbiological carbonates to structural geologists, even with some success, and is notorious for the puns and bad jokes he inflicted on students and staff alike! He ended his term as HOD on a high note, in the form a research paper that Identifies order or pattern in strata on the basis of quantitative interpretation, which will have a profound effect on future stratigraphic and sedimentological research.

We thank Pete for his tremendous contribution to the Department, through the COMPASS consortium, developing distance learning and, of course, until recently, as Head of Department. We will miss his expertise, humour and commitment to all aspects of departmental life and wish him all the very best in his new position.

Dave Mattey

Congratulations to . . .

Andrew Scott, Bill Chaloner, Claire Belcher and Christopher Roos who organized a Royal Society scientific discussion meeting in London, 14–15 September 2015, resulting in "**The interaction of fire and mankind"**, a volume published as Phil. Trans. R. Soc. B. volume 371, 252pp.

Here the complex interrelationships between fire and mankind that transcend international borders and disciplinary boundaries were discussed. The spectre of climate change highlighted the need to improve our understanding of these relationships across space and time. This meeting examined historical, evolutionary and biophysical tensions inherent in the fire–climate–society nexus and was intended to advance the international, interdisciplinary science necessary to address contemporary and future fire challenges. A follow-up satellite meeting at the Royal Society Kavli Centre, Chicheley Hall, from 16 to 17 September 2015 was entitled "Contradiction, conflict, and compromise: addressing the many dimensions of sustainability in human–fire–climate relationships". Broadly speaking, these included sustainability safeguards of contemporary human health, property and livelihoods without compromising those of future generations or the integrity of our environment. These dimensions have fire at their core – it is capable of threatening or enhancing them. This meeting explored the interrelationships of these four themes in the context of a fifth—climate change—with implications for socio-environmental sustainability.

The satellite meeting was organized in a series of breakout group discussions interspersed with synthetic presentations by group leaders. The aim of this structure was to interrogate the key issues relating to fire, humanity and sustainable social-ecological relationships first among experts in that particular domain (e.g. human health) and then among groups made up of a mix of scholars. Small group discussions focused on key gaps in knowledge and policy heuristics for adaptable consideration of sustainability issues in diverse but globally interconnected social, political, economic and environmental contexts. Finally, the meeting concluded with a plenary synthesis in which the organizers presented the conclusions of the breakout groups, highlighting key problems for future research.

From Dave Mattey, Head of Department

This bumper edition of the newsletter marks the end of an era. Derek has been compiling newsletters for nearly 35 years and in this final edition, on behalf of the Department I would like to thank Derek for his tremendous contribution to departmental life and for all the time spent gathering material, prodding people at the right time and putting the Departmental Newsletter together every month. Derek will say the newsletter is now old-fashioned and time for new technology – old-fashioned, most certainly not, but maybe there are other ways to published it. Somehow I don't think tweeting news and reports 140 characters at a time is going to work, but we must continue the newsletter tradition and I welcome ideas and views about how to do this next term. Whatever we do, Derek's newsletters will be a very hard act to follow and will be greatly missed.

From Derek Blundell

very many thanks to everyone who has contributed to the production of Departmental Newsletters over the years, with articles, photos, etc., and have had to put up with my constant pleas for help. Your efforts have been well worth while and your comments much appreciated.

I have enjoyed the job immensely – it has been a great privilege

Department of Earth Sciences

Conferences

4. Quaternary Research Association Annual Discussion Meeting – *Meighan Boyd*

4. Tectonic Studies Group Annual Meeting – *Lloyd White*

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7. Volcanic and Magmatic Studies Group Meeting – *Kyriaki (Sandy) Drymoni*

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Quaternary Research Assn Annual Discussion Meeting

6th–8th January 2016, Royal Holloway

Meighan Boyd presented work from Greece that she completed as part of her PhD project at the Department of Physical Geography, Stockhlom University:

Stalagmites from Greek caves provide new climate information

Stalagmites from caves where people lived over 5000 years ago contribute a new high resolution climate record to the larger picture of variations in the climate of southern Greece. This research, uses stalagmites from caves to provide information on climate variations with an end goal of being able to identify how climate impacted the societies and people who lived in the area. Using stalagmites from Alepotrypa Cave on the Peloponnese peninsula of Greece, the results show that variations in rainfall and vegetation, as well as the degree of human activity in the cave from 6400 to 1000 years ago. Alepotrypa Cave is best known as an important Neolithic settlement. Alepotrypa Cave is a fantastic place to work. It has a very special atmosphere because you can clearly see the traces of the people who lived there so long ago. By studying the stalagmites from the cave, we can learn even more about their activities, including how and when they changed the climate within the cave. Stalagmites can act as a sort of historical archive, as well as a climate archive in caves where people have been living. Elemental analysis of the stalagmites has contributed new information about the timing and nature of human activity within the cave in addition to a wider picture which provides a climate reconstruction covering the period up to 1000 years ago, after the cave was closed by an earthquake in the late Neolithic period.

Photo: Giorgos Maneas

Rapid climate variations around 4200 years ago, which have been observed in other regions, are reconstructed from the Alepotrypa Cave in high resolution for the first time in the Peloponnese. Similar rapidly drying climate is seen also at 3200 and 1600 years ago.

The factors which control the climate in the region are a complex combination of large scale processes and more regional influences. Variations in the trace elements of the stalagmites show clear indications of human impact on the cave environment, with some stalagmites showing changes related to specific activities, such as the burning of animal dung within the cave.

This research has laid the basis for a continued research collaboration which brings together the disciplines of climate research and archaeologists at Alepotrypa Cave.

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Tectonic Studies Group Annual Meeting

Lloyd White

(with photos from John Browning, Lucia Perez-Diaz and Birkbeck)

The annual Tectonic Studies Group (TSG) Meeting was held at UCL and Birkbeck from 6th to 8th January 2016. Royal Holloway was well represented, with talks from Agust Gudmundsson, John Browning, Tetsuzo Fukunari, Lucia Perez-Diaz and myself, as well as poster presentations from Lucia, Mohsen Bazargan, Max Webb and Benjamin Jost.

Lucia and Ben both picked up awards for the best talk and best poster presentation respectively. This marks the second year running that Royal Holloway postgraduate students have taken out these prizes, with Eldert Advokaat having taken the best presentation award at last year's meeting in Edinburgh.

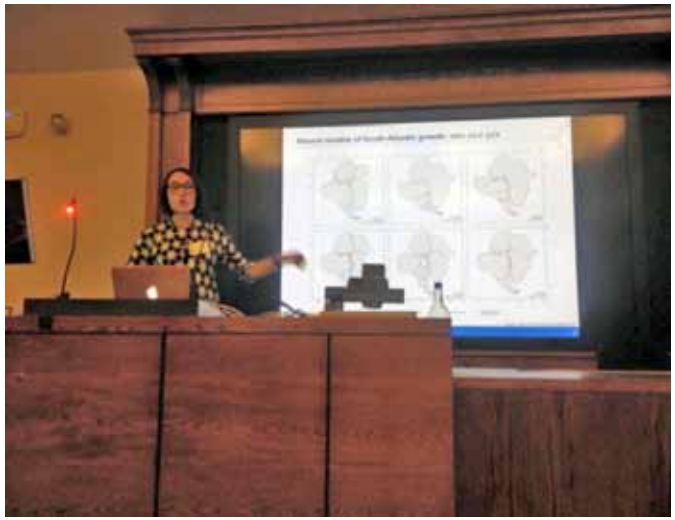
This year's meeting took on a slightly different format, with two and a half days of research presentations, and a half-day short course on microtectonics (i.e. microstructures observed in thin section and finer scales). The short course was run by Prof. Cees Passchier of the University of Mainz and author of the highly influential textbook "Microtectonics". This course gave Birkbeck the chance to show off their new petrology teaching lab, which is a new teaching space for ~70–80 students with microscopes linked to computers. This setup allows the lecturer to share microscope images to the classroom, and for students to more easily ask questions about particular objects that they've observed through their microscopes.

On the day before the conference officially began, I was fortunate to also attend a one-day training course for Midland Valley's "Move" software suite. While there was a considerable amount of material packed into one day, this provided a useful intro-

duction to the software and a demonstration of its basic functionality. I'm hoping that this software can be used to build quick and simple demonstrations of 3D structures for undergraduate teaching.

Several of us were also fortunate to go along to the conference dinner, which was held on a large riverboat that took us up and down the Thames. This provided a great opportunity to chat with other colleagues from around the UK and the rest of Europe, and to take in some very fresh brisk winter air.

With our Department having a particular strength in structural geology and tectonics, I expect that we will make an equally impressive demonstration at next year's conference.



Lucia's talk on tectonic and paleobathymetric reconstructions of the Atlantic Ocean won the best student talk of the conference.

Birkbeck's new petrology teaching lab, where the Move and Microtectonics workshops were held

A very happy Lucia after receiving her prize cheque

Benjamin Jost receiving his prize cheque for best poster presentation.

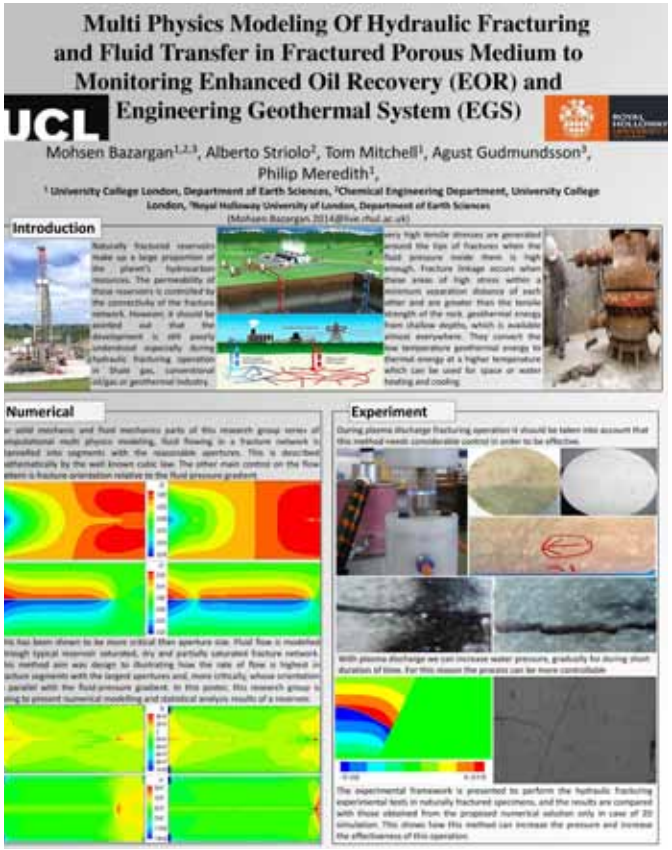
Lloyd gave a talk on how quickly tectonic processes can occur, showing examples from recent results in SE Asia.

Mohsen Bazargan presented a poster on behalf of himself, Alberto Striolo, Tom Mitchell, Agust Gudmundsson and Philip Meredith

Naturally fractured reservoirs make up a large proportion of the planet's hydrocarbon resources. The permeability of these reservoirs is controlled by the connectivity of the fracture network. However, it should be pointed out that the development is still poorly understood especially during hydraulic fracturing operation in oil/gas or geothermal industry. Normally, in reality very high tensile stresses are generated around the tips of fractures when the fluid pressure inside them is high enough. Fracture linkage occurs when these areas of high stress within a minimum separation distance of each other are greater than the tensile strength of the rock.

Numerical modelling focused on fluid mechanics and solid mechanics. The solid mechanics part explored the key controls on fracture formation, propagation, linkage and arrest, which determine network connectivity and consequently permeability. Mechanical properties of host rock layers can determine whether a propagating fracture either penetrates or arrests at a contact between layers or any existing fractures. Originally softer layers, for instance shale, tend to cause arrest, but can stiffen over time with increased burial and diagenesis. Changing mechanical properties of host rock layers mean fracture network connectivity and associated permeability evolve and can increase or, alternatively, decrease over time.

Furthermore, in fluid mechanics part of this research group series of computational multi-physics modelling, fluid flowing in a fracture network is channelled into segments with reasonable apertures. This is described mathematically by the well known cubic law. The other main control on the flow pattern is fracture orientation relative to the fluid pressure gradient. This has been shown to be more critical than aperture size. Fluid flow is modelled through a typical reservoir fracture network, illustrating how the rate of flow is highest in fracture segments with the largest apertures and, more critically, whose orientation is parallel with the fluid-pressure gradient. In this poster, this research group presented numerical modelling and statistical analysis results of a reservoir analogue.



Multi-phase fluid flow is tested in fractured reservoir analogue models to view the effect of fracture networks in the case of optimizing enhanced oil recovery (EOR) and Enhanced Geothermal System (EGS). The results show extensive connectivity of fractures is crucial for efficient penetration of the injected phase into the reservoir. Finally, for fluid flowing in a fractured reservoir, fractures act as faster pathways for injected materials to travel through than the matrix.

Back

VMSG 2016

Kyriaki (Sandy) Drymoni

I strongly support the Volcanic and Magmatic Studies Group (VMSG) of the Geological Society and its annual meetings, so this year I participated in the 52nd VMSG conference from 6th to 8th January at Trinity College Dublin (Ireland).

Trinity College is one of the oldest universities in Great Britain and Ireland, was founded by Henry VIII in 1546 and most of its major buildings date from the 16th and 17th centuries. On the first day of the meeting we had the opportunity to take a guided tour of the campus and admire the amazing Clock Tower and the Great Gate, as well as the Department of Geology and its spectacular decoration.

This year the meeting was focused on the effects of volatiles on eruptions from the point of the view of the deposits, LIPs and subduction zone magmatism, with interesting keynote lectures from Prof. Guido Giordano (Università Degli Studi Roma Tre, Italy), Prof. Balz Kamber (Trinity College Dublin) and Jon Blundy (University of Bristol, UK) respectively. The Mineralogical Society Hallimund lecture this year was given by Prof. David Pyle (University of Oxford) on "Understanding the Impacts of Volcanic Eruptions". Finally the VMSG award for this year was presented to Prof. Yan Lavallee from University of Liverpool for his outstanding contribution to the evolution of volcanology in conjunction with his ethos and passion that boost him to the top. Personally I am really pleased because Yan is a very nice person and an amazing scientist that I admire a lot.

I always enjoy hearing and meeting up with my volcanology friends, researchers and academics all around Europe but much more because it is nice to find people that work on the same topic, which gives me the opportunity to share knowledge and talk about my ideas and how to pursue my PhD project.

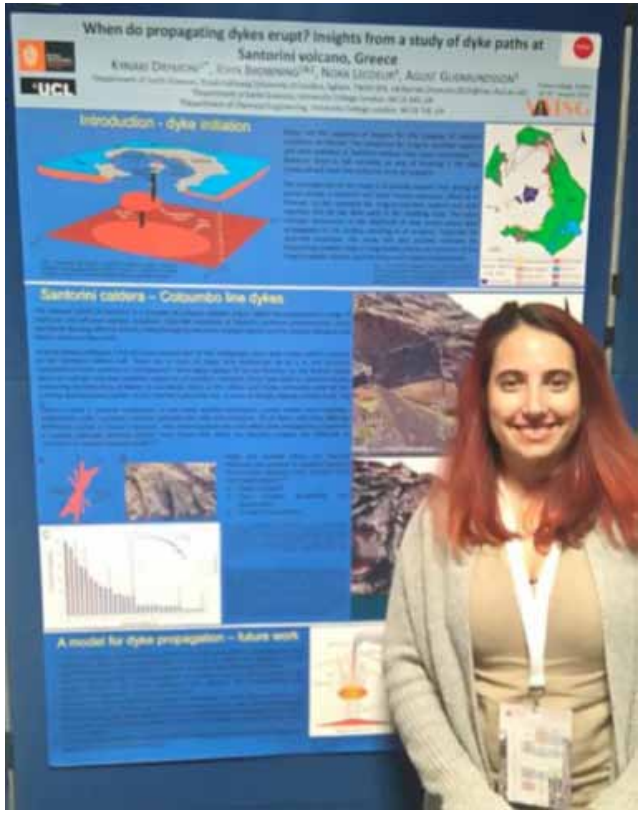
at Trinity College Dublin

with my friend Dr. David Neave (University of Hanover) at the Irish closing party

The conference dinner was held at the Old Jameson Distillery.

My lightning talk and poster this time was about "When do propagating dykes erupt? Insights from a study of dyke paths on Santorini volcano, Greece" (where I was born) which had great feedback and interest as dyke propagation is still one of the great unsolved mysteries between volcanologists.

I am so happy to have had the opportunity to visit Dublin, the traditional Porterhouse Pub, the famous Old Jameson distillery and the beautiful Trinity College library. I am looking forward to participate in the next meeting, which will be held in Liverpool. Until then, may the luck of the Irish be with us!



with my poster presentation

Next stop… GERMANY!

Sandy Drymoni

From 13 to 17 of June I had the opportunity to participate in the Melts, Glasses & Magmas (MGM) workshop which took place at Ludwig Maximilian University of Munich (LMU), Germany led by Prof. D. Dingwell and his research group. The lectures were very educational and we had excellent discussions on Melt Thermodynamics and Rheology, Equation of state and Magma Fragmentation. Prof. D. Dingwell is one of the most renowned scientists in Experimental Volcanology and I feel so much privileged to have been one of his students so far.

For the second part of the workshop we were introduced to the LMU experimental volcanology lab. We had lectures from the departmental staff about the available techniques (familiarise ourselves with the equipment, learn how to operate them, how we prepare the samples and how we interpret the data). LMU has a fully equipped lab with RAMAN spectrometers, Thermomechanical Analysers, Calorimeters, etc.

Moreover, we participated in a PhD defence. Dr. Fabian Wadsworth is an exceptional young scientist and I wish him massive congratulations! Also we attended a Lunch- break lecture by Prof. Cesare Fernando from University of Padova who introduced us to what can we learn from melt inclusions in migmatites and granulites.

Finally, I was very grateful that I discussed my ideas and thoughts with other students, made fruitful relationships with other institutes and nice friendships, drink a lot of Bavarian beer together and taste traditional German food!

Prof. Dingwell (centre) with the 2016 participants

Optical dilatometer: very useful for studying dust/ash volcanic particles

MGM participants with the LMU research group at the icebreaker. I'm at the back with the red hair!

The horizontal dilatometer (DIL) measures the coefficient of linear thermal expansion α of a rock sample

Back

Passive Margins 2016

The Second Roberts Conference

Ken McClay

The second conference honouring former Visiting Professor David Roberts was held on 6th – 8th April 2016 in the Windsor Building, Royal Holloway. Organized and sponsored by the Fault Dynamics Research Group, this international conference was an outstanding success with over 190 attendees from around the world. Participants included presenters from Australia, the USA, Brazil, Malaysia, China, Egypt, Norway, France, Spain, Germany, Denmark, Belgium, Italy as well as many from UK academia and industry.

David Roberts, who sadly passed away in 2013, was a key figure in the understanding of continental margin evolution. He worked in geoscience roles including global exploration for companies such as BP and Premier Oil, and taught at Royal Holloway. The Roberts Conferences aim to continue his work of discovery and inspiration.

An exciting programme of 42 papers and 24 posters were presented over the three days. Highlights of the conference included the introductory presentation by Rod Graham who set the scene outlining current issues in understanding passive margin development. Keynote presentations were given by Tony Doré of Statoil on the Arctic margins, Webster Mohriak (Rio de Janeiro University) on the Brazilian margins, Gianreto Manatschal (Strasbourg University) on Alpine analogues for passive margin tectonics, and James Pindell on Gulf of Mexico and Campos-Santos basin evolutionary models. Informative and thought provoking presentations were given by Bill Bosworth (Apache, Egypt) on the evolution of the Red Sea Gulf of Suez rift systems, and Pedro Restrepo-Pace (Murphy Malaysia) on Niger delta tectonics.

The Windsor auditorium was packed

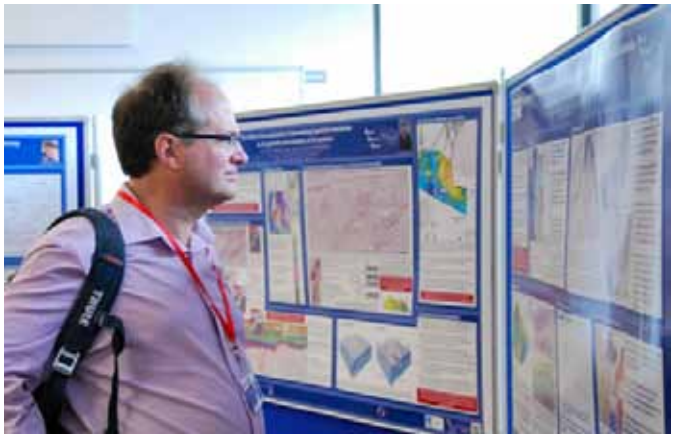
Posters created a great deal of interest

Refreshment breaks gave opportunities for discussion

Former RHUL alumni and staff figured prominently at the conference with very high quality presentations from Marta Perez-Gussinye, Graeme Eagles, Tim Reston, Samir Khalil and Ken McCormack.

Because they can become deeply buried and preserve sediments and structures, passive margins provide key information about the tectonic evolution of regions and mechanisms of crustal extension. The process of extreme continental extension and mantle serpentinization was discussed by Webster Mohriah, Gianreto Manatschal. James Pindell, Rod Graham, Marta Pérez-Gussinyé and Tim Reston.

Kevin D'Souza, Marta Pérez-Gussinyé and Tim Reston



Chris Elders during the poster session

The south Atlantic is an important passive margin and several talks considered processes from fundamental break-up mechanisms, deposition of syn-rift evaporites, as well as deformation of post-rift deltaic sediments. Javier Tamara, Mark Rowan and Pedro Restrepo-Pace gave excellent talks on these themes.

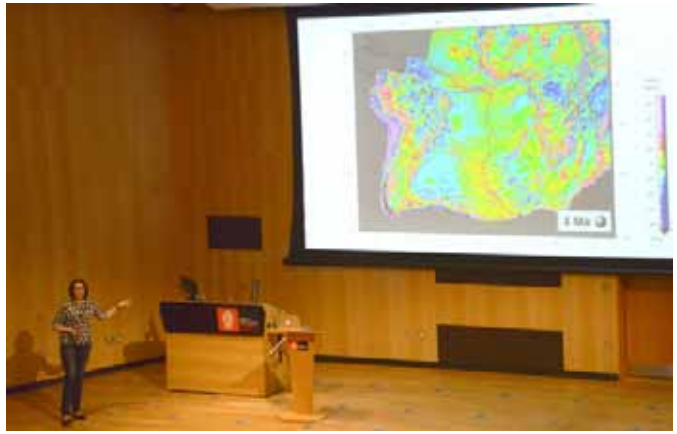
With a strong history of research in the passive margins of Australia by workers past and present at Royal Holloway, there was a prominent focus on Australia, Gondwana break-up and some of the superbly imaged basins of these margins. It was good to see 2010 Tectonics MSc graduate Kenneth McCormack return to talk about the Beagle sub-basin of the NW shelf of Australia. Chris Elders, now at Curtin University and greatly missed since leaving Royal Holloway in 2013, reviewed the NW shelf, while our own Lloyd White provided a great talk on perhaps the most important rifting event of the Phanerozoic – the break-up of Gondwana.

Former Fault Dynamics researcher Tim Dooley, now at the Bureau of Economic Geology, Austin Texas, gave a superb presentation showing his simple but extremely elegant analogue models of salt movement over fault blocks and horst structures.

Current RHUL PhD students, post-doctoral researchers and staff presented high quality posters and talks. Of particular note was the presentation by Javier Hernandez Molina on contourites along the South Atlantic margin. Great presentations were also given by Lucia Perez-Diaz on the South Atlantic margin, by Nicola Scarselli on passive margin instabilities, fault scarp erosion and slide complexes, by Awad Bilal on the NW Shelf of Australia, and by Javier Tamara on an example of a deepwater, gravity-driven fold belt complex offshore Brazil. Many positive and congratulatory comments were received on the quality of research being carried out in our Earth Sciences Department and in particular on the posters and talks by the PhD students.

The conference papers will be published as a Geological Society of London Special Publication.

Many thanks go to the organizing committee who led the way in making the conference a great success, particularly James Hammerstein, Nicola Scarselli and Kevin D'Souza; also many thanks to Kevin D'Souza and Lucia Pérez Diaz for all the photos and Ian Watkinson for extra text.



Lucia Pérez Diaz explaining her and Graeme Eagle's model for south Atlantic spreading

Current and former RHUL staff and students at the conference

Departmental Newsletters for over 30 Years

Derek Blundell

I first compiled an annual newsletter in 1982 when I was still at Chelsea College to keep our graduates in touch with the Department at a time of major changes. The first few issues described the events leading to our move to Royal Holloway to join with the geology departments of Bedford and King's Colleges. Included were photos of Queen's Building under construction. The newsletters were printed on paper and costly by modern standards to produce and distribute (by post) so I initiated the Geology Graduates Association to pay for them with a life subscription of £10, my idea being that each year's cohort would pay for that year's production and receive free copies thereafter. Unfortunately I underestimated the costs and was exceedingly glad in 1999 when the newsletters could be produced electronically and distributed free. Copies of all the earlier issues (apart from 1990, which is lost) are held in the College Archives in Founders Building, subsequent issues being stored on CD discs. All the issues since 2008 are listed on the Departmental website under "Alumni". The Annual Newsletters hold the history of the Department in quite a vivid and personal way since they are made up of articles and reports written at the time about current activities, many of them by postgrad students and research assistants – these are the ones who do much of the work! The newsletters underline and illustrate the vibrancy of the Department over 30 years, that has grown immensely over this time; grown in numbers, postgraduate activities, range and scale of activities and in global stature.

Alec Smith uinitiated monthly "information sheets" in 1986, compiled by Jennifer Callard, one of the secretaries, to keep staff up to date, but I transformed them in 1992 into monthly newsletters for all staff and students, compiled by Julie Brown. Thanks go to Matthew Thirlwall for insisting that undergraduates should be included in the readership to help instil a sense of belonging within the Department. An improvement in digital technology when "InDesign" was introduced by Adobe in 1998 allowed me to compile the newsletters digitally and this has carried me through the past 18 years or so. Nowadays I can put together the Annual Newsletter by assembling articles from the monthly newsletters and checking that I have permission from the authors that I can put their work on public display.

I am wholly indebted to Mark Longbottom for his help and advice over the past 30 years, both with the technology and the substance of the newsletters – truly I could have done nothing without his constant help and support. I am equally grateful to Julie Brown, who knows more than anyone else about the way the Department works, and who has kept a close eye on staff activities and which staff may be away at any given time.

I have savoured many of the highlights recorded by the newsletters over the years and want to recall just a few. In the early years we did all we could to publicise our work and seek support from industry, particularly with the MSc course, which in 1990 won the BP Exploration Prize for its innovation, having "broken new ground with an integrated approach to surface and sub-surface geology" and concluded with a symposium as the oral exam. Both Martin Menzies and Andrew Scott organized international conferences to enhance our reputation. Ken McClay established the Fault Dynamics Research Group of international standing built around analogue (sandbox) models of sedimentary sequences growing and deforming that could be compared with seismic reflection sections. It was funded by a consortium of oil companies, a concept that evolved over the

Receiving the BP Exploration Prize at the Institute of Directors (Alec Smith on left)

years to the present STAR project. Dave Waltham created seismic sections derived from the analogue models. He also produced numerical models of carbonate platforms to enhance Dan Bosence's interpretations. Ian Davison successfully added salt to the analogue modelling.

At undergraduate level one final year course simulated the annual UK petroleum licence round in which Professor John Brooks, head of the DTI team that assessed oil company licnce bids, agreed to take on our student teams and interview them at the D TI office in central London. In 1992 Princess Anne visited Royal Holloway at just the right time to see our students in their dress rehearsal for the following day's interview at DTI.

By the early 1990s, Tony Barber had secured funding for the continuation of the Southeast Asia Research Group, supported by a consortium of six oil companies, and Dave Waltham had set up a new Interpretation Lab, complete with state-of-the-art computer facilities for both seismic data processing and modelling. Dave had also managed to obtain major discounts on the software.

At the same time we were intent on building our geochemical facilities. Matthew Thirlwall was in charge

Princess Ann enjoying the fun of the rehearsal

of high-resolution mass spectrometry, whilst Dave Mattey looked after scanning electron microscopy, to develop state of the art resources over the years. Matthew has since enlarged and extended his remit for us to be an international centre for developments of geochemical techniques in both radiogenic and stable isotopes, involving Multi-Collector Inductively Coupled Plasma-Mass Spectrometry.

A new era began in 1992 when Euan Nisbet accepted the appointment as Foundation Professor of Geology in succession to Alec Smith and his wife Mary accepted a part-time lectureship – more of this later.

In 1995 we had to undergo a Teaching Quality Assessment (TQA) of the Department required by the universities funding agency (HEFCE). Preparations for the visit were intense, with Julie Brown and Maureen Boylan from Registry both doing an immense amount of work. During the visit, from 13th to 16th March, members of the Assessment Panel sat in on lectures, practical classes and tutorials, and listened to project presentations by teams of final year students, including the "Egham 7th round" bids for North Sea exploration blocks, held at the DTI offices in London. At the end they resoundingly declared us "Excellent". I wrote in the 1995 Annual Newsletter: "That week, for me, was the culmination, when everyone was so supportive, our friends in industry, our former students returning to lend their presence, and our Saturday evening party (a bbq in the Quad). I simply don't have the words to express my thanks properly. I just know that in all the changes that have occurred and which will continue in the future, this collective ethos is the most precious thing that we must hang on to at all costs. It is our fundamental strength, in good times and bad, and is what truly makes the job so enjoyable and worthwhile."

In 1996 Dave Mattey and I presented an undergraduate course in Planetary Geology. Neither of us knew much about it so we set up the course as one of discovery for the students. We explained that we knew no more than they did, so learning the subject was a joint endeavour. We arranged them into teams, each concentrating on particular planets, and asked them to give a presentation of their findings (mainly from the internet). After a couple of years, Dave and I had acquired quite a decent knowledge of the subject.

In 1997 Martin Menzies took over as Head of Department. One of his first jobs was to implement the four-year MSi course.

Our first cohort of MSci graduands with academic staff at the degree day, 13th July 2000

TQA: staff at the Saturday evening party

April 1998 brought good news from the HEFCE with the award of £226k for refurbishment in Geology and the creation of a Centre for Geochemistry and Geochronology with specialist facilities for environmental and resources research. The College agreed to provide matching funds for this initiative, allowing £452k for a major upgrade of the facilities on the lower floor of Queens Building and the installation of a new plasma mass spectrometer in early 1999. The refurbishment was completed by mid-February and the "Isoprobe", as our new multicollector ICP mass spectrometer is called, arrived in Manchester weather.

Martin was also involved in a new venture on the Conjugate Margin to Yemen when he, together with Cindy Ebinger, Ken McClay and two graduate students (Ellen Wolfenden, Ingrid Ukstins) headed off to Ethiopia in late November 1999. The main aims of a reconnaissance week were to establish the field logistics for the main field programme, which followed, to discuss future field expeditions and to establish a formal teaching and research link between RHUL (Geology) and the Geology Department at the University of Addis Ababa. In February 2001, Euan Nisbet delivered the

Fermor lecture at the Geological Society on "Garnets, Moving Continents, and the Influence of Life on the Face of the Earth", invited because of his holistic approach to the study of the conditions necessary for early life on Earth, and his considerable experience in Archaean Geology. Martin Menzies spent a week in south China with Yigang Xu at the Chinese Academy of Sciences (CAS) Institute of Geochemistry in Guangzhou (Canton). Yigang completed his PhD at IPG Paris with Jean-Claude Mercier and joined RHUL as a post-doctoral researcher (1994–95). His short time with us produced four research papers on various aspects of mantle geochemistry and an outline for a CAS-RS link on the Red River fault.

Meanwhile, Dave Lowry followed up on Euan's other research passion: modern greenhouse gas emissions in the atmosphere. "Of all the places to choose for a background air sampling station," he reported, "why Ascension, a volcanic mass of some 150km^2, approximately 1800 km from Recife, Brazil and Freetown, Sierra Leone, and more than 1000 km from St. Helena. Surely there are more inviting tropical islands. Well, Ascension has the most constant winds in the world, the SE trades. This means that during the period June to September there is excess methane and CO_2 in the air of Ascension which is sourced in the savannah burning of south-central Africa. The magnitude of this signal we hope to quantify using isotopes." This he did later, with much success.

In 2002, Andrew Scott went to Monserrat. "If you say you are going to a Caribbean Island to work, few believe you. The clear blue sky, hot sunshine (between 80 and 90ºF) and waving palm trees hide a more sinister side of the Island on Montserrat. After a dormancy or several hundred years the Soufriere Hills andesite volcano woke up in 1995. Since then there have been many major spectacular explo-

Florida provides a rare opportunity to study a number of delicate and varied ecosystems all of which seem to be under threat either directly or indirectly from Man's activities. For this reason the MSc EAA students undertook a 10 day field trip to South and Central Florida. Difficult as it was to tear ourselves away from Britain in January, we bravely packed our shorts and T-shirts and jetted off to Orlando on 4 January

sive eruptive phases of the volcano resulting in the burial of the capital, Plymouth, and the evacuation of the southern 3/4 of the Island and a reduction of the population from over 10,000 to around 4,000 today. Major eruptions have resulted from the build up of lava domes, which have collapsed, and given rise to major vulcanian activity. Not only are there huge eruptive columns of ash which rain down over a large area but there are associated deadly pyroclastic flows and surges. I am interested in charcoal in the fossil record and have been working on the history and impact of fires in ancient ecosystems. I have also worked on fossil plants preserved in volcanic ashes and lavas in the Lower Carboniferous. In many of the ash deposits I had been looking at, there is frequently charcoal.

The question has always been: are there charcoals from wildfires or are they charred by hot lava or ash? The fieldwork was a spectacular success. The

Scots to the fore – degree day 2001

pyroclastic surges had tended to char only one side of trees and logs, giving a thin charcoal crust. In contrast, trees and logs entombed in the flow deposits were charred throughout. One spectacular deposit in the outskirts of Plymouth included large lava blocks of more than 2m across, with rafts of charred logs with masonry and melted lead pipes! I also uncovered a series of charred upright trees!"

In December, 2002 Martin was able to report the result of the latest Research Assessment Exercise

"Awarded Grade 5: an internationally and nationally Excellent Geology Department"

In 2003 the University of London conferred personal chairs on Head of Department Professor Mary Fowler and on Professor Margaret Collinson.

Ted Rose retired was given a great send off by the students.

In 2004 Claire Belcher, Margaret Collinson and Andrew Scott were searching the world for speci-

mens of charcoal at the K/T boundary that could signify a global firestorm, possibly triggered by an asteroid strike.Their conclusion, published by Claire and Margaret in the journal *Geology* was that "Fireball passes and nothing burns".

On 14th July 2006 around 100 former students returned to celebrate our 21st Anniversary at a BBQ on a fine evening, following the degree and prize-giving ceremonies, including graduates from 1990 through to 2006. It was wonderful to meet up with them all again. A great occasion, with excellent food and plenty to drink! Many thanks to Chris Elders, Kevin d'Souza and Julie Brown for all their hard work in organizing it, and to the second-year students, Neil Holloway and others who helped out on the day.

Also in 2006, Dave Mattey began his subterranian-exploits along the Atlantic seaboard to calibrate the climate record in speleothem. As he explained, "it is well known that stalagmites preserve long undisturbed records of the oxygen isotopic composition of cave dripwater and this is telling us something about how climate has changed, but exactly which processes – be it climate, aquifer hydrology or cave environment – control the isotopic composition of cave carbonates is only just being recognized as important. The underlying principle behind all this is that the oxygen isotope composition of rainfall is controlled by a combination of the moisture source, transport distance and temperature. The weighting of these variables depends on geographical position: in temperate latitudes temperature controls the isotopes, whereas in subtropical and tropical regions the amount of rainfall controls the isotopes. Thus the oxygen isotope records in speleothem from say Ireland will tend to record temperature and speleothem from China tend to record monsoon rainfall amount. In subsequent years Departmental Newsletters have followed his progress to reach

Professors Mary Fowler and Martin Menzies toasted the Department on its 21st birthday

global proportions, most recently his recent trip to Vietnam to explore some of the largest and most spectacular caves and karst regions in the world.

Another to have taken up a new field of research was Dave Waltham who, appreciating that planets like Earth with long term climate stability are very unusual, reckoned we are unlikely to discover advanced extra terrestrial life. In an article in *Astronomy and Geophysics* in 2007 he asked the question "Half a billion years of good weather: Gaia or good luck?" He concluded that if Earth-like conditions are needed for the development of complex life, we will be less likely to discover aliens, and more likely to find that human-induced climate change could be more damaging than already imagined.

In 2007 Euan Nisbet led a Royal Holloway team that included Dave Lowry, Srimathy Sriskantharajah, Rebecca Fisher and Mathias Lanoisellé to monitor levels of greenhouse gases, such as Carbon Monoxide, Carbon Dioxide, Methane and Hydrogen, in our laboratories as part of a 4-year EU-funded project involving 38 research laboratories from the EU, Norway, Switzerland and Russia, working together under the leadership of the Laboratory for

Installing a drip counting and water colecting system built by Mick Slocombe

the Study of the Climate and the Environment in Paris.

From 2008 onwards, all the annual Newsletters are listed under "Alumni" on the Department's website and so are more easily accessed.Therefore I don't need to recount the many stories they contain, which you can read for yourselves: suffice to mention the highlights, with a reference to the date of the Newsletter.

2008

Having extended our range of subject matter since 1985, in January we decided that it would be a good time to change our name and become a Department of Earth Sciences, "because that is what we do." We also decided that it was time to restructure and re-name our MSc courses. In place of "Basin Evolution and Dynamics" we chose "Petroleum Geoscience", a clearly understood description of the course. Complementing this, the MSc course dealing with environmental assessment and analysis has been re-styled "Environmental Diagnosis and Management" to reflect the way the subject has evolved and the science and its applications have become more quantified and methodological. A 3D

Visualization system and enhanced computer hardware and software were installed in the Petroleum Geoscioence MSc teaching lab, to keep us at the industry state of the art .

At the end of August, Mary Fowler handed over to Dave Waltham as Head of Department, having led the Department for the past six years through a challenging and exciting period.

Professor Agüst Gudmundsson and Dr Dan Le Heron joined us in February; Professor Peter Burgess arrived in September and Dr Ross Haacke in October.

Just before Christmas the results of the HEFCE 2008 Research Assessment Exercise were announced nationally, from which we came out very well with a "Quality Index" (QI) of 72.5%. This placed us joint fifth amongst the Earth Science Departments, in an elite group, with the highest QI of any Department in the Faculty of Science at RHUL.

Chris Elders was instrumental in creating a new Dual Award MSc course in Petroleum Science at Tyumen State Oil and Gas University (TSOGU) in Siberia, sponsored by TNK–BP, being taught by both Russian and RHUL staff. The "Dual Award" meant that the students were enrolled at both TSOGU and RHUL. All the preparation work – refurbishing and equipping labs to modern standards, preparing the academic content of the course, recruiting students, just everything – was completed in less than 12 months so that the course began on time on 29 September with 20 students.

The NERC RESET (RESponse of humans to abrupt Environmental Transitions) Project got under way with Martin Menzies leading our contribution to compile a masterfile of the geochemistry and geochronology ($^{40}Ar/^{39}Ar$ and/or ^{14}C) of major European tephras (volcanic ash) erupted over the last 10–100,000 years, mainly to be found from the Azores to Turkey and Iceland to Pantelleria.

MSc students and staff who attended the Opening Ceremony of the new MSc course on 23 October

2009

In April, our "team snow" of Martin King, Holly Reay and James France participated in the OASIS project (Ocean– Atmosphere– Sea-Ice and Snow) based at the United States' most northern settlement at Barrow, Alaska (71.18°N). The OASIS project drew several dozen researchers together from Toronto, Colorado, Grenoble and RHUL to tackle a number of outstanding questions in polar chemistry. Holly and Martin braved the terrible weather during the first two weeks of the campaign by wrapping up in a large number of layers, and keeping going in best British tradition. The RHUL experiments determined the optical properties of the Barrow snowpack and sea-ice alongside chemical measurements of the snow made by the Grenoble team and atmospheric gas flux measurements made by the Canadians and Americans.

2010

Martin King installed a cold blast sea ice chamber at Huntersdale to generate sea ice that is doped with different black carbon concentrations and record the reflectivity and light penetration depth into the sea ice using techniques already proven in the field.

Holly Reay and the freezing hair – who says -30°C is too cold to work outside?!

2011

was one of the best years ever for research grant announcements, including the launch in January of a new 3-year consortium to support SEARG, led by Robert Hall, adding four new oil companies to the existing five. Research on salt tectonics modelling has been advanced significantly by Jürgen Adams and the Salt Tectonics Group. The Fault Dynamics Research Group, led by Ken McClay, has a particular focus on the development of 4D models for reservoir structures (STAR Project) as well as fault-related folding and fracture development in various tectonic settings. Euan Nisbet, Dave Lowry, Rebecca Fisher and Mathias Lanoisellé, who run our Greenhouse Gas monitoring programme, have extended it from Svalbard and Egham south to Ascension Island and the Falkland Islands (in 2011), so that they can measure along the full length of the Atlantic.

Chris Elders with Sergey Lebedev, Nadejda Borovikova and Ksenia Zervando

For the first time, we were delighted to welcome three of our Russian MSc students who had completed the course in September 2010 and travelled from Tyumin, Siberia to Royal Hollway in July 2011 to receive their degrees in person.

At an International Conference on Craton Formation and Destruction in Beijing, April 2011, Martin Menzies held a reunion with Three pre-eminent Chinese Earth Scientists who had trained at RHUL in the 1990s. In discussion, he reckoned that the North China Craton is renowned for its "ridgelike" heat flow and thin lithosphere akin to that found in ocean basins. This could only have happened by loss of the cratonic keel. Extrusive and intrusive activity in the Mesozoic (120–130 Ma) shows that by that time the lithosphere was hot and reactivated, allowing the transfer of magmas to the surface. The change must have taken place in a 350 M yr window (480–130 Ma). This sparked a new interest for Martin that continues to the present.

For Dan Le Heron, September saw the start of an exciting new oil industry-funded initiative in the Department, the Neoproterozoic Research programme. Live oil and gas in rocks 800–540 million years old is known to exist in Brazil and West Africa, when the two regions were joined together as part of the Rodinia supercontinent. He seeks to understand the location and setting of source rocks, the nature of the potential hydrocarbon reservoirs, and aspects of the structural development of large Neoproterozoic basins. He began in Brazil and continued in Namibia, where he and his new research student Marie Busfield worked on the 700 Ma Chuos glacial succession acknowledged as a type area for "snowball Earth". Their aim was to characterize the sedimentary deformation features of glacial origin and to study and present a new model for the origin of the ironstones.

2012

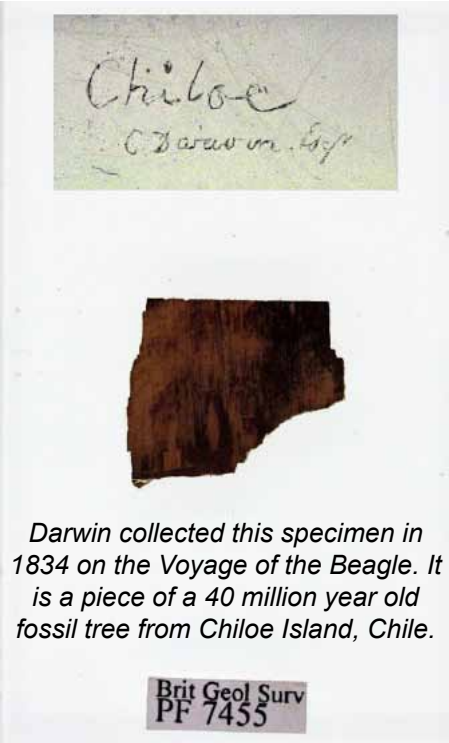
Mary Fowler resigned to take up her new post as Master of Darwin College, Cambridge – a major appointment for her, for which she deserved many congratulations, but a sad loss to us. Later in the year, Professor Jason Morgan arrived from Cornell to take over the Headship of our Department in place of Dave Waltham.

Camping: tent-mounted 4WD

Christmas Day at Dome C

Amelia Marks spent four weeks over Christmas carrying out fieldwork at Dome C situated at 3,233 m above sea level on the east Antarctic plateau. Daytime temperatures seldom rose above -25°C, and that's summer! Her fieldwork included experiments to measure the bidirectional reflectance of snow surfaces for subsequent use for satellite calibration, and improve satellite reflectance measurments.

Through the year, at least 60 scientific papers were published by members of the Department on a wide range of Earth Science topics. These included a major new treatise on "Regional Geology and Tectonics", edited by Dave Roberts and Bert Bally. These included three papers written by John Mather and Ted Rose, who also edited Geological Society Special Publications 362: "Military Aspects of Hydrogeology". They served to remind me that a number of former academics who retired some years ago are not truly retired but have turned their efforts to doing all the research that they never had time to do when they were full-time staff.



Darwin collected this specimen in 1834 on the Voyage of the Beagle. It is a piece of a 40 million year old fossil tree from Chiloe Island, Chile.

While searching through an old cabinet, Howard Falcon-Lang spotted some drawers marked 'unregistered fossil plants'. Inside the drawer were hundreds of beautiful glass slides made by polishing fossil plants into thin translucent sheets. Almost the first slide he picked up was labelled "C. Darwin Esq."

2013

On 11th November 2012 a Mw 6.8 earthquake ruptured the Sagaing Fault, 100 km north of Mandalay, Myanmar. Most of Myanmar's population lives close to the Sagaing Fault, and Ian Watkinson went to talk to them. He reported what they told him

"These fractures opened up during the earthquake and my house was badly damaged. The fractures were over one metre deep so I filled them with soil so the children wouldn't fall into them."

Dinner following Chris Elder's Disaugural lecture

Ken McClay, Julie Brown and Kevin D'Souza organized a dinner to mark the completion of Chris Elders' final MSc course and celebrate his appointment as the Chevron Professor of Petroleum Geoscience at Curtin University when he moved to Perth, Australia, in October. By way of a finale to his time with us Chris presented his thoroughly entertaining "Disaugural Lecture". *(Group photo below left)*

Marie Busfield and Dan Le Heron spent a month in the field looking at Neoproterozoic glacial deposits of the Kingston Peak Formation in Death Valley, California. Whilst temperatures get murderously hot in the basins, temperatures on the somewhat more elevated peaks such as in the Kingston Range are more manageable. Stunning basin outcrops contain numerous dropstones and reveal the development of beautiful subaqueous fan complexes dominated by turbidite and debrites. Many of the dropstones are striated, attesting to a clear glacial origin. This was an olistostrome succession (the deposit of a huge underwater instability). Rather than sliding downhill, it transpires that olistoliths "tombstone" down slope.

Dan, looking remarkably Victorian, at the sight of a boulder-sized dropstone in the Kingston Peak Formation.

Back

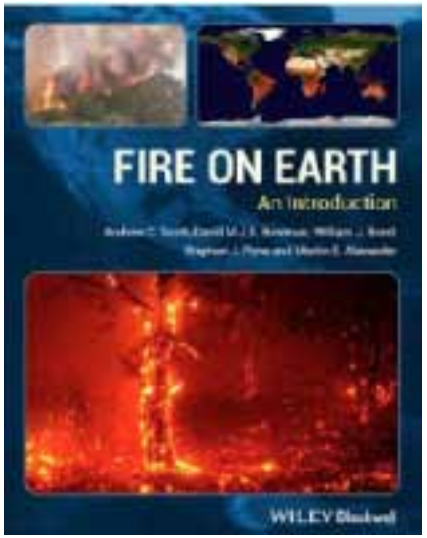
2014

Pete Burgess took over as HOD at the end of January 2014, providing a new impetus to the Departent. Another new impetus came from recently arrived Reader in Sedimentology Javier Hernández Molina. His involvment in integrated studies of continental margins, deep-water sedimentary processes and the interaction of bottom circulation along margins, and Contourite Depositional Systems led to his taking charge of a 35-day cruise aboard the Spanish reseach vessel *RV Sarmiento de Gamboa* to investigate erosive features and associated sandy deposits generated by the Mediterranean outflow water around Iberia during its Pliocene and Quaternary evolution. The survey data included single-channel seismics, multibeam echosounding and sediment sampling together with continuus gravity and magnetic observations. On selected areas a ROV system with a high definition submarine camera was deployed. The cruise resulted in a large number of research publications and a far better understanding of the fluid and sedimentary processes following the Messinian salinity crisis. The contourite sands represent a completely new and important deep water sand type.

The onboard scientific team

RRS James Clark Ross at Rothera

On 27th February, College hosted the launch of the "Fire on Earth" Book website. It was a great time and Bill Chaloner introduced Andrew Scott, and Prof. Stefan Doerr, head of Geography at Swansea University, gave the thanks. Many former staff and students attended and it was great to see so many familiar as well as new faces, who had come from as far away as Spain, Manchester, and Wales etc. for the occasion.



2015

A few months later, Javier was on a cruise off the margin of West Antarctica aboard *RRS James Clark Ross* to collect marine geological and geophysical samples and data to support a deep sea drilling proposal. Monobeam and multibeam echosounders, high resolution seismic, multichannel seismic reflection profiles, together with magnetic and gravity data were gathered. Sediment samples were taken with piston cores and box cores and oceanographic data were collected.

Our MSc Petroleum Geoscience team entered the AAPG Imperial Barrel competition for the European Region 2015 and WON it in March, beating 21 teams from other leading universities in 10 different countries! It was a tremendous achievement, which took them on to the global finals in Denver at the end of May. There they competed against the best in the world, the 11 regional winners from over 100 teams. Our MSc student team then went on to WIN the global final of the Imperial Barrel Award competition in Denver.

The winning team collecting the Imperial Barrel Award in Denver. L to R: Ben Said, Stuart Munro, Kimberley Dunn, Low Wan Ching and Arran Waterman with tutor Nicola Scarselli

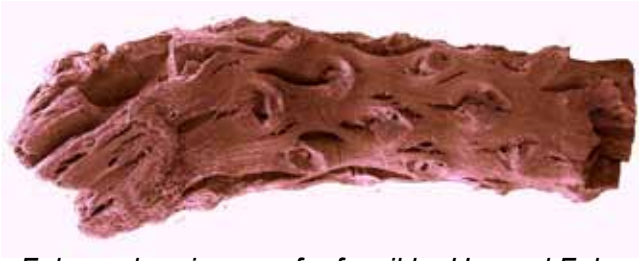
Oldest pine fossils reveal fiery past

Howard Falcon-Lang

Scientists in the Department of Earth Sciences at Royal Holloway have found the oldest fossils of the familiar pine tree that dominates Northern Hemisphere forests today. The 140-million-year-old fossils are exquisitely preserved as charcoal, the result of burning in wildfires. The fossils suggest that pines co-evolved with fire at a time when oxygen levels in the atmosphere were much higher and forests were especially flammable. Dr. Howard Falcon-Lang, who discovered the fossils in a quarry in Nova Scotia, Canada, said, "Pines are well adapted to fire today. The fossils show that wildfires raged through the earliest pine forests and probably shaped the evolution of this important tree". Modern pines store flammable resin-rich deadwood on the tree making them prone to lethal fires. However, they also produce huge numbers of cones that will only germinate after being scorched in a fire, ensuring a new cohort of trees is seeded after the fire has passed and competing vegetation has been destroyed. The new findings suggest that the widespread fire-adaption of modern pines can be traced back to the fiery world of Cretaceous times when this group of trees first evolved.

The co-authors on the paper were Prof. Margaret Collinson, and former MSc by Research student, Viola Mages who graduated in 2015. Hear the radio broadcast of Howard and Andrew Scott dicussing the discovery: http://www.bbc.co.uk/programmes/b0735qgs starting about 16 minutes into the programme.

Back



False-colour image of a fossil by Howard Falcon Lang –The fossils are just a few mm long.

Athena SWAN

Kyriaki (Sandy) Drymoni and Marianne Brett (Athena Swan committee)

Once upon a time in ancient Greece on Mount Olympus a girl was born, sprang full grown and in armour, from her father's forehead, Zeus. Fully gifted with wisdom, courage and inspiration she protected the law and justice and served as a guardian of strength and crafts as well as the divine intelligence. Her name was ATHENA.

In modern times, around the world, physical and social factors discourage and sometimes even prevent women from pursuing academic careers. As a result, even in the UK, there is a high attrition rate of women in science past the PhD level, which results in gender imbalance in one of the most important pillars of human's evolution.

ATHENA SWAN (Scientific Women's Academic Network) is an Equality Challenge unit established in 2005 in Britain to encourage and recognize commitment to advancing the careers of women in science, technology, engineering, maths and medical employment in higher education and research. Our Department's committee now consists of Dr. Paola Vannucchi (chair of the SAT), Prof. Peter Burgess, Prof. Dave Mattey, Dr. Howard Falcon-Lang, Dr. Amy Gough, Susan Lee, Julie Brown, Kevin D'Souza, Marianne Brett and Kyriaki Drymoni. We are proud to have been awarded an Athena Swan bronze departmental award which recognizes the Department's commitment to good working practices and advancing the representation of women in science.

We would like you to feel excited and positive towards the Athena SWAN accreditation goal, so we are here to provide some answers to your FAQs.

Why does it matter if there is a gender disparity in academia, or in our Department? How will this affect me?

Diversity, in all its forms, allows robust creative problem solving as people tackle research questions from different perspectives and backgrounds. Promoting diversity and equality in the workplace is aimed at providing everyone with a safe and happy work place environment, where they can feel their contributions are valued and their future is bright, regardless of their gender, nationality or ethnicity. A more diverse set of employees gives a more diverse set of skills, which leads to benefits for all. A quick search of academic papers reveals that businesses that have a more gender balanced employee base also show increased performance and profits. We want everyone in our Department to feel valued for their contributions and to understand how they can progress their career in the way that they would like. The Athena SWAN self-assessment is allowing us to identify and tackle areas of weakness that affect both men and women.

Our survey results highlighted some important areas for improvement, so we are putting together an action plan to tackle them. These include ensuring that everyone understands how they can apply for promotions, access career advice and ensure that their work load is appropriate. We are also looking at training against unconscious bias, bullying and harassment.

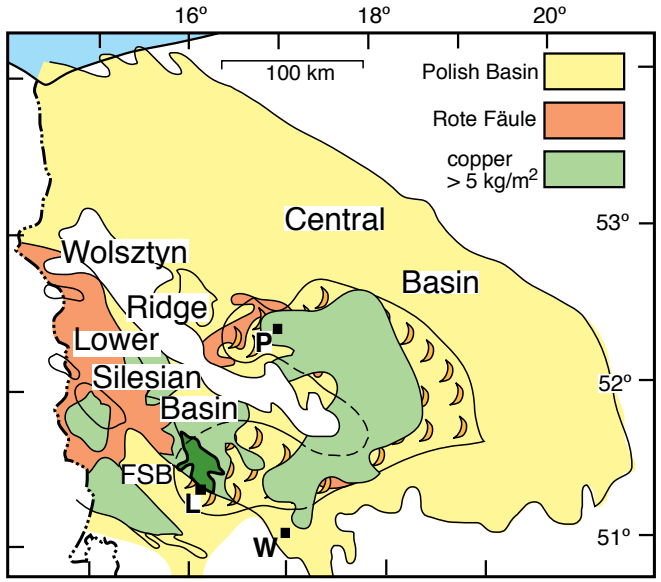
GEODE and the Polish Kupferschiefer copper deposits.

Derek Blundell

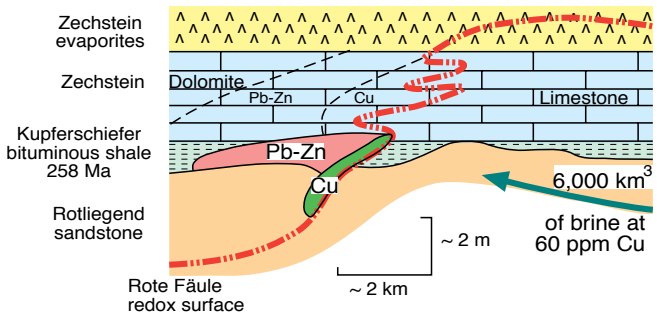
The publication of a recent paper by **Dave Alderton et al** represents the culmination of my research that spans almost fifty years, from my first paper on the palaeomagnetism of the Lundy Dyke Swarm (*Geol. Mag.* **94**, 187–193 (1957) that indicated a Tertiary age, to my latest, due to the generosity of Dave Alderton, on a subject that I know little about.

My involvement in the latter began when in 1996, seeking for a successor to the European Geotraverse, I was inspired by the advice of Professor Rudolf Trümpy to "find the connection between mountain building processes and ore deposit formation." That led me to set up a new research programme, "Geodynamics and Ore Deposit Evolution in Europe – GEODE" under the auspices of the European Science Foundation. I chaired its Steering Committee, which actively guided it from April 1988 until its conclusion in June 2003 and created a coherent research community that continues through to the present. We published a number of joint reseach papers over this period, ending with the publication of a book "Geodynamics and Ore Deposit Evolution in Europe", edited by Nick Arndt, Peter Cobbold, Chris Heinrich and myself.

Although I had gained a lot of experience in managing programmes of this kind through the European Geotraverse, I had next to no knowledge about ore deposit formation. However, I did know something about sedimentary basins and seismic interpretation from my involvement with BIRPS. I therefore began to take an interest in sedimentary ore deposits, in particular the truly remarkable Kupferschiefer copper deposits of Poland which have been continuously exploited for around 1000 years and probably have more published accounts than



L Lubin (dark green) P Poznan W Wroclaw



Schematic cross-section

any other mineral deposit worldwide. This is when Dave Alderton first came to my rescue. We looked at a paper by Craig Jowett published in 1986 that attributed the mineralization to convective recirculation of brine within the Upper Rotliegend red bed sequence in a closed circuit, driven by elevated heat flow from Triassic rifting, and seals provided by Zechstein evaporites. To account for the accumulation of around 350 million tons of copper in the Lubin district, Jowett's model required the brine to carry 1,000 ppm copper in solution leached from Permian volcanics deeper in the section, precipitated in reducing conditions associated with a redox surface known as Rote Fäule and recycled about 19 times, taking nearly 6 million years. The age of the Kupferschiefer shale is 258 Ma but that of the main mineralization, according to Jowett, was early Triassic ca. 220 Ma. However, the concentration of copper in the brines required for the model is far higher than the 1 ppm observed in present day Rotliegend pore waters and significantly higher than levels elsewhere responsible for sandstone-hosted copper deposits.

David and I, together with Harry Kucha, Pawel Karnkowski and Slawomir Oszczepalski, produced an improved model, in which saline fluids circulated within sheared basement as well as the sedimentary column and were driven by a coseismic strain mechanism to generate a flow of brine up basement faults that seal in the Zechstein, then flow up-dip in top Rotliegend aeolian sandstone. Our calculations showed that a reasonable volume of brine contained in basement fissures could be pumped through Rotliegend aeolian sandstone by coseismic strain: M = 5 earthquake events every 200 years can deliver 6,000 km^3 in <10 m.y. with 60 ppm Cu sufficient to account for the amount of copper in Lubin. Whilst producing a more realistic model that took into account the active Variscan tectonics in the region we still needed to reduce the concentration of copper circulated in the system.

David has now overcome this deficiency by undertaking a series of new Re–Os age determinations on mineralized material from the Polish Kupferschiefer to elucidate the timing of mineralization and thus the likely mechanisms of ore deposition.

Working with David Selby he has analyzed three

mineralization parageneses with ages that fall into two ranges: 245.2 (±1.6)–264.7 (±1.8) Ma and 162.3 (±0.8)–184.3 (±2.2) Ma. These results substantiate previous age determinations and confirm that mineralization took place in several stages, from soon after Kupferschiefer sediment deposition in the Upper Permian and for at least 100 m.y. after, until at least the Cretaceous. The genesis of the mineralization can be explained by the episodic release of hydrothermal fluids from the subsiding adjacent Southern Permian sedimentary basin.

Unique 20-year record of an 80% decline in atmospheric CO at Egham.

Dave Lowry, Euan Nisbet et al.

Back in 1996 we began a programme of continuous monitoring of atmospheric carbon monoxide collected from the roof level of Queen's Building, and measured on high-precision equipment in the Greenhouse Gas laboratory. Euan and Dave realized that we were conveniently situated at the western edge of the densely populated Greater London area. With the wind blowing from the West we were in clean air drawn from generally unpolluted areas stretching back to the Atlantic. With the wind coming from the East we were in air polluted by traffic and other sources in London and beyond. The contrast in CO mixing ratio, a measure of pollution extent, was readily apparent. However, finding the funds to support this research was difficult as Research Councils were loath to support what they regarded as routine observations. The CO measurements reported here largely fell through the funding cracks and were supported through other funding to the lab, and they have managed to keep the measurements going since late 1996. The big reduction in CO since the introduction of catalytic converters means that it is rarely measured by local councils for the past 5 years as it is not seen as a problem any more, and most of the records stopped before the recent levelling out of the concentrations. The paper was started about 5 years ago, got put on the back-burner, had more years of data added, until last October when we finally had a push to get it ready for submission. This is typical of the funding problems that have beset climate change research. The outcome of our research shows that with focus on specific policies and technologies, particular emissions can be curbed and this has seemed to work in the case of carbon monoxide. The challenge now is to translate this success into steps to reduce other harmful pollutants. While our air can be said to be cleaner in terms of CO, nitrogen oxides and black carbon emissions have increased."

The Greenhouse Gas Laboratory nowadays forms one element of a global network of similar monitoring laboratories. Thus the Royal Holloway team can see their results in the light of concurrent growth in Asian CO emissions inventories. India shows a steady rise during the 1990–2010 period, and the slow rate of increase in Chinese emissions speeds up significantly after 2000.

Southeast Asia Research Group Activities

Report by Robert Hall and colleagues

The current industry consortium supporting the SE Asia Research Group finishes at the end of 2016 so, with the present low oil price, forming another consortium will be tough. Flying the flag for the research group is therefore particularly important at the moment so presentations at major meetings are a priority; there have been several. Furthermore, our annual May meeting in Jakarta was the last opportunity to meet our existing companies in SE Asia during the current consortium and present our work; we shall have our final meeting of the 2014–2016 SEARG consortium at RHUL in December.

Sam Melia, Max Webb and Lloyd White at a nodding donkey in the oil-producing Klamano field in the Salawati Basin, West Papua.

Robert Hall kicked off the meeting season with keynote presentations at two Geological Society of London meetings. The Janet Watson meeting in late April focused on hydrocarbon exploration and Robert presented an invited talk on the activities of the group with a theme of SE Asia and Australia–Asia collision: 30+ years of working with industry. At the end of May the subject of the Geological Society's Arthur Holmes meeting was the Wilson Cycle where Robert gave another invited talk on subduction initiation and how it can be observed in eastern Indonesia; this generated a lot of discussion.

Because of the Arthur Holmes meeting Robert arrived late in Jakarta and therefore, for the first time for many years, missed the Indonesian Petroleum Association Annual Convention to which SEARG are regular contributors. However, we had two presentations in the programme, one by Jesika Chandra, RHUL 2015, one of the Petroleum Geoscience MSc students who SEARG regularly fund. Jes presented the results of her project on the South Halmahera

Oil seep in Kais Formation carbonates of the Salawati Basin, West Papua.

basin. The second presentation was by Sebastian Zimmerman who presented some of the results of his PhD study on sandstone provenance in the Banda Arc. Despite a fever, probably picked up on the flight to Indonesia, Sebastian's talk went very well and he was awarded a prize for his presentation. At almost the same time Sebastian learned that his first paper reporting the results of his PhD had been accepted by *Gondwana Research*.

The IPA Convention was followed on the Monday afterwards by the SEARG consortium meeting in Jakarta, where there were talks by Jesika Chandra, Sam Melia, Max Webb, Lloyd White, Sebastian Zimmerman (represented by Robert as Seb had to fly home following his fever), Amy Gough, Alfend Rudyawan, Albert de Montserrat Navarro and Robert Hall. The meeting thus had a very good coverage of ongoing and recently completed projects ranging from MSc and PhD to staff research and from west (Vietnam, Sumatra) to east Indonesia (Banda and Papua). After the meeting the research group dispersed to various part of SE Asia. Lloyd, Max and Sam headed east to Papua. They examined Mio-Pliocene clastics of the oil and gas producing

Idyllic cove near the northernmost point of the Australian Plate in West Papua – only reachable by boat (or on foot if prepared for an extremely long hike!).

Bintuni and Salawati Basins, visited outcrops along the Sorong Fault Zone, and ventured to the northernmost tip of the Australian Plate. The group also discovered fresh oil-bearing carbonates in a quarry, currently used to make cement. Oil seeps in this region were first reported nearly 100 years ago by Dutch geologists and are part of the highly successful Salawati Basin. There is still much to learn about the geology of this relatively poorly studied region, but we remain hopeful that additional oil and gas will be found in wells to be drilled in the next year in the nearby Bintuni and Cenderawasih Basins by some of our current consortium members.

Amy, along with Jes, set off for Sumatra to target Eocene to Miocene clastic sediments in the Central Sumatra Basin, adding to on-going work in the south of Sumatra. The field season started in the city of Pekanbaru, before traversing the eastern edge of the Barisan Mountains. Exposure in the region was at an all-time high, mainly due to efforts reducing the area of oil palm plantations. As a direct result of this, plenty of samples were collected for

Amy Gough on a river traverse in the Sihapas Formation, Sumatra.

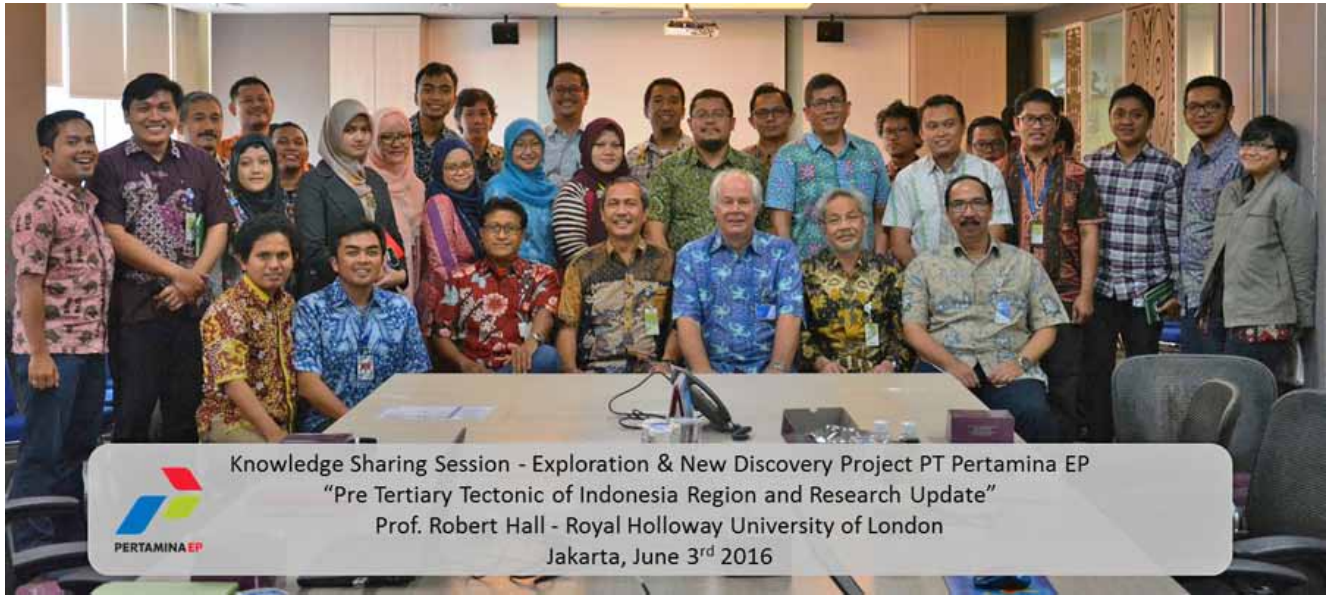
analysis, including samples of pre-Cenozoic basement lithologies which are necessary to interpret the Sumatran detrital zircon ages. As well as the excellent exposure of the sediments they were also lucky enough to visit the Toba supervolcano caldera and Mount Sinabung, which had erupted one week previously.

Robert went east, but only a relatively short distance, to Jogjakarta in Java where the hotel had a spectacular view of Mount Merapi, Indonesia's most active volcano, which is fortunately in a quiet phase. Robert gave a 3 hour talk on Indonesian tectonics to 200+ students who belong to one of the region's AAPG student chapters, and signed a certificate of attendance for each one. A spin-off from this meeting was another Petroleum Geoscience MSc studentship for 2016 entry funded by the Indonesian government. Another was a very large piece of polished limestone as a commemorative reminder of the meeting. Finally, back to Jakarta for two talks at the national oil corporation, Pertamina, on Friday on the Pre-Cenozoic tectonics of the Indonesian region.

Jesika Chandra, Amy Gough and Mas Firman (driver) in front of Mount Sinabung, Sumatra.

This session was rewarded with a model of a Sulawesi sailing boat, almost identical to the Shakti, a traditional Bugis boat, now used for diving trips, and hired by oil company explorationists accompanied by SEARG researchers for several expeditions to eastern Indonesia since 2009. On return to London we learned that another Malaysian research student would be joining the group, as a result of another trip to SE Asia last year, this time funded by a Malaysian scholarship from Petronas.

Overall, a busy period of presentations, fieldwork, recruitment for SEARG and its thriving group of 4 post-docs and 10 postgraduates. It is appropriate to observe that SEARG has grown over the last 30+ years from the First Consortium for Geological Research in Southeast Asia initiated by Derek Blundell at Chelsea College in 1982 with Tony Barber as Project Manager. It is clear that the group has made fantastic contributions to furthering the understanding of the geology of SE Asia and now has an outstanding international reputation. What is perhaps most rewarding is looking back at how many geologists we have trained from the region.



Robert Hall and Pertamina staff, Jakarta.

Robert Hall and limestone memento, AAPG students, Yogyakarta.

We regularly meet ex-SEARG and ex-Petroleum Geoscience MSc students in company offices and at meetings – many now in very senior positions, and often responsible for sending more students to

Mount Merapi from hotel, Yogyakarta

RHUL – which clearly demonstrates the impact the group has had over the past 30+ years. Thanks and good luck in your post-newsletter retirement, Derek!

Back

SEARG: Southeast Asia Research Group – In Scotland

Lloyd White, Benjamin Jost and Max Webb experienced a week in sunny Scotland. They joined Dr. Daniel Viete, Edward Inglis and Erin Scott from Durham University to look at classic locations of the Barrovian and Buchan metamorphic sequences both north and south of Aberdeen.

You probably think it odd that a group of geologists working on the geology of West Papua had ventured so far north of the equator. We could say that it was deep fried mars bars and whisky that lured us so far 'off course', but the real reason was that we wanted to compare the similarities and differences between the metamorphic sequences that we are investigating in Indonesia with the classic locations of northern Scotland.

Left to right: PhD students Max Webb (RHUL), Erin Scott (Durham), Edward Ingliss (Durham) and Benjamin Jost (RHUL) sample some local tucker.

The bay north of Portlethen shows incipient migmatites with pinch and swell textures/boudins which along with focused geochronology indicate the Barrovian metamorphic sequences are associated with crustal extension.

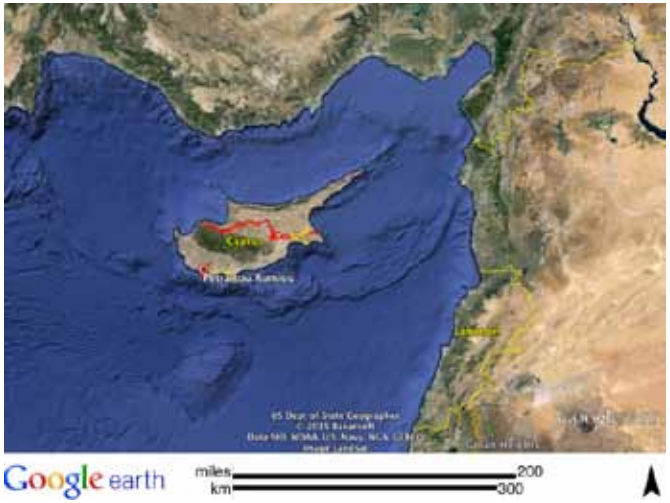
We found many similarities between the metamorphic rocks from the classical locations in Scotland and those we see in West Papua

Lloyd's colleague Daniel Viete did his PhD research on the timing and duration of metamorphic pulses in the Buchan and Barrovian sequences, so we asked if he might lead a field trip so we could look at these rocks.

Our time in Scotland showed us that many of the outcrops were similar to those we observe in West Papua ¬– particularly a Buchan Sequence that Benjamin Jost is examining that is possibly linked to pulses of Carboniferous–Permian magmatism. The trip to Scotland was therefore highly valuable to Ben's PhD research. Ben was also fortunate to win a Mineralogical Society prize to offset some of the costs of this trip.

This was a great opportunity to see some classical localities and to spend some time getting to know the postgrad students from Durham. This also gave Daniel and I a good opportunity to discuss funding for a future project on the timescales associated with short pulses of metamorphism in different locations around the world.

Fieldwork



Cyprus and Petra Tou Romiou outcrop location.

Contourite facies in the Petra Tou outcrop.

Deep- water sedimentary facies with hemipelagic – pelagic sediments, fine grained turbidites and potential reworked turbidites.

Drifters in Cyprus

Javier Hernandez-Molina

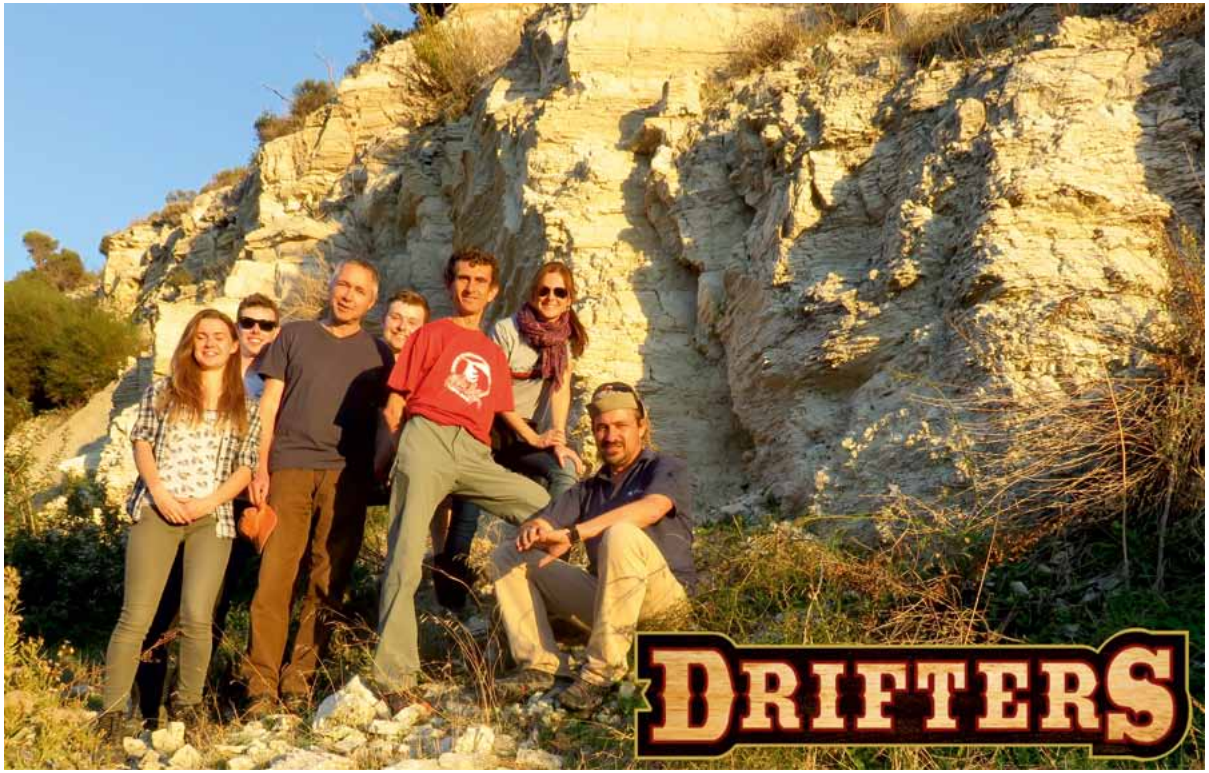
On the 5th December, we started the long journey from Royal Holloway to very sunny Larnaca, Cyprus, to meet with colleagues from Spain, Germany and Scotland, to study the contourites (or "drifts") and turbidites deposits of the Lefkara Formation (Eocene-Oligocene).

The first day in the field included an orientation of the proposed localities identified during an earlier expedition (Petra Tou Romiou and Agios Konstantinos), as well as organising the work to be completed over the next few days. This involved splitting the group into teams of two or three in order to log the outcrop sections in detail, and identify key litholological, sedimentological and ichnological characteristics of the formation. Despite the ominous workload and warm sunny weather, Keo (local Cypriot beer) became the evening drink of choice of the "Drifters team" composed this time by: F. Javier Hernandez-Molina (RHUL, UK), Estefanía Llave (IGME, Spain), Francisco J. Rodriguez-Tovar (Univ. Granada, Spain), Heiko Huneke (Univ. Greifswald, Germany), Adam Creaser (RHUL, UK), Jon Caswell (RHUL, UK) and Leona Hyslop (RHUL, UK). Dorrik Stow (Heriott-Watt, UK) also made a brief appearance during the first few days to discuss about the Lefkara Formation.

The "Drifters team" executed a very detail sedimentary log of about 200 m of the Lefkara Formation, from the beach up to the top of the hills at Petra Tou Romiou. Alongside these logs, photos and a good number of samples were taken for micropaleontology, grain size, thin section, petrological, XRF and ichnofacies analysis to be completed over the next months. This multi-disciplinary study is important since the Lefkara Formation is one of the few examples of ancient contourites recognised worldwide, and potential results would have implications for a better understanding of similar deposits in other ancient records and present marine basins.

Examples of Ichofacies ( ) in the upper part of the sedimentary section of Petra Tou.

A relaxed evening for the "Drifters team" having a local beer in the "Drifter" restaurant.



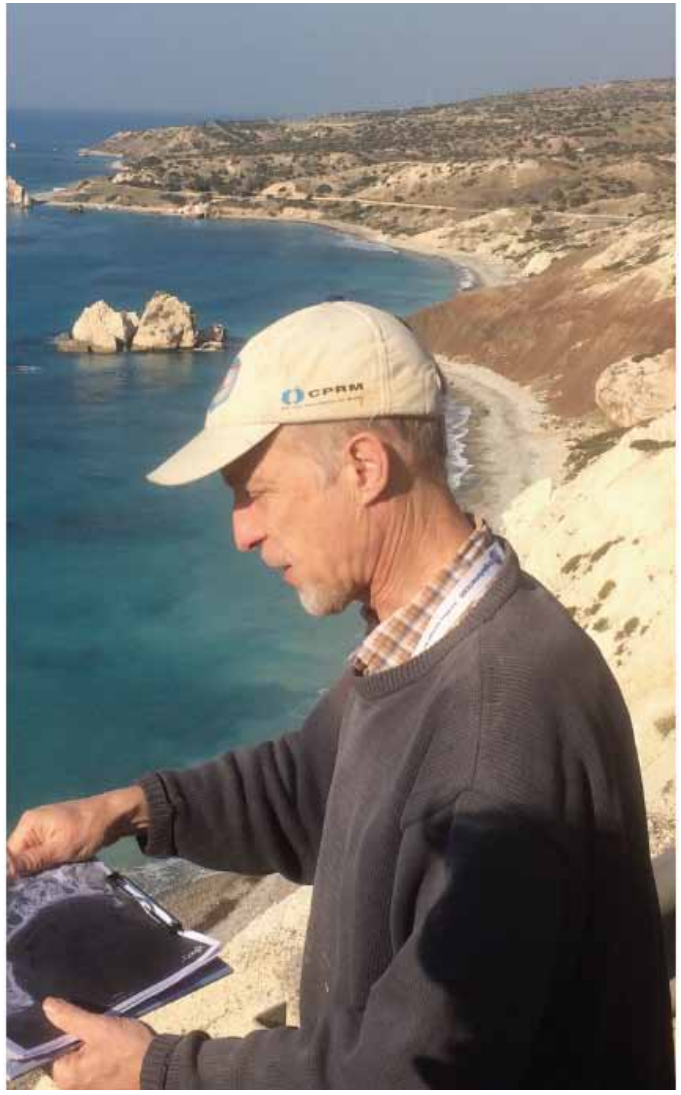
The "Drifters team" at Petra Tou (from left to right): Leona Hyslop (RHUL, UK); Jon Caswell (RHUL, UK); Heiko Huneke (Univ. Greifswald, Germany); Adam Creaser (RHUL, UK); Francisco J. Rodriguez-Tovar (Univ. Granada, Spain); Estefanía Llave (IGME, Spain); and F. Javier Hernandez-Molina (RHUL, UK).

Back

Cyprus 2015: An investigation into Oceanic Crust – *Martin King*

How long has Dave Alderton been going to Cyprus?

Dave Alderton has been running or involved with this field trip for over 20 years. Officially this may be his last trip. I do not think so somehow, I think he will miss the beautiful weather below



The Cyprus 2015 field trip

was concerned with looking at evidence of the oceanic crust, black smokers and may be the closest thing to touching a petrographic Moho if that were possible….. Oh and ophiolite.

A 4.5 hour flight from Gatwick too early in morning brought us to Cyprus and one of the nicest hotels I've stayed in: Complete with huge breakfast and dinner buffets, three pools, balconies with sea views, saunas and the like, and nightly entertainment (complete with Zoba the Greek). The students lowered the average age of the hotel guest by about 30 years and really appreciated the buffets - I have never seen so much food eaten. Interestingly one of the guests was Dan Le Heron's old supervisor. ***Day 1*** was a drive up towards the summit of Trodos exploring mantle rocks, including Dunite pods. The road cuttings, old mines lay the geological story out easily and in beautiful detail. Altered serpentinites werealready present. A short drive round and the natural asbestos proved particularly interesting. Much more interesting than my explanation of lung function and damage,

Day 2 was one of few days with rain and we explored the sheeted dykes and lava of Trodos including the mineralisation at the Agrokipia mine pictured above. The weather slowly improved with the exception of ***Day 3*** mapping at Margi in overcast conditions and a little rain, but porous rocks that stick to your tongue more than made up for that. The rest of the trip was in beautiful warm weather and so much sunshine that my veins were coursing with vitamin D. The following days were spent exploring Arakapa fault zone, amazing melanges and Petra Tou Romiou lithologies. The field days were long and in the melange (upper right) one can see the reddening colours of the sun, and perhaps a request for liquid refreshment in shadow writing. This was also one of the few days when we had impromptu lectures about lenticular clouds and the belt of Venus (the Earth's shadow) owing to some favourable meteorological conditions. A team photograph was taken near Aphrodite's rock in glorious sunshine and the trip ended the next day after a visit to the sedimentary structures on the Governer's beach and an unusual mine deposit.

This was my first time to Cyprus and I was impressed with what the trip demonstrated and how the story came together. The students worked hard during the day and in the evenings. A record must have been set for feedback and the return of coursework by Christina in something like 6 hours.

Almeria Field Trip 2016

Amy Gough

On the 7th of March the 2nd year geologists made their way to Almeria to start a two week fieldtrip. This trip was led by Javier Hernández-Molina, Pete Burgess, Christina Manning, Amy Gough, and a plethora of PhD students. After a long day of travelling, we arrived at the apartments and were treated with a spectacular sunset for the first evening. This was a huge improvement from the rain and wind we were met with the previous year.

The next day we took the entire group out to introduce them to the modern day sedimentary processes that occur in rivers, beaches, and alluvial fans. Alongside this, we also examined the impressive Carboneras Fault Zone (which would prove important during the mapping week). From the second day onwards, we divided into two groups to investigate the local geology. The students visited the impressive volcanics around Los Frailes, and got the chance to complete a geological map and cross section. Following this came the Nijar Basin, where we saw debrites, turbidites, Porites reefs, the Terminal Carbonate Complex, and the impressive Nijar dacite (complete with garnet xenocrysts). I often wonder how many geologists have garnets from here?

In the Sorbas Basin we got acquainted with everybody's favourite blue marls, extensive evaporites, and bird-footprint rich sandstones. We were incredibly lucky to be joined by Francisco Rodriguez-Tovar from the University of Granada, who is an expert in ichnofacies. He treated us to additional information throughout the day, and a talk in the evening session. Finally, we visited Tabernas Basin, home of 'Mini Hollywood' and spaghetti westerns. Here we saw impressive submarine canyons and the famous 'El Gordo' seismite.

Pete summarizing the geology of the Carboneras Fault Zone and telling the students some bad good jokes

Christina Manning was a welcome addition to the group for the second mapping week. The students, armed with new field skills, embarked on their independent mapping training. This trip is the precursor to their longer four week mapping project later this year. After spending a day daunted by the complex geology, all of the students really settled in to their mapping. They seemed excited to complete a map all on their own, and everyone worked really hard to achieve this. Mid-week the students got the chance to complete a log near the mapping area at Argamasol. Some students were lucky enough to find a fossilised whale bone, which are common in the Gulf of Cadiz and the Alboran Sea in the latest Pliocene deposits. Before we knew it, the end of the fieldtrip had arrived and it was time to take our tired, but happy, students back to Royal Holloway. Before we left we enjoyed a group paella at the restaurant across the road from the accommodation, which was a great end to a great trip. Thanks must be extended to fieldtrip leader Javier for ensuring that the trip ran as smoothly as it did, and to the students who were a pleasure to teach.

Javier teaching the students about beach profiles on the first day. His carefully dug trenches show how the beach evolved through time

The students examining a flow banded dacite dyke in Los Friales. You can spot PhD students Alex Clarke and Rafika Ismail having an interesting discussion.

Javier getting the students excited about submarine deposits in Nijar Basin. They saw the complete succession of the basin, and spent another day logging the Tortonian sediments

Slumping in the Tabernas Basin. The students being impressed by the incredible structures throughout the basin.

PhD students Alex Clarke, Sam Melia, Antoine Thieblemont, Rafika Ismail, Nils Kollert, and myself. Adam Creaser left the trip at the start of the mapping week. We had as much fun with the geology as the students

Can everyone say BLUE MARL? The red group smiling after a great day in Sorbas. We were joined by Francisco Rodriguez-Tovar from the University of Granada. He is an expert in ichnofacies, and taught us all a lot. He even gave us an evening lecture

Look at the spectacular blue sky! The 2nd years promised us that they always had great weather – and they were correct.
The entire group after logging at Argamasol. Even Aaron Rooney managed to complete the log with a broken toe.

Back

MSc Pyrenees field course 2016

Ian Watkinson

This April/May the Petroleum Geoscience MSc once again travelled to Spain for 10 days to study the interactions between sedimentation and collisional tectonics in the central Spanish Pyrenees. Thirty seven MSc students fresh from their final exams attended the field course, initially based in Huesca. Phil Hirst, formerly of BP, kindly joined us once again, and we had the invaluable support of Kevin D'Souza and PGR demonstrators Chanida Kaewkor and Silvia Crosetto.

The field course began with a spectacular drive-by traverse across the frontal thrust system and piggyback Jaca Basin. Since introduction of a nominal fieldwork fee in 2015 we have been able to use two large coaches rather than a fleet of people carriers for transport, so it is possible to have panoramic views and group discussions about the geology enroute. A brisk walk up into the mountains close to the French border revealed stacked fault propagation folds and outcrop of a knife-sharp thrust fault inferred to splay from the basal Gavarnie Thrust at depth.

The Spanish Pyrenees are famed for their 3-D exposure of syn-kinematic growth strata. A couple of days were spent studying these in detail, looking closely at variations in sedimentation style and sediment pathways on the north and south side of the External Sierras frontal thrust system. Phil Hirst led an expedition into the Ebro foreland basin to study some beautiful 2-D and 3-D exposures of Oligo-Miocene fluvial sediments.

During the second week we were based in the tiny village of Labuerda, close to Ainsa. From here we were once again able to hike into the mountains to view structures in the axial zone. The southward tilting of south-directed thrust sheets meant it was

The field team standing on a Middle Eocene reef flanking the Mediano anticline (Photo: Kevin).

possible to see an exposure of the basal detachment system in the Monte Perdido National Park, and to investigate the crystalline basement of its footwall. This in turn led to discussions about the provenance of sediment making up the syn-kinematic strata and the timing of exhumation and intra-basin fold growth.

The highlight of the trip was a hike onto the Cotiella massif to view growth strata related to the inverted Armeña listric fault, developed during Late Cretaceous raft tectonics. The remains of a thick late snowfall threatened to curtail the hike several times, but we were able to pass safely to reach a high plateau from where a seismic-scale panorama of the growth strata could be observed.

The students were on fine form and were a credit to the university. From their own observations they produced superb cross sections from the axial zone into the foreland basin, as well as gross depositional maps showing palaeoenvironment and sedimentary facies/pathways for early and late syn-collisional stages. Despite long days, significant physical exertion in the field and late evenings working, they were always positive and enthusiastic, and a pleas-

Late syn-tectonic Oligo-Miocene fanglomerates at Aguero village (Photo: Ian).

Phil Hirst and students discussing chlorite-bearing and chlorite-barren sandstones at the edge of the Ebro Basin, immediately below the frontal thrust system (Photo: Ian).

ure to spend time with.

Overall the trip was enjoyable and incident free. Predicted storms materialised only as picturesque early morning low cloud over the hills, despite ominous sun haloes the day before. The sun shone every day and a light snow flurry lent a festive atmosphere. A small explosion in the otherwise quiet Labuerda village square smashed glass and necessitated the changing of underwear, but turned out to

Basement outcrops (including slates, two-mica granites, amphibolites, sillimanite-biotite schists and serpentinite) below the Gavarnie Thrust in Monte Perdido National Park (Photo: Ian).

Students on a hill overlooking thrust sheets of the Cinca Valley (Photo: Ian).

Crossing a snow-filled valley on the long but enjoyable climb up to view the Armeña growth strata (Photo: Ian).

The 'nature table' at Ainsa Quarry. Turbidites with trace fossils, bioturbation, bored clasts (in the drilling sense), tool marks, fossil wood and oyster shells (Photo: Ian).

The field team high on the Cotiella massif with Late Cretaceous Armeña growth strata behind (Photo: Kevin).

be just one of our bus tyres exploding (repaired by a crack team sent from Tremp the very same night). I would like to thank Kevin *'dos postres'* D'Souza, Phil, Chanida, Silvia, also Javier, Lynne and Lucia for additional help organizing the trip in the UK, our drivers Jordi and Xavi, Nurri at Fonda Carrera, and of course all the students.

VASTness of Vietnam Caves

***Dave Mattey and* Angel Fernandez-Cortes**

Angel Fernadez-Cortes and I recently visited Vietnam as guests of Dr. Trinh Anh Duc, an environmental chemist at the Vietnam Academy of Science and Technology (VAST), located in Hanoi. Duc is working to build up speleothem proxy research to improve palaeoclimate records in Vietnam (almost non-existent at present). We had the privilege of seeing some of the largest and most spectacular caves and karst regions in the world to identify suitable study sites and assess potential for collaboration.

The first part of the trip was with old friend Nigel Harris from the OU (of granite petrogenesis and Himalayan tectonics fame) who by coincidence was visiting Hanoi at the same time as a guest of the Institute of Geology. We combined forces and tagged along with their field trip to look at some of the tectonic features of the Hanoi Basin and visit Ha Long bay, the world famous drowned tower karst. The next day we visited the Trang An fluvial karst, located about 100 km south of Hanoi, which is a very popular weekend tourist attraction. It was indeed the weekend, and I can confirm it was extremely popular – we joined up with 1,150 boatloads of cheery Vietnamese families and various wedding parties to be expertly rowed by 1,150 lady oars-persons across a lake towards towering limestone cliffs, not quite knowing what to expect. Off we went, following a long crocodile of rowing boats and, nine cave passages, 10 lakes, 4 temples and 3 hours later we amazingly arrived back at the same place where we started, with a pretty comprehensive understanding of how the tower karst is underlain by a complex network of low water-table caves which interconnected the doline lakes. The staggering number of 1150 boats is no exaggeration, lines of them crossing lakes can clearly be seen from space….

Tower karst of Ha Long Bay

Trang An karst, paddling off into the unknown…

Paddling into a water table cave…

Crossing a doline lake, into the next cave passage. The lines of boats are visible in Google Earth.

Some of the cave passages were 200m long, with a roof just high enough to squeeze under

Back

The second part of the trip was a visit to the UNESCO Phong Nha-Ke Bang National Park, a huge karst area about 300km south of Hanoi, crossing into Laos and even now barely explored. The 38 km long Phong Nha Cave is regarded by British Caving Association as the top cave in the world due to its four records: the longest underground river, the highest and longest cave, broadest and most beautiful sand beaches inside caves, and the most spectacular stalagmites and stalactites. The cave was fully surveyed by the BCA in 2009, which extended the total length the underground river to 56 km and among other discoveries stumbled across the world's largest cave chamber, Son Doong, which contains stalagmites 90m high. These cave systems are truly vast, formed in limestones of Devonian and Carbonferous which here are 1000m thick, thrusted and folded, and karstified for over 300my. Paradise Cave is part of the Phong Nha system accessible to tourists and the stunning show cave is in itself over 1 km long. From the end of the tourist path we continued another 4 km along vast passages which were mostly a stroll along dry sandy beaches following a river channel. After a couple of km the passage become more confined where during the summer monsoon the cave obviously flooded to the roof, forming an impassable sump. In March, at the end of the winter this passage is mostly dry but choked with sticky clay through which was cut a slot filled with deep water. Some of this water had been pumped out to permit cavers to swim (we regretfully declined this option) or use a small boat to pass along a canal under the low roof. The small boat turned out to be very wobbly tin bath. Several return trips got the party past this obstacle, thereafter the cave opens up again to wide sweeps of river passage,100m wide in places until it dropped away down rifts. Ahead over large boulders was an immense breakdown chamber where you could only feel the void, the roof and walls barely illuminated by lamps. Then after another kilometre or so, a sudden change, a narrow low section through a maze of columns which opened out again into another vast space, this time with a glimpse of daylight in the distance – this was a skylight looking down to the active river below and up a shaft to the forest above, maybe 250m from the land surface down to the river.

The entrance to Paradise cave, Phong Na-Ke Bang National Park. Vast.

Stalagmites. big ones…

Stalagmites. Little ones…

Three men in a bath…

The active underground river can be accessed further up the valley by boat through a spectacular portal in the cliffs. This was bombed by the Americans to block its use by Ho Chi Minh as a storage depot during the war. The nearby rice paddies are peppered by bomb craters (now handy fish ponds) and the entrance cliffs scarred by rockfall and shrapnel.

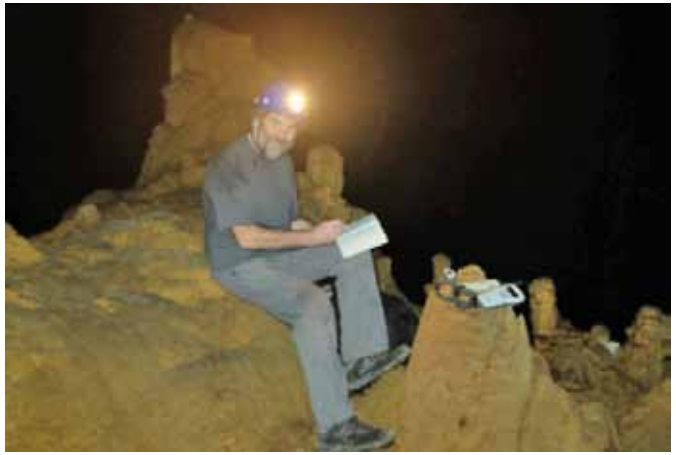
Trekking towards the daylight… The three spots of light on the left are reflecting marker posts showing the trail, 50–100m apart.

Even so quite large boats can follow the underground river in for several km, and the channel is marked by navigation buoys.. You don't find these in caves very often… Again the river cave is stunning with huge decorations but a stiff climb above the active river entrance leads to another highly decorated cave system, which we found was probably the best option for palaeoclimate study. This cave has a more stable microclimate environment and contains abundant 'candle' form stalagmites ideal for climate proxy studies. Cutting a long story short I fear the good people involved with cave management may not be ready to support scientific endeavor just yet… despite all the necessary government paperwork and national park permissions.

Window to the forest above

The river cave by boat

A reception committee waiting for us at the end of a day's caving led to a long 'discussion' about some of the samples we had taken. It all ended well, Duc went back and recovered the 20 or so samples we have collected (all broken fragments from the cave sediments) and the next step is to get some pilot U-Th ages measured by collaborators in MIT to see where we are on the palaeoclimate age scale… always a bit of a lottery (is it Holocene, last glacial, or.. etc etc), but whatever the age there is huge potential for reconstructing SE Asian monsoon dynamics from a region which remains almost unstudied.



Air measurements in Tien Son Cave

Angel, Trinh Anh Duc (right) and Trinh Hong Quan piecing together a stalagmite jigsaw from fallen fragments in Tien Son cave.

Back

EDM field trip to observe contaminated land remediation in Staines

Dave Alderton

Those of you who have been here more than a few years will remember that the view from room 240 back towards London included the Staines gasholder as a major visual feature. Now it is no more, as the old gasworks site in the Causeway is currently being prepared for redevelopment and the gasholder has been demolished. Unfortunately the production of gas from coal was a messy business and most old gasworks sites have a long legacy of pollution. The Staines site is no exception and so, before redevelopment can take place, the site needs to be remediated. Many of the graduates from the EDM (Environmental Diagnosis and Management) MSc course will go on to work in this industry and so a visit to see the work in progress was highly appropriate. (Indeed, on arrival, we were met by a former graduate who is currently working on the site remediation).

The site is contaminated by various types of hydrocarbon; some of this ground can be treated on site, but the more contaminated material must be disposed of off-site. We saw the classic method for remediating hydrocarbon-rich soil by using natural, bacterial degradation. The soil is piled on impermeable pads ('windrows') and turned regularly; so that after a few weeks the hydrocarbons have hopefully been broken down and the soil can be reused.

Soil being piled on impermeable pads ('windrows').

More difficult materials are sometimes encountered, including containers filled with coal tar and the classic 'Blue Billy' (ferricyanide). Needless to say there is a distinctive aroma on the site as the petroleum products are exposed to the air.

The plan is that the remediation will be complete in June. Apparently, planning permission (for something undisclosed) will be lodged with the local Council in the next few weeks. Perhaps the new view from room 240 will be of luxury riverside apartments!

Discussing how to dispose of a container filled with coal tar

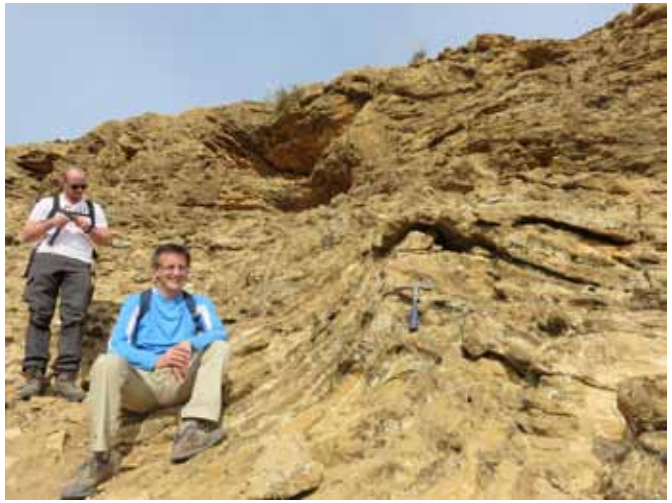
'Blue Billy' ferricyanide

“Drifters” Fieldtrip in Morocco

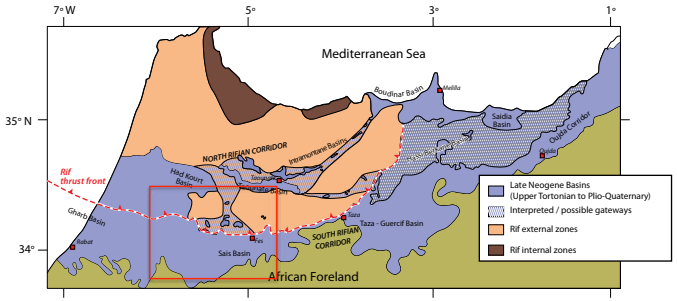
Javier Hernández-Molina

The “Drifters team” executed a number of detailed sedimentary logs of the Ben Allou sections (8–7.51 Ma) and Haricha (7.24– 6.38 Ma) outcrops. Alongside these logs, photos and a good number of samples were taken for micropaleontology, grain size, thin section, petrological, XRF and ichnofacies analysis to be completed over the coming years. We identified sheeted sandy deposits with moderately to well-sorted sands, rip-up mudclasts, reactivation surfaces, cross-stratification, bi-gradational sequences, and erosional scours which are interpreted as the products of bottom currents along the marine corridor in northern Morocco (Rifian Corridor). Some of these features can also be found in fluvial and shallow marine environments, but the occurrence of marine silty marls stratified within the sandy layers with deep infaunal benthic foraminifera, indicative of slope-type water-depths of 600 to 300 m, supports the interpretation of contourites. However, the interbedding of cross-bedded features with silty marls, planar beds and thin rippled layers indicates episodes of fluctuating velocity. Similar deposits and structures have been identified from cores in the Gulf of Cadiz, where the Mediterranean Outflow Water from Gibraltar deposited during the Pliocene–Quaternary a large, sand-rich (> 75%) sheeted drift over a mid-slope terrace. The broadly westward palaeocurrents resemble the dominant flow direction of the present day Mediterranean overflow water which also shows tidally influenced subordinate paleocurrent directions.

Beds with cross-stratification in the Ben Allou section interpreted as submarine dunes.



Francisco Sierro (Univ. Salamanca, Spain) and Wouter de Weger (Utrecht Univ. Netherlands) in the Ben Allou section with some of the impressive fluid migration structures.



Study area location (red square) in northern Morocco (Rifian Corridor).

The Ben Allou village.

Local people at Haricha laughing about our sedimentological interpretations.

The "Drifters team" at Sidi Harazem outcrop (muddy & sandy contourites) composed pf (from left to right): Mohamed Amine Manar (ONHYM); Walter Capella (Utrecht Univ. Netherlands); Dorrik Stow (Heriott-Watt, UK); Estefanía Llave (IGME, Spain); Wouter de Weger (Utrecht Univ. Netherlands); Francisco Sierro (Univ. Salamanca, Spain); F. Javier Hernandez-Molina (RHUL, UK); and Antoine Thieblemont (RHUL/TOTAL, PhD. Student).

Back

Sagaing Fault palaeoseismic trenching

Ian Watkinson

On 23rd March 1839 an earthquake centred on Myanmar's ancient capital Amarapura, just south of Mandalay, killed several hundred people, caused widespread devastation including still-visible damage to the solid brick Mingun Pagoda, and appears to have resulted from failure of several hundreds of kilometres of the central Sagaing Fault. The fault, which accommodates ~21 mm/yr of India's northward motion with respect to east Asia, subsequently generated numerous M>7.0 earthquakes along its northern and southern segments, but the central 260 km never failed again. In the intervening 177 years the fault has thus been loaded by 3.7 m of far-field offset, already sufficient to generate a M>7.9 earthquake. This seismic gap straddles the modern capital Nay Pyi Taw and tips out at Mandalay (2015 pop. 1.22 million).

Efforts to understand the seismic behaviour of this problematic section of the fault have included opening palaeoseismic trenches during the past year.

Morning lecture by Ray Weldon, as the fields are ploughed.

Excavation of trench number 4 (the 'wet trench').

Draining the 'wet trench', aka large snake trap.

The 'dry trench', evidence of modern gravitational sliding but no tectonic faults.

One site, where there is geomorphic evidence of recent surface rupture north of Sagaing city, was considered so prospective that an international trenching party was organised during early March 2016, with a view to training local geology students and developing new collaborations.

The project involved opening five palaeoseismic trenches, a ground-based LiDAR survey of several kilometres of the ruptured segments, drone-based aerial photography and re-occupation of GPS survey sites established by French workers in the late 1990's. There were also daily lectures by the project leader and San Andreas Fault palaeoseismic veteran Ray Weldon, as well as other international participants.

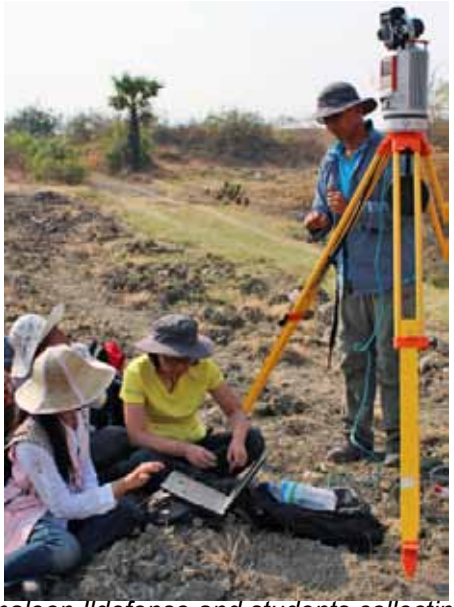
The trenches quickly yielded evidence of substantial modern transpression. Coseismic thrusts with > 1 m heave (and unknown lateral displacement) coincided with topographic ridges 2-3 m high. The thrusts deformed strata containing pottery fragments and religious artefacts. While it is tempting to assign this earthquake to 1839, ^{14}C dating of the pottery

3-D exposure of a historic surface rupturing reverse fault.

Drone for aerial photography, in front of the 'box trench' exposing a fault propagation fold.

Surface rupturing oblique thrust (red flags), with associated topographic relief.

Kyle Bradley and students mapping active tectonic geomorphology away from the trenches.



Sorvigenaleon Ildefonso and students collecting LiDAR points for a cm-resolution digital elevation model.

and associated charcoal is needed to confirm the date. Perhaps more significantly, older deformation involving uplifted and eroded fault propagation folds (still in soil horizons) may help to evaluate the recurrence interval of strong 1839-style events.

As if to underline the problems the Sagaing Fault gives Myanmar, the hotel in which we stayed had been destroyed by a Mw6.8 earthquake in 2012. At the time it had been 3 stories high. It was later rebuilt in the same location, but twice as high.

The project was a great experience and I am grateful to Ray and Li Li Weldon, Wang Yu, Kyle Bradley and Eric Lindsey at Earth Observatory Singapore, Soe Min, Saw Ngwe Khaing and Myo That at the Myanmar Earthquake Committee for organising such a fascinating palaeoseismic campaign. I am also grateful to several people in the department for helping me escape for a while, particularly Abigail Davies, Nicola Scarselli and Silvia Crosetto (who also joined the Sagaing trenching before beginning her own palaeoseismic trenching on the Shan Plateau). My participation was funded by a Santander travel grant.

Sagaing city straddling the Sagaing Fault zone (note fault-bounded pressure ridge in the background), just 10 km from Mandalay.

Department of Earth Sciences

People

Home **Conferences** **Events** **Fieldwork** **Research**

PhD successes

Congratulations to . . .

John Browning, who at his viva on 28th November 2015 successfully defended his PhD thesis on "Thermo-mechanical effects of magma chambers and caldera faults". John will continue his research career with a Postdoc Fellowship at UCL in the New Year.

Giulia Zazzeri, who successfully completed her PhD viva on 19th November 2015. Her thesis was entitled "Methane Emissions in UK: Deciphering Regional Sources with Mobile Measurements and Isotopic Characterisation". She will continue to work in the greenhouse gas lab for a short while and will be participating in a measurement campaign studying methane emissions in France in December with LSCE.

Sebastian Zimmermann, who successfully completed his PhD viva on 24th November 2015. His thesis was on the "Provenance of Mesozoic sandstones in the Banda Arc, Indonesia'. Sebastian is is an active member of the Circus Society at Royal Holloway, and is currently applying for jobs.

Eldert Advokaat, who successfully completed his PhD viva on 4th December 2015 with his thesis on "Neogene extension and exhumation in NW Sulawesi ".

Alfend Rudyawan, who on 22nd January successfully completed his PhD degree by passing his viva examination. His thesis was on "Neogene Stratigraphy, Structure and Magmatism of the Central North Arm of Sulawesi, Indonesia". He plans to return soon to Indonesia to take up a lectureship at the Geology Department of the Institut Teknologi Bandung (ITB).

He celebrated after the viva with a party in the Department at which everyone enjoyed the Indonesian delicacies that he had provided (right).

The Borrowdale Trophy, 2015

When Jon Wright died suddenly in his final year exactly 20 years ago, his parents set up a Prize to commemorate his life. His fellow students and the staff all contributed to the Prize Fund.

Jon was a brilliant student, who had mapped across the Borrowdale Volcanics in the Lake District to complete his undergraduate field mapping project. His work had been so good that he was posthumously awarded a first class honours degree in geochemistry by the University of London.

The tangible expression of the Jon Wright Memorial Prize is the Borrowdale Trophy, which is exhibited in the showcase in the Geology Foyer. The Trophy is a specimen of green tuff from the Borrowdale Volcanic Series, collected from a quarry within the area that Jon mapped. His parents wanted the Trophy to go to the students judged to have shown the most progress and achievement in geology through fieldwork in their second year. They also wanted the prize winners to use the funds in whatever way they chose, to enjoy their third year as undergraduates.

On Thursday, 20th October, Head of Department Prof Pete Burgess presented the Jon Wright Memorial Prize to Leona Hyslop and Nicholas Fairhurst for their outstanding achievements in fieldwork during their second year.

Nicholas Fairhust receives the Borrowdale Trophy from Prof Peter Burgess

Congratulaions to Leona Hyslop. Sadly she was unable to receive in person her share of the Prize and the Trophy.

Miguel Andres-Martinez, who on 17th February successfully completed the viva for his PhD thesis on “Rifted margin architecture and the interplay between mantle, crustal and surface processes from geodynamic numerical experiments. “

Congratulations to . . .

Margaret Collinson on her award of the Lyell Chair, following the retirement of Martin Menzies, the previous holder.

Martin Menzies, who is now Professor Emeritus and Chinese Academy Professor.

Howard Falcon-Lang on his efforts to build a database of our Department’s graduates through the establishment of the Linkedin Group called “Royal Holloway Geologists”, which has now grown in a year to a total membership of 641.

Jason P Morgan who received the Augustus Love medal 2015 of the European Geosciences Union (EGU) in recognition for his career-long research in the field of Geodynamics. Throughout his career Jason hasdone research on a remarkable breadth of geodynamicaltopics and has published an impressive number of landmark papers that continue to influence and inspirethe geodynamical community. His enthusiasm for science combined with his very thorough knowledge of Earth sciences and at times unconventional ideas haverepeatedly opened up new avenues of geodynamical research. This recognition is well and long deserved.

Lucia Pérez-Diaz, who was awarded a prize for the best talk at the TSG annual discussion meeting

Ben Jost who was awarded a prize for the best poster presentation at the TSG meeting.

This is the second year running that Royal Holloway postgraduate students have taken these prizes, with Eldert Advokaat having taken the best presentation award at last year’s meeting in Edinburgh.

Selena Smith (Margaret Collinson’s postdoc 2007–2009) and **Nathan Sheldon,** who’s baby boy, **Bodhi Kai Smith-Sheldon,** was born on Thursday, 21st January. Bodhi refers to the tree that Buddha sat under to gain enlightenment . Everyone is well and doing fine.

Agust Gudmundsson on his award of £28,000 from Weld on Sweden to support a PhD project to be carried out by Mohsen Bazargan. Mohsen has been doing rock-physics experiments in UCL (with Philip Meredith and others), as well as numerical modelling of hydraulic fracturing and heat transport and related topics.

Euan Nisbet, David Lowry and Rebecca Fisher, who were granted £471,256 from the Natural Environment Research Council, for their project entitled “The Global Methane Budget”. This will allow them to continue as world leaders in this field.

Ken McClay and his team who organized the Roberts Passive Margins conference. It was an outstanding success with many RHUL presentations – from Javier HM, Lloyd, Lucia, Nicola, Javier TM, Awad and great posters from the Compass group. There were many present and former RHUL staff and students. We received many compliments on the research being done at RHUL and particularly that by the research students.

Zoe Matthews (BSc Physical Geography and Geology) who has been awarded the Harrison Prize as the best joint honours finalist.

Sandra Clement (BSc Geology} who has been awarded a Lillian Heather Prize for excellent 1st year work.

Back

Congratulations to. . .

Our MSc team who came a very creditable second in the European regional final of the Imperial Barrel Award 2016, – finishing ahead of over 17 other universities’ teams from around Europe to claim second prize and a $2,500 scholarship for their Department. This was the best we could expect them to do, following last year’s triumph!

Alex Kurobasa reports: The Imperial Barrel Award (IBA) is an annual prospective basin evaluation competition for geoscience graduate students from universities worldwide, organised by the American Association of Petroleum Geologists (AAPG). In this global competition, university teams analyse a dataset (geology, geophysics, land, production infrastructure, and other relevant materials) to assess the petroleum potential of a given geographic basin. Each team is then required to deliver their results in a 25 minute presentation to a panel of industry experts who assess each presentation on the basis of technical quality, clarity and originality.

The team, said: “Work on the IBA went above and beyond normal university student hours. Work would begin every day after lectures and finish late

Our MSc team receiving their award:
L to R: James Forbes, Viet Tran, Alex Kurobasa, Sascha Roest-Ellis and Bernie Vining (Industry Advisor)

at night for 8 weeks right up until the competition. Teamwork and morale combined with the skills we learnt along the way was a huge part of our success, and we would strongly recommend any budding petroleum geoscientists to take part. The wide range of skills learnt along with the experience in geology, geophysics and geochemistry will be essential in our future careers. The team particularly wishes to thank their advisors Nicola Scarselli, Leigh Truelove and Bernie Vining for their support and encouragement.

Back

Welcome to . . .

Dr. Anirban Basu, who is taking up the post of Lecturer in Geochemistry. Anirban comes to us from the Lawrence Berkeley National Laboratory and he will contribute to teaching in geochemistry and environmental science and developing research in remediation of contaminants in groundwater systems and in new isotopic tools to identify palaeo-redox proxies.

Antoine Thieblemont, who reported: "I have been a PhD student in the TOTAL Research Department since January 2016. I am from France and I graduated in 2016 from the Engineering School of LaSalle Beauvais with a Degree in Petroleum Geology. For my Master's thesis, I carried out a velocity model, building in a compressional salt domain in Angola. I had to refine the salt interpretation and the structural analysis of the area to identify new exploration targets and reduce prospect risk. Now, at Royal Holloway, I am working on a project about the depositional features of contourites along the African and South-East American Margins: their onset, evolution and implications for hydrocarbon exploration. This will be supervised by Dr Javier

Antoine and the "drifters" team in Morocco, enjoying the view

Hernández-Molina and sponsored by TOTAL E.P. The main objectives for my thesis will be: 1) identifying the contourite depositional features and how bottom currents and controlling factors (e.g. sea-floor morphology) lead to particular contourite facies, sequences and sedimentary structures; 2) establishing a depositional model for contourite depositional systems involving their initiation, processes, facies (seismic, sediment) and architectural elements and 3) conclude about the potential of contourite systems as potential reservoirs/seals for oil and gas. To do it I will use the database of TOTAL (2D and 3D seismic with well calibrations) and also data from scientific expedition (ODP). The results are expected to be useful in the petroleum industriy for predicting the sandy deposits (reservoir potential) and the muddy deposits (seal potential) within a contourite. I have already had my first week in the field in Morocco (see February Newsletter), a really nice experience to start my thesis, with contourites along the Rifian Corridor, a field analogous to the deposits from the Gulf of Cadiz.

Farewell to. . .

Angel Fernandez-Cortes, who will be leaving us this month to take up a prestigious tenure-track post in the University of Almeria. Angel came to us with a Marie Curie Intra-European Fellowship to work on a project with the genius acronym 'SMACKS' –Sourcing Methane And Carbon dioxide in Karst Systems. This links work he pioneered at the National Museum of Natural Sciences in Madrid measuring CO_2 and CH_4 in cave and soil air and our work in Gibraltar to identify pathways and fluxes between karst and the atmosphere. Methane is especially interesting as both our studies showed that the karstic unsaturated zone is a fast methane sink – the issue is the precise mechanism that drives this, and here we had divergent views that we were making progress to resolve experimentally. I think Angel must hold the record for accrued air miles jetting around Europe to collect samples of air from caves and soil at regular intervals. Fortunately for Angel but unfortunately for us, the academic post at Almeria came up (his home city where his wife and family live!) so he leaves the MC Fellowship early. We look forward to continuing working together in Gibraltar and other European caves and, maybe, as pictured, collecting soil gas two weeks ago in Vietnam, in a new collaborative venture involving the Vietnam Academy of Science and Technology, Madrid, MIT, Almeria and ourselves. We wish him all good luck in his new post and hope to see him back in the Department soon!

Dave Mattey

Sad News: Alec Smith

photo: Kev

Derek Blundell

It is with great sadness that I have to report the death of **Alec Smith** on 12th November 2015 following a heart attack. He was born in Wakefield in January 1932 but his family moved to Wales in 1934 where he grew up. Married first to Joan, he had a son and a daughter. Later, in 1990, he married Anita, who survives him, and changed his name to Kenyon-Smith.

He won the John Hughes Open Scholarship to UCW Aberystwyth where he was an undergraduate from 1950 until 1953 when he graduated with 1st Class Honours in Geology. He stayed on at Aberystwyth for postgraduate research based on a study of the Aberystwyth Grit Series, which involved examining the coastal cliffs from New Quay to Borth. There he learned how to interpret turbidites and understand their formation. After three years he was awarded a Ph.D. in 1956. Having won an '1851 research postdoctoral scholarship', he continued for one more year at the 'college-by-the-sea' and finally left in 1957, having set up a project on turbidite sedimentation in the Polish Carpathian mountains, with Krakow University.

He then embarked upon a thirty-five year career in the University of London. In 1957 he was appointed lecturer in Geology at UCL and ten years later he was promoted to a Readership. During that period he focused on an investigation of the submarine geology of the English Channel, in collaboration with Bristol University.

In a succession of research cruises he mapped the seabed sediments across most of this huge area by collecting core and dredge samples. He discovered that the channel had been formed as a result of at least two catastrophic floods. He published the work in 1985: "A catastrophic origin for the palaeovalley system of the east-

ern English Channel". *Marine Geology* **64**, 65–75. "The partially infilled valley system found in the floor of the eastern English Channel is not typical of a normal river system. Instead, the valley formed in a catastrophic flooding event. It is unusually straight and wide, with prominent, streamlined margins and kilometre-scale grooving of the valley floor; the axis of the valley contains elongated islands characteristic of megaflood erosion. This megaflood must have come about by the breaching of a permafrost-sealed Chalk barrier at the site of the present Dover Strait in late Quaternary times. This permitted the scouring of the exposed Channel floor and modified the palaeovalley system. He estimated that at least 100,000 km^3 of flood waters were involved in this short-lived event were released from a lake developed between an ice front in the central North Sea and the northern limb of the Weald-Artois anticlinorium." They cascaded through the Dover Strait, leaving plunge pools that remain, infilled, to the present day. The first flood was initiated some 425,000 years ago during a major extension of the continental ice sheet into lowland central Europe and Britain. A second massive discharge occurred about 155,000 years ago.

Alec was also very active in studying sedimentary geology of various regions of Japan from 1972 to 1992 and was Visiting Professor, Tokai University, Japan from 1975 to 1980. He was a participating sedimentologist with the Deep Sea Drilling Programme, Leg 87, Nankai Trough off S.E. Japan from 1980 to 1985. He was also fascinated with the origin and alteration of ikaite (CaCO3.6H2O) that is only stable in water just above freezing, which he worked on with Doug Shearman. It is best known from its occurrence in Ikka fjord in southern Greenland, though he was never able to see it *in situ*.

In 1977 Alec was appointed Professor and Head of the Department of Geology at Bedford College and set about creating a modern and vibrant department. Soon after his appointment he became caught up in University politics: in March 1980 we all had to respond to the Swinnerton-Dyer "Committee on Academic Organization" that had been set up to investigate the workings of the University of London with a view to rationalization. Each with a small geology department potentially at risk, Alec and I (as head of Geology at Chelsea College) agreed to keep all options open but decided that a policy of active response to the Swinnerton-Dyer Committee would be wiser than maintaining a low profile, despite the inherent risks. We privately agreed to see what we could do to bring the two departments together, the first step being to consult our colleagues about the idea. Alec invited the Chelsea teaching staff across to Bedford for a joint meeting, held in March 1981. There, we agreed that the idea was worth pursuing; but how to do it? Alec hit on the brilliant idea of creating an impact by sending a telegram to the University Secretary at Senate House saying that the two Departments would like to amalgamate and asking how the University could help us to achieve this end, and this he did on behalf of us all. His initiative succeeded beyond all expectations and, as they say, the rest is history. Meanwhile it took until May 1982 for Bedford College to agree to move to Egham and join Royal Holloway and only in February 1984 was agreement reached for the Geology Departments of Chelsea and King's Colleges to join Bedford at Royal Holloway.

Thus, in 1985 Alec was appointed Foundation Professor of Geology and Head of the new department at Royal Holloway, but such was the haste of those later decisions that the Department had to be housed in portacabins for the best part of a year until Queen's Building became habitable. Alec's first priority was to agree on the design of the new building that we had been promised as part of the deal. Alec had a tremendous task to get things together, starting from scratch to recruit new staff and students, create new undergraduate degree programmes with a balanced repertoire, organize the structure of the Department and advertise our presence. In July 1985 he appointed Julie Brown who moved from Bedford College as Departmental Secretary and became the anchor that held us all together. We were boosted by two new academic staff appointments in October 1985 – an "Academic Initiative" post won by Alec for Dr Martin Menzies as Lecturer in Geochemistry and a Lectureship in Sedimentology for Dr Lynne Frostick. Within the following 12 months we were joined by Dr Ken McClay, Dr Dave Waltham and Dr Dan Bosence, to bring our academic staff complement to 21. He also secured the funding for major new equipment, including a mass spectrometer to support the research of Matthew Thirlwall. Through his enlightened leadership he was pivotal in creating a style that has endured very successfully for the past 30 years. He retired in 1992, then assisted the Principal at Royal Holloway until 1995.

In addition to his responsibilities at Royal Holloway he organized several national and international conferences: he was elected Treasurer 1971–77 and Vice-President of the Geological Society, London 1990; President of the Geologists' Association 1980–1982; Chairman, Greenwich Forum; Chairman, Watt Committee on Energy; Chairman, Geological Grants Committee, Natural Environment Research Council; President, Section C (Geology) British Association for the Advancement of Science, (1991–1992); Geological Advisor to Kuwait University, (1991–1992); and creator of the magazine *Geology Today* in 1985.

He was the recipient of many awards: The Coke Medal of the Geological Society of London, 1990; Fellow of the Society for Underwater Technology;

and Fellow of Royal Holloway University of London, 1998. His record of over 100 published scientific papers is prodigious. He is also the author, or co-author, of four books: Geology, 1974; Exclusive Economic Zones - British Dependencies; Geology of England and Wales, Geological Society, 1993 and The Evolution of Clastic Sedimentology, 2005.

The Earth Sciences Department at Royal Holloway is his legacy.

His obituary was published in the May 2016 issue of *Geoscientist*

Two notable alumni: Andrew Hill (1946-2015) and Mike Golden (1947-2015)

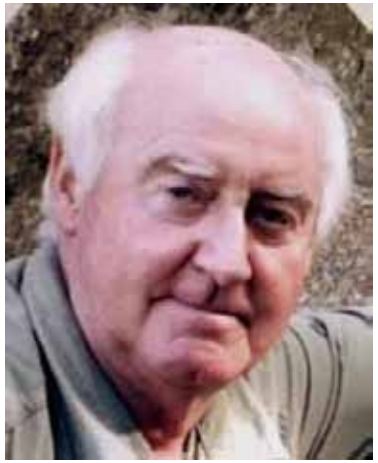
Andrew C. Scott

I was shocked to learn that two of our distinguished alumni Andrew Hill and Mike Golden had died within two weeks of each other. Both were post-graduate students at Bedford College (one of the precursor departments to our own) and both had been demonstrators to me as an undergraduate.

Andrew Hill was made a notable alumnus of Royal Holloway in 2012 and was very proud of the honour. Andrew was born in Nottinghamshire in 1946 and received his BSc from the University of Reading in 1967. He then went to work with Bill Bishop who was an expert on the fossil vertebrates from East Africa and the environment for the evolution of early hominids. Andrew was encouraged to look at the taphonomy of the vertebrates and undertook observations on modern bone assemblages as well as experimental studies, all designed to help in the interpretation of the fossil deposits. It was a very exciting time in East African research at that time and I vividly remember Richard Leaky visiting the Department and talking to us about his discovery of early Hominid fossils from Africa.

Andrew Hill

Mike Golden



Andrew moved to Kenya in 1975 and this area remained the focus of his research for all his life. He became the director of the International Louis Leaky Memorial Institute for African Prehistory from 1980-1981 and then as Research Fellow and Research officer of the Kenya National Museum. He was then a Post-doctoral Fellow at Harvard University. In 1985 he was appointed to the faculty of the Department of Anthropology at Yale University, obtaining the rank of full Professor in 1992 and became Head of the Anthropology Division of the Peabody Museum in 2005. This must have been a particular pleasure for him as his supervisor Bill Bishop had been appointed director of the Peabody at Yale in 1977 but died before he could take up the position.

Andrew carried out fieldwork not only in Eastern Africa (Uganda, Tanzania and Kenya) but also in Pakistan and the United Arab Emirates. For many years he directed the Baringo Palaeontological Research Project, a multidisciplinary Research programme operating in the Tugen Hills in the Rift Valley of Kenya. More recently he was involved in an exciting drilling project that drilled sites throughout Kenya and Ethiopia to clarify the environmental context of human evolution.

Mike Golden was born in 1947 in Greenock, Scotland. and. He took his BSc in Geology at Glasgow University and like so many others from Glasgow went to London to undertake his PhD at Bedford College. He acted both as a demonstrator at the same time as doing his PhD (which he obtained in 1979). Mike joined a group of geologists undertaking geological mapping in East Africa under the then head of Department, Basil King. By the time that Mike came to Bedford, King's research was well known as he was awarded the Murchison Medal from the Geological Society in 1971 (when I was a second year undergraduate). The east African project was to geologically map the whole of the East African Rift Valley and provide the geological framework for unraveling it's evolution. This programme was the reason that Basil appointed Bill Bishop to the staff and why igneous geochemistry was developed in the department –a legacy that continues at Royal Holloway today.

After teaching at a University in Nigeria, Mike went in to the oil industry, working in Exploration for both Esso and Amerada Hess. He was an expert on the exploration of West Africa and the west of the Shetlands. In 1992 he set up his own consulting company, Golden Associates based in Cranleigh, Surrey. He was a talented linguist, speaking Russian, French, Swahili and Ukrainian. He was a farmer and combined this with his geological work. Over the past 2 years he suffered from Ill health and he died on 31 August 2015. See *Geoscientist* Feb 2016, p.28

51. The Arctic in a pool: measuring directional reflectance of sea ice in Winnipeg. – *Maxim Lemare*

52. Ages and character of basement rocks in Southeast Vietnam. – *Juliane Hennig*

53. Correlation of the onshore and offshore stratigraphy of Vietnam using zircon U-Pb dating and provenance analysis – *Nils Kollert*

54. Tectonic Geomorphology of the Actively Inverting Subduction-related Myanmar Basin –– *Isaac Kenyon*

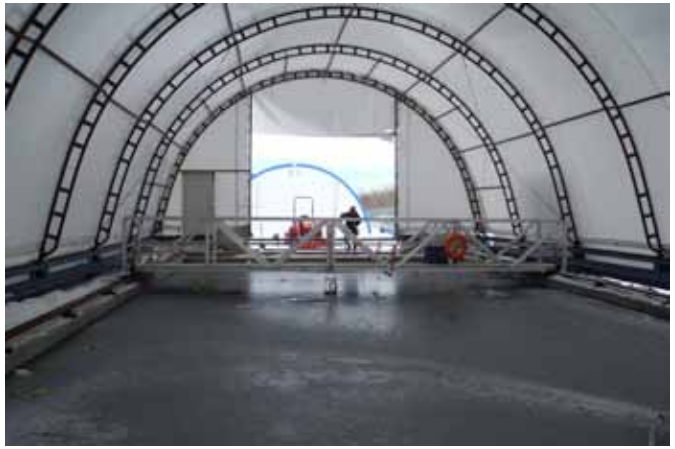
54. Investigation of the chemical effects of hydrothermal alteration in a Silurian lava pile – *Natalya Zavina-James and William M Cranston*

The Arctic in a pool: measuring directional reflectance of sea ice in Winnipeg.

Maxim Lemare

As I stepped on to the sea ice, the surface undulated, rattling the instruments ten metres away. The surface was deemed safe to walk on by the local experts, but only by a couple of centimetres. Treading carefully, I moved over to the instrument to launch a new run. I then returned to the warmth of the control cabin a few metres from the ice. Indeed, I was not in the Arctic Ocean, but at the Sea-ice Environmental Research Facility (SERF) located at the heart of the campus of University of Manitoba, in Winnipeg, Canada. The facility's main component is an outdoor artificial seawater pool (20 metres long, 10 metres wide and 2 metres deep), equipped with a movable roof to control snow cover and ice growth. The pool is filled each winter with a mix of fresh water and a weighted combination of mineral salts to replicate the conditions found in the Arctic Ocean.

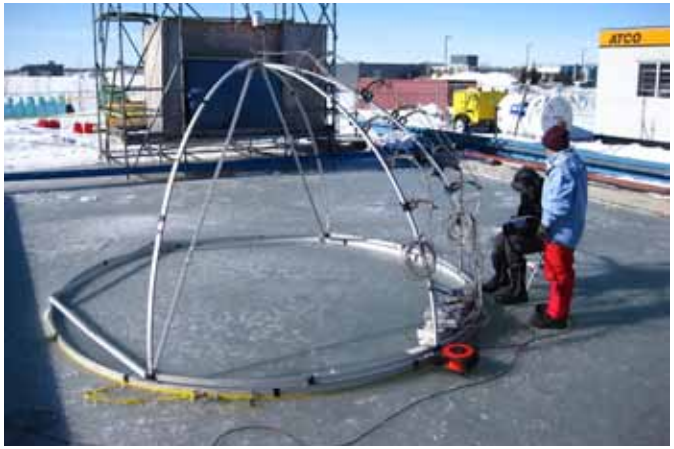
I first heard of SERF in February 2015, when I participated in the ASP "snow covered sea ice" field school in Nuuk, Greenland, thanks to funding from the Research Committee in the Department. Although we have a small indoor sea ice tank on campus (at Huntersdale), where we perform directional reflectance measurements under artificial illumination, the idea of comparing our data with a large outdoor facility boasting natural illumination conditions was thrilling. The researchers from University of Manitoba that I met at the field school put me in contact with Professor Wang, in charge of SERF, who gave me the opportunity to deploy our field instrument on the pool this winter.



The artificial sea ice pool with the roof on, in preparation for the February 2016 campaign.

The idea of the trip to SERF was to deploy the Gonio-RAdiometric Spectrometer System (GRASS) on bare sea ice to measure directional reflectance. Indeed, measurements of the bidirectional reflectance distribution function (BRDF) of sea ice are scarce, yet of paramount importance for the correction and calibration of Earth observation satellite sensors. GRASS is an instrument that records quasi-simultaneous, multi-angle, hyperspectral measurements of the Earth's surface reflectance. The measurements at SERF will provide data for the validation and parameterization of a radiative-transfer model used in collaboration with the National Physical Laboratory (NPL), my co-supervisors, for the calibration of Earth Observation satellite sensors.

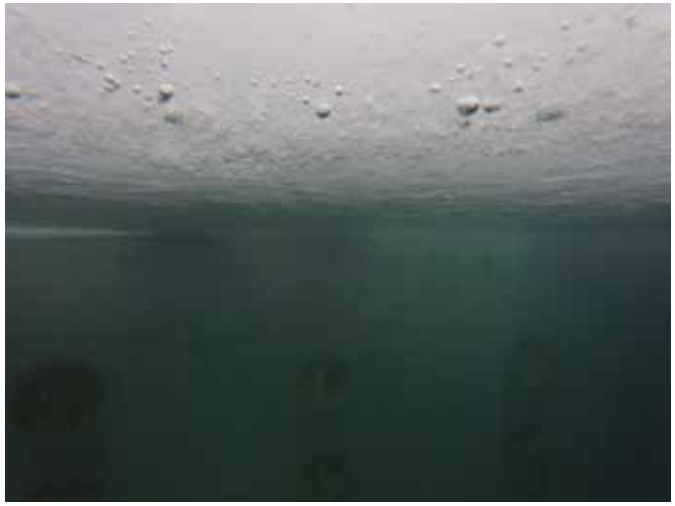
With help from the Kirsty Brown Memorial fund, I was able to plan a two-week campaign in Winnipeg, assisted by Claire Greenwell, a physicist from NPL. On the ice, we were working alongside a team of Italian researchers from University of Rome 3, who were looking at the dielectric properties of the ice for planetary exploration (they are essentially looking for water on Mars and other planets). We have to admit that we were jealous of them at times, as



Collecting our first BRDF of bare sea ice with GRASS on a sunny but rather cool day (-22ºC).

they were able to perform measurements every day. Indeed, having to rely on the sun as an illumination source, we were constrained by the weather conditions and could only measure with clear skies. The first week was overcast and a couple of snowstorms rolled in, forcing us to perform ancillary measurements (such as looking under the ice with a Go-pro camera, or measuring chlorophyll content).

When the weather was really bad, we went skating on the river nearby, and experienced an exciting game of NHL hockey. However, after a worrying first week, our luck turned and the overcast sky cleared up, finally allowing us to perform measurements. The air temperature was surprisingly warm, hovering around -5ºC most days, which was surprising. Last year at the same period, a master student was working in slightly more difficult conditions with temperatures averaging -38ºC and a wind chill factor of -50ºC. This freak "heat wave" made working on the ice rather pleasant. A short snow storm mid-week followed by a beautiful blue sky allowed us to obtain the BRDF of snow covered sea ice, which changes the spectral response immensely.



Below 13 cm of sea ice.

The two weeks spent in Winnipeg were a fantastic experience. We came away with novel data albeit in the difficult weather conditions. We met with lots of researchers from different backgrounds (the sea ice community is large at U. of M.: over 100 people work on sea ice alone) and set up new collaborations! And of course we got to savour a LOT of maple syrup!

Back

More from our new post-docs and research students to introduce themselves and tell us about their new researchprojects:

Ages and character of basement rocks in Southeast Vietnam.

Juliane Hennig

I have recently started a postdoc post with the Southeast Asia Research Group to research on sedimentary provenance and geochronology, and act as the lab technician on the SEM (secondary electron microscope) for EDS analysis and cathodoluminescence (CL) imaging. Originally, I am from Germany and did my diploma (equivalent to MSc) in geology/palaeontology at the TU Bergakademie Freiberg (Germany).

I have already worked with SEARG during my PhD studies on the "Age, origin and exhumation history of magmatic and metamorphic rocks of NW Sulawesi, Indonesia" which I finished in December 2014. The project combined field observations, petrology, thermobarometry and geochronology to determine the timing of magmatism and metamorphism in the area as well as the exhumation histories of these rocks which form high mountains in northwest and central Sulawesi. Some of the metamorphic rocks turned out to be much younger than expected (the youngest rocks were formed at ca. 3 Ma and were previously thought to be Mesozoic or older) and were intruded by coeval magmatic rocks and subsequently exhumed to 1.5–2 km elevation. Metamorphic and magmatic rocks yielded very fast cooling and exhumation rates which are related to a metamorphic core complex exhumation in an extensional setting. During this project I had the great opportunity to carry out three field seasons in Sulawesi and perform U-Pb, Ar-Ar and (U-Th)-He ra-

On top of Mount Merapi in Central Java (Indonesia).

diometric age dating at The Australian National University and the University of Melbourne in Australia.

This study will be followed up by investigating further the beginning of Neogene magmatism using Ar-Ar radiometric age dating of basaltic rocks and sediments to get further insights into the tectonic evolution of Sulawesi and eastern Indonesia.

Furthermore, I started a small project earlier this year to analyse and date some metagranitoids and granitoids from the northwestern part of the Schwaner Mountains in southwest Borneo. U-Pb

Large beach outcrop near Phan Thiet (Vietnam) exposing Cretaceous volcanic rocks which are intruded by a Paleogene basaltic dyke.

zircon dating of metamorphic and igneous rocks of the Schwaner Mountains carried out in a previous project of the SEARG revealed the absence of an assumed pre-Mesozoic basement and yielded mainly Cretaceous ages, suggesting the rocks were all formed and overprinted in a volcanic arc related to the accretion of the SW Borneo block to Sundaland in the Cretaceous (Davies, 2013; Davies et al., 2014). However, a Triassic metatonalite was reported in the literature by Setiawan et al. (2013) and some of the rocks that were now analyzed from this area contain Triassic and Jurassic zircons, indicating that the northwestern part of the Schwaner Mountains already belonged to Sundaland in the Triassic and therefore may represent the southernmost extent of the Malay Tin Belt.

Recently we have started new projects in Vietnam to study the ages and provenance of Mesozoic and Cenozoic magmatic and sedimentary rocks on land as well as their offshore equivalents in the South China Sea. Therefore, a small group of us, including Amy Gough, Tim Breitfeld, Nils Kollert and myself, have carried out a ten-day field trip to the Da Lat Zone in southeast Vietnam for reconnaissance and sampling. The rocks will be analysed and correlated to offshore material from wells provided by Repsol (formerly Talisman Vietnam) to get a better understanding of sources, sediment pathways, and the tectonic evolution of the South China Sea.

Correlation of the onshore and offshore stratigraphy of Vietnam using zircon U-Pb dating and provenance analysis

Nils Kollert

I am one of the new members of the South East Asia Research Group and started my PhD project in September 2015. I conducted my Masters in Energy and Mineral Resources and my bachelor degree focused on Georesources Management at the RWTH Aachen in Germany. My Masters thesis deals with alteration processes of Banded Iron Formation into iron ore in Western Australia. For that, I did extensive field work including pit and outcrop mapping on an active mine site in the Pilbara in Western Australia. For data analysis I used reflected and transmitted light microscopy and geochemical analysis. The outcome was a structural and mineralogical model of the active pit and ideas for further exploration strategies. The fieldwork for my bachelor thesis was held in Southern Italy to investigate syntectonically deposited sediments.

Before starting with my PhD, I worked on short term contracts for Wintershall and Deutz Erdgas/ Exxon Mobil looking at seismic interpretation as well as a data review on gas fields in Germany.

Pardoo mine, Pilbara, Western Australia

The basis of my PhD project is the correlation of the on- and offshore stratigraphy of Vietnam focusing on the Da Lat zone located in South-Central Vietnam and the two offshore basins Cuu Long and Nam Con Son in the South China Sea.

Vietnam is a new area to be tackled by the South East Asia Research Group. A first field trip was undertaken in October 2015 to get an overview about the geology and highlight possible additional research topics. Additionally, a first batch of samples has been collected for U-Pb zircon dating.

A subsidiary aim of my project is to get a better understanding of the sedimentary pathways in the region and ultimately provide further insights into the development of hydrocarbon-bearing basins in the South China Sea.

Back

Three Lyell Scholarships were awarded in 2015 to support undergraduates in their penultimate year to undertake projects relating to research activities in the Department. The following articles explain how the Scholars made use of their awards.

Tectonic Geomorphology of the Actively Inverting Subduction-related Myanmar Basin

Isaac Kenyon

This small research study used remote sensing to interpret geomorphic features and drainage to understand the evolution of folds, thrusts and strike-slip in the inverting transpressional Central Myanmar Basin (CMB). Such surface studies can be used to more fully understand subsurface data when exploring for hydrocarbons. Little is known about the basin's 3-D geometry, structural and depositional evolution. The project's aims were:

1. Understanding the types and distribution of sedimentary facies, and their relative ages.
2. To determine the relationship between deposition and ongoing inversion.
3. To understand the role of erosion in sediment supply and basin inversion.

These objectives should yield a better understanding of the tectono-stratigraphic evolution of the rapidly developing CMB. The aims were tackled using ArcGIS – carefully picking out sedimentary features in the landscape from a variety of satellite-based imagery, including Landsat and SRTM. Inversion-related structures were also identified, to show the relationship between inversion and evolution of the sediment pathways through the basin.

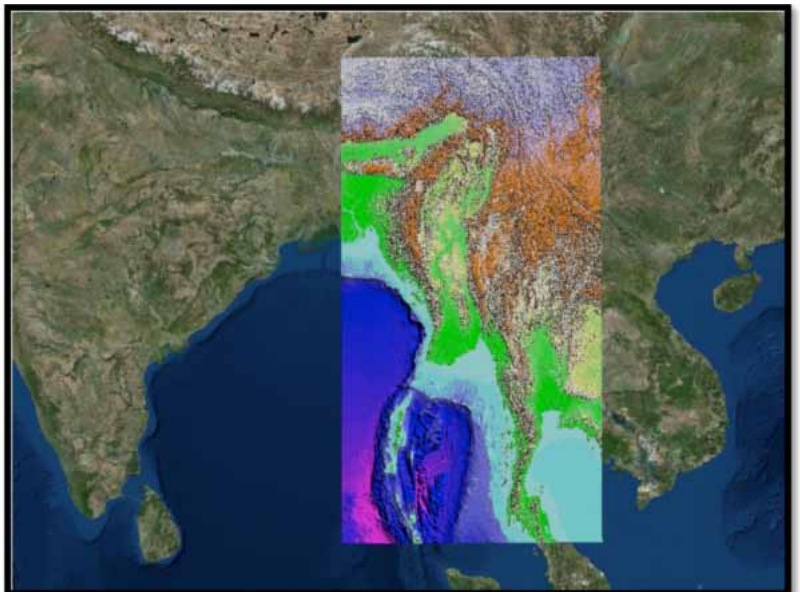


Figure 1

Figure 2

I began my project with some research into the regional setting of the CMB, plus generic studies of inversion tectonics and tectonic geomorphology to get an overview of the topic. I was then provided with a 90 m digital elevation map of Myanmar and a very high resolution World Imagery Map to interpret using ArcGIS (Figure 1). The aim was to map all modern and palaeo-rivers across the central basin and record where they have been deflected by or incised into the Neogene growing folds (Figure 2). I recorded all these geometries using shape files.

The project has helped me to learn how to use ArcGIS before my MSc in Petroleum Geoscience, to explore a frontier petroleum basin. I developed a greater understanding of fluvial systems, inverted basins and tectonic geomorphology as well as gaining an insight into whether I would be interested in researching this basin further in my MSc course which I can now say is the case. I will look forward to potentially undertaking a thesis project that is field based in the Pyay sub-basin in the CMB, providing me with field geology experience in a frontier basin.

Investigation of the chemical effects of hydrothermal alteration in a Silurian lava pile

Natalya Zavina-James and William M Cranston

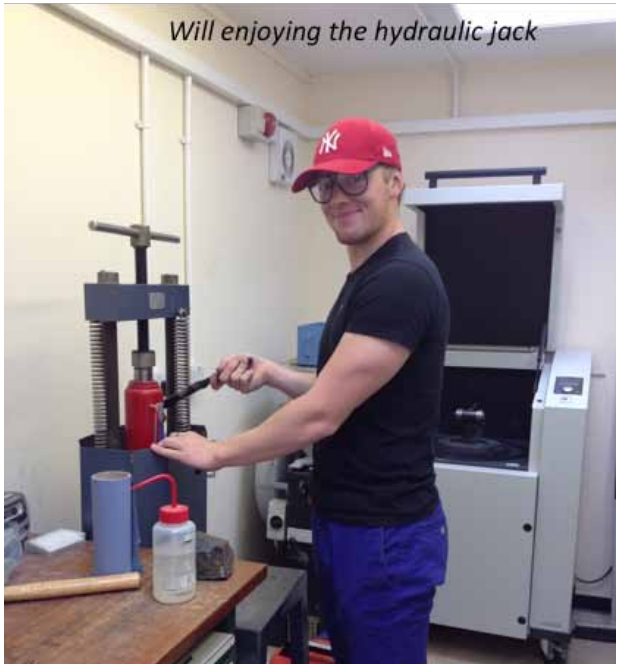
The primary aim of this project was to identify the extent to which alteration had affected the bulk chemistry of a Silurian lava pile near Oban, Western Scotland. The lavas here exhibit a wide range of secondary minerals – significantly carbonate – which when observed in thin section is commonly seen to have replaced olivine. Understanding changes to the bulk chemistry of these rocks will enable us to gain a better understanding of these alteration processes and a better ability to interpret the primary chemistry. The lavas sampled ranged from olivine-bearing basalts to plagioclase-rich andesites and the specimens were studied through XRF analysis, both for major and trace element concentrations.

The idea was to compare specimens from within single flows, because it is there that we observe the effects of alteration, and so multiple specimens from each flow were obtained.

We began by crushing the samples to a powder using the Tema. Portions of the rock powders were then weighed out, mixed with a binding agent, and pressed into pellets for trace element analysis. The remaining powder was used to make fusion discs for major element analysis.

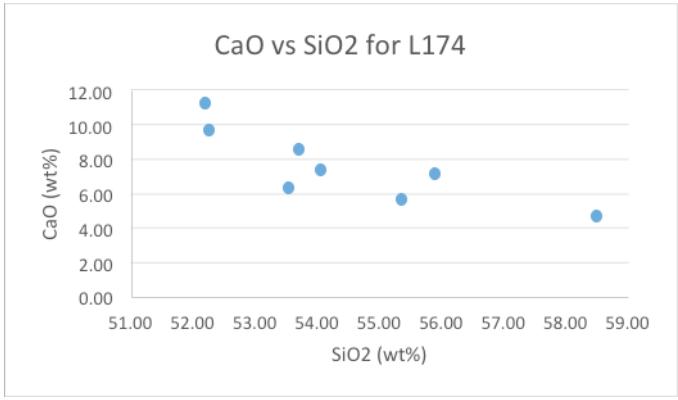
The data obtained from this analysis exhibited some interesting silica fluctuations, with some flows showing up to a 6–7% variation in silica between samples. While some thin sections of the samples contained quartz xenocrysts, the flows showing high silica variability did not contain these xenocrysts. Xenocrysts of quartz are essentially primary igneous features, increasing the amount of silica in the flow. Any significant fluctuations in silica across a single flow can thus be an indicator of alteration. There is also a notable negative correlation between silica and CaO as the addition of calcite can reduce silica. This type of correlation is expected from igneous processes, but is also observed within individual flows, relating instead to dilution by calcium carbonate. The concentrations of elements such as niobium, yttrium and zirconium are expected to remain constant within flows, with the exception of dilution effects.

The chemistry of flow L176 is both interesting and surprising. While Ti/Zr ratios are relatively constant, other trace element ratios such as Nb/Zr, Zr/Y, and Ba/Rb exhibit considerable variation across the flow. Yttrium, Nickel, Copper, and Zinc also show considerable ranges, implying either post-crystallization alteration or dilution. The case for dilution can be supported by the high LOI (Loss on ignition) values; higher amounts of calcium carbonate present in the rock will increase LOI. The variability



in Calcium across the flow also suggests this. This variability, however, is not high enough to solely account for the dilution. Major elements such as magnesium and potassium are highly variable, with magnesium appearing to decrease where calcium increases. This is linked to what we see in thin sections of this sample, where magnesium-rich olivine crystals have been replaced by calcite and a calcite vein can be observed running through the section. In contrast to the pronounced alteration of L176, both trace and major element concentrations for L178 are very constant. While there is a 2% variation in LOI, indicating some alteration, the bulk chemistry of this rock has not experienced any pronounced alteration. Even in flows that show quite a bit of alteration in thin section, the chemical effects of the alteration are variable.

When analysing the data from flow L181, there were some noticeably different elemental concentrations and ratios across the three samples from this flow. Nb:Zr ratios thought to not change due to alteration allowed us to confirm at first glance that flow chemistry is homogenous and all were from an individual flow as first thought. Upon closer inspection, however, heterogeneity within the flow does exist, with L181C being of significantly higher Si content than A or B. When looking in hand specimen there we noted two tiny calcite- rich areas. The XRF data, however, does not back this up: we observed higher Si in L181C ,suggesting that these veinlets are not calcite and possibly secondary or hydrothermal Silica. The lack of high CaO and LOI back this up, too. Sampling flows multiple times and from multiple locations enables alteration processes to be distinguished from primary igneous processes, giving us a better idea of how secondary alteration processes take place. Understanding this will increase confidence in the interpretation of primary signatures. In several flows, for example, there are CaO-silica correlations that mimic igneous processes (see graph below). It is important to pay attention to these “false positives” in order to understand the igneous processes and differentiate these from post-crystallization alteration



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