Photo: Krakatoa, Indonesia on the Recent GPS Tour by Robbie Churchill (4th year Geophysics MSci)
Welcome to the all new ‘Prospector’ magazine! The magazine showcases all the amazing and varied things our students get up to. Whether that is an internship, UROP or adventure, the Prospector is here to show you the diverse range of opportunities students can all been involved with, and to inspire more of the same. We also have a section on recent alumni to see how they are using their ESE degree.

So why did we need a Prospector? The student body in our tight knit department has a wealth of knowledge and experience. However, year after year confused undergrads roam endlessly around job sites not knowing where or what to apply for and even what their peers have been up to. We thought there must be a better way; a way of bringing together some of the wise words of the alumni; a way of sharing some experiences from current students and a way of displaying some of the current and ground breaking research opportunities undergraduates can take part in during their summers.

So have a read, get inspired to climb a mountain range, sail an ocean, work as a high-flyer in the city or intern in the space sector! Whether you are a prospective student, a hardened 4th year or even a nostalgic alumni it’s awesome what people around you get up to and we are looking forward to finding out what else our students have been doing.

We aim to release an issue twice a year and need as many stories, photos and work experiences as possible. So why not write in a little page and tell us all what you have been up to out of the lecture theatre?

Enjoy!

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The Geophysics society (GPS) has an annual tour. The aim of this tour is to further the knowledge and skills learnt in the lecture theatre and is open to all students. The lucky participants are drawn out of a hat! Each tour involves outreach work as well as an opportunity to see some incredible geology and geophysics in action. Previously, the society has been to Mt Etna and Pompeii, and this year we had our first non-European trip to Indonesia! Here’s a little more about our trip.

Singapore
Arriving in Singapore to our hostel in Little India we went straight into tourist mode (consisting mainly of complaining about the humidity). In the city we headed to the harbour front where the Marina Bay Hotel is located, a huge 3 tier hotel with a ‘boat’ supported on the top, and headed to the Gardens by the Bay at the base of the hotel. We wandered around the gardens, a conservation effort by the government to integrate wildlife into the city. Whilst waiting for a light show using artificial trees in the gardens, there was another display to behold, the bats in the garden came out from their hiding places and were swooping down scarily close to where we were sitting. We sought refuge from the humidity in the National...
Museum’s air conditioning; it highlighted the diverse range of cultures and lifestyles in Singapore and even had a section on the geological history of the region! Returning to the Gardens by the Bay we entered the Cloud Forest, a large conservatory that highlighted how the meteorology affects animals, flora and fauna as altitude increases. We made sure to pay attention so that we could try and recognise things when we were climbing Mt Sibayak. The 3rd was Ed’s birthday, so in the evening we celebrated in Clarke Quay, a pretty area with restaurants on the water, and had Vietnamese food in a place called Little Saigon. It had great food and an even better live band.

Beristagi
With an early flight to Indonesia, we arrived in Beristagi after a couple of hours drive and a pit stop for lunch where we had our first encountered with traditional Indonesian cuisine. We ordered some lovely nasi goreng (fried rice) and mee goreng (fried noodles), little did we know this was all we’d be eating for the next two weeks... Once we got to Beristagi we decided to walk around the town, visit the local market and go in search of a local hot springs. Unfortunately, Google lied and ‘Hot Spring Nicole’ did not exist and so we headed back to the hotel for a dip in the pool and some more nasi goreng.

After a lovely night sleep in our fancy hotel room we had another early start in preparation for an action-packed day. After a 7am breakfast (more nasi goreng) we were taken by our tour guides to the base of Mt Sibayak. The walk to the top of the 2,200m mountain took about 3 hours, with quite a steep initial ascent through a forest. An hour from the top the forest thinned and the views were amazing, it was our first
glimpse of Mt Sinabung, currently Indonesia’s most active volcano. As we ascended we were met with active fumaroles and sulphur crusted rock fragments and at the summit we had views of Sibayak’s crater, Mt Sinabung and the forest-filled valley, a breath-taking scene. We got back into taxis and headed on our way to Sipisopiso waterfall, giving us time to recover from our active morning. Sipisopiso waterfall is located on the tip of Lake Toba where we were greeted with another incredible view, a beautiful setting for lunch! The walk to the bottom of the waterfall ended with us being cooled by the spray of the water into the plunge pool. After only staying there for five minutes we were drenched, but at least it stopped us overheating on the journey back to the top! Once we’d all arrived at the top we continued our journey on to our accommodation at Lake Toba.

Parapat

Lake Toba is Southeast Asia’s largest freshwater lake, and the largest caldera lake in the world. It was formed ~80,000 years ago by a volcanic eruption: the caldera that was created and eventually collapsed in on itself and the high-sided basin that remained filled with water to form the lake. This eruption is believed to be the largest in history. A second, smaller volcanic eruption, 50,000 years after the first, created an island the size of Singapore in the middle of the lake, Pulau Samosir. We got the ferry across to Pulau Samosir to learn about Batak culture and experience the volcanic activity on the island. We were taken to a traditional Batak village and to the interesting geological sites on the island, such as a lava flows, hot springs and the new active volcano that is forming at the edge of the island. We had the opportunity to swim in the lake itself which was an incredible chance to take in the sheer scale of the lake and how big the volcano would have been. We also went hiking in an area of protected rainforest near the lake that enabled us to learn about the flora and fauna of the region and see a family of gibbons.
**Bandung**

Leaving the island of Sumatra for Java we arrived at our next stop: Bandung. In the centre of the town we discovered a sculpture museum where we actually bumped into the artist that had made the majority of the sculptures outside and proceeded to give us a guided a tour. We were then taken into his workshop where he was in the process of completing a 20-year-old project to create a sculpture that will be bigger than the statue of Liberty! We went to the Centre for Volcanology and Geological Hazard Mitigation (CVGHM) to watch presentations, including topics on volcanic hazard mitigation, landslide monitoring and earthquake monitoring. The areas spoken about had been studied by all our travellers and meant we were able to have long discussions with experts from the centre after the talks. We were able to gain valuable insight into some of the things we had seen on Mt. Sinabung like previous eruptions and landslides. En route to Jakarta we visited Tangkuban Perahu, a stratovolcano with an easily accessible crater rim that provided some stunning views of the surrounding landscape.

**Krakatoa**

After an overnight stay in Jakarta we boarded a boat to Krakatoa. Krakatoa is a set of volcanic islands around 50km off the West coast of Java which were formed due to the eruption of a much larger island in 1883. The boat chugged its way through the deep blue waters of the Indian Ocean, past steep sided islands smothered in rainforest and volcanoes blackened by recent eruptions. The island we were visiting, Anak Krakatau, was only 90 years old and was uninhabited - except for a few giant monitor lizards which we spotted later on. We set up camp on the beach in the shade of the jungle. That afternoon was spent snorkelling, hiking and eating freshly cooked food. In the evening we hiked up to the volcano to watch the sunset, which was out of this world! Climbing the volcano was worth the sacrifice of waking up at 5am. The sulphur plumes and yellow-stained rocks rising up against astunning backdrop of the other volcanic islands is an experience we will all remember for a long time.
“Krakatoa is a set of volcanic islands around 50km off the West coast of Java which were formed due to the eruption of a much larger island in 1883.”
Returning to Jakarta, we started our day at the Meteorological, Climatological and Geophysical Agency (BKMG) where we listened to presentations on different techniques they use to assess and monitor Tsunami and earthquake hazard in Indonesia and the wider reaches of the Indian Ocean, given a tour of their Tsunami early warning centre systems and even got to try their earthquake simulator!

We then travelled to Pertamina University where we listened to talks on geothermal energy production in Indonesia and the research going into how to extract energy from their volcanic resources on the Indonesian islands. Afterwards we had a Q&A session with the speaker alongside students from Pertamina University who attended the talk with us. After the event we spoke to the geophysics students of the university about our society and the range of activities we did year-round as they intended to set up their own equivalent society. It was great to interact with both the students and academic staff and be able to share our experiences to help them to become a successful society. The people at Pertamina University were lovely and we felt we made a good grounding for future relations with their department (and new society), whether it be an exchange of some kind or research collaborations.

We returned back to Singapore for our last full day where we went back to the harbour front where got to experience the Hill Street Tai Hwa Pork Noodle Stall, a Michelin-star street food stall, and went to the iconic Fort Canning Park. For our final evening we went back to our favourite bar, Little Saigon, and reminisced about the past two weeks. It was an emotional goodbye to South East Asia. We’d all had an unforgettable trip with plenty of once in a lifetime experiences! We were able to see four volcanoes. Two of those infamous for causing the largest eruption, and the largest tsunami, ever. These experiences couldn’t have been had in Europe, let alone the UK, and were inspiring for all. We all learnt a great deal about the Pacific ring of fire, and what the Indonesian government are doing to mitigate against the risks of living on it.

Azores Summer 2018

This summer the Geophysics society are travelling to the Azores, read about it in our next edition, or follow photos on Instagram #gpsazores18!
Undergraduate Research Opportunities Projects (UROP)

A ‘UROP’ provides an opportunity for students who have yet to graduate from their degree to participate in real research. The express purpose is for the participant to acquire experience of the research undertaken by a particular member of staff or research group by either undertaking a project or developing technical skills. All students are invited to apply, even those graduating in summer.
During summer 2017, Emily Gusterson and myself joined the Surface Processes Group at Imperial College London for an undergraduate research opportunity with Dr Dylan Rood. We joined his current research into the use of cosmogenic radionuclides for the determination of historical coastal erosion rates beyond when records began.

The project aims to reconstruct Holocene coastal erosion and provide data to test current predictive models, aiding the development of sea level and coastal erosion forecasting. In less than a week we travelled 1000 miles across Britain, visiting rocky coastal platforms at Bideford, Scalby and Dunbar. I led the team at Bideford, ensuring the safe and efficient collection of quartz-rich sandstone samples in a transect from the cliff to the furthest accessible part of the platform. Precise GPS, laser ranging and drone technologies were implemented to create 3D models in ArcGIS of each platform for later use in numerical modelling and data display.

Following field collection, we purified the samples at Imperial’s CosmIC labs through crushing, milling, washing and magnetic separation to isolate quartz. The quartz samples will soon be sent to ANSTO to determine Be-10 levels, the cosmogenic radionuclide of interest, in each sample ready for interpretation. The UROP also gave us the chance to partake in the group’s meetings where we got an insight into the scope of on-going global research within the group, including a host of MSci projects, as well as discussions on recent papers. The UROP gave me an invaluable understanding of planning and implementation of field projects, academic research and laboratory work which will no doubt shape my choices for my MSci and beyond.
In Summer 2017, I had the opportunity to work under Dr Ian Bastow on a research opportunity to investigate the African Cenozoic Hotspot Tectonism. Our aim was to image the African Superplume. I was part of a four-member team tasked with data processing and preliminary analysis of teleseismic P-wave arrivals. I thoroughly enjoyed working in a collaborative environment and being challenged to make independent decisions thus developing my confidence to take initiative. Not only was the work intellectually stimulating, but the opportunity to observe the application of class taught theory to practice allowed me to gain an invaluable insight into the world of research. Not to mention, being credited on the published results as a co-author in my second year as an undergraduate is something I am definitely proud of!

**African Cenozoic Hotspot Tectonism**

Sneha Desai

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**Emplacement Mechanics of Giant Sill Intrusions**

Eleanor Chung

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Last summer I had the opportunity to undertake a UROP with Dr Craig Magee. I used high quality 3D seismic data to look at sill emplacement and associated deformation. I spent six weeks interpreting a sill, of size $>4475\text{km}^2$, within the Exmouth Plateau on the NW continental shelf of Australia. I characterised the sill, including the magma flow direction during emplacement, and both brittle and ductile deformation associated with the sill. This ductile deformation included an anticline in the stratigraphy above the sill. Using the software Petrel, I was able to collect data which allowed me to analyse the extent of ductile deformation to prove that the anticline was solely caused by the magma emplacement. I was also able to interpret the tectonic history of the area by mapping out stratigraphic horizons surrounding the sill and their relationships with the local fault networks. The research that I undertook can be applied to current volcanic prediction methods, as the accuracy of magma movement interpretations can be improved.
Internships

One of my key interests is in planetary science, and between my third and fourth year I was lucky enough to be accepted to the Lunar Planetary Institute (LPI) Internship program, based in Houston, Texas. This was a ten week independent research project that had similar aspects to that of the UROP project, which looked at mantle plume dynamics on earth. The main aim of the project was to understand the mantle plume dynamics beneath the Devana Chasma rift system on Venus. This project again was programming based; I had to model the lithospheric flexure of the rift system using Magellan altimetry data. From this a more detailed understanding of the rifts supportive mechanisms could be understood and linked to the mantle dynamics beneath the rift. With the work I completed at this internship I was then able attend and present this at the Lunar Planetary Science Conference, thus giving me my first experience at an academic conference. The LPI has very strong links with NASA, so during the internship all the interns were able to have tours around the Johnson Space Centre. We were allowed access to the Lunar Rocks and Stardust Labs, Mission Control and my personal favourite, the Robotics lab where we could ride on a Mars Rover prototype vehicle! This was such a great opportunity to travel and learn.

The project gave me an insight into how to conduct real scientific research, and being given the opportunity to go to a conference helped to develop my scientific writing and communication skills. These will be invaluable for the future.
In summer 2016 I undertook a 2 month internship at Mott MacDonald in the Dams and Reservoirs division in Cambridge as a geotechnical engineer. I worked on a variety of projects producing cross sections of local reservoirs as well as ground models for regional construction of reservoir storage tanks across the north of England. I was further involved in the organisation of external talks from clients and site visits across the UK. The opportunity for travel both within England and abroad within this sector appeals to me greatly and one I had not truly considered before undertaking the experience. In doing so, I gained greater insight into the application of geology into the extensive and continuously expanding engineering sector. I have since been offered a role at the company aiming to work initially with clients on redesigning outflow and foundation expansion of a tailings dam in Mongolia.

My advice would be to really try as many experiences as you can! Building up your CV throughout your degree will really help you stand out and by experiencing all aspects of the geosciences from research to industry and from, for example, mining and minerals, to petroleum engineering will allow you to decide fields you may prefer to others. Being proactive and seizing opportunities has definitely been the most rewarding aspect of my degree!
I graduated Imperial with a Geophysics MSci and started a PhD at the university of Leeds with the focus of refining current glacier models. Primarily I study their density using full waveform inversion (an up and coming geophysical modelling technique mostly used by the exploration industry).

Within my first month of starting the PhD I was involved in a project that was looking into the calving of the giant iceberg A68 (four times the size of London!) from the Larsen C ice shelf in Antarctica. This meant that myself and one other geophysicist had the opportunity to travel down to Antarctica to collect seismic data, with the aim of being able to image the stress relief fractures in the remaining ice shelf since the break off. I was thrown in at the fieldwork deep end, and had I not had the excellent opportunities from Imperial to use seismic equipment before, I would not have felt confident in doing this! We camped out on the ice shelf for a few days and made the most of the 24 hours daylight, working all through the night to make sure we got as much data as possible. With the distraction of the occasional penguin and a few equipment hiccups (to be expected!) we managed to get all the data we had intended on collecting. It was a slightly more intense start to my PhD than I had been expecting, but it was the most amazing opportunity! Now I’m back in the slightly warmer Leeds, it’s a matter of processing the data and seeing what can be learnt from it before my next trip out to the Hardangerjøkulen Icecap in Norway.

Using exploration techniques with a glaciological approach really sparked my interest as a geophysicists, as it’s an area that is comparably under explored but can entail the use of novel geophysical methods, and I’m looking forward to where the next three years will take me!
Since I left Imperial I started as a BP geologist in the Reservoir Development. The structural and geophysics modules at Imperial come in so useful in day to day work at BP. For the oil and gas industries the basins analysis and sedimentology MSc courses are definitely worth the hard work! My first two years were filled with the RSM as Regalia officer, DLB field trip officer and year rep. My last two years were spent with the University London Air Squadron, a secret within uni that most people don’t find out about. I joined the Air Squadron so I could fly as much as I like, not only for free but being paid to do it. Once starting on the squadron I found that there was so much more than flying to get involved in…I went on a week’s paragliding, a week skiing, a week sky diving, a week mountaineering….the list of activities is endless (as you get paid for it and make an awesome group of friends too that I’ll be friends with for life!).

Upon leaving the Royal School of Mines with a degree in MSci Geophysics I started work Clarksons Research, with two Geology students from my year and even more ESE alumni already at the company. Clarksons Research is the market research division of Clarksons Platou, the world’s leading provider of integrated shipping services: including Shipbroking, Financial Services, Research and Port Services.

I currently work on the Market Research Desk, which produces intelligence, in the form of publications and online data platforms, for the global shipping industry and to support other areas of the business. The desk specifically produces publications with data and market commentary on the demand for shipping, including shipping and trade, and the supply of ships to the global fleet, focusing on ship building and demolition.

In terms of transferable skills, my earth science degree gave me an in-depth understanding of the economics and the process behind two of the main drivers for shipping trade, the Oil & Gas and Metals & Mining industries. The interest in these industries that I developed during my degree has been the groundwork of my career so far, having also worked for CRU, and Metals & and Mining consultancy/intelligence provider, on two summer internships. To write analysis pieces on global trade, an analyst needs firstly to be able to think on a global scale, a skill which my degree helped me to improve, but also think statistically, another soft skill developed throughout mathematical and computing courses during my time at ESE.
This section is to let you know that a degree isn’t all about the work, there are some amazing experiences you can have alongside your degree! Featured in this is an article on going on a year abroad, an opportunity to spend your third year of an MSci in a foreign university, with options both in Europe and further afield. You can apply directly to the ‘Year Abroad’ degree course or transfer once you are in the department.
Sailing across the Atlantic
Ed Clark

If you were to ask me if I wanted to spend 5 weeks in a confined space eating only tinned food with 22 other people I would ask you how you even thought that was appealing, however tell me it’s part of a race and I’d get to sail the Atlantic I would jump at the chance, and that’s exactly what I did.

Flying out to Canada at the start of August to embark on a return journey that would take the best part of 3 weeks to cover the distance we had flown in just 8 hours, the scale of the task hadn’t really set in. We set off from Halifax in Nova Scotia on an extremely warm day with temperatures in the mid 20’s. It felt more like an equatorial Atlantic crossing than the stormy northern passage we had been warned so vehemently about.

Sailing is an uncertain venture so with the race start 100 miles out to sea the fleet ambled towards the start line not knowing what lay before them, the plan was simple; follow the weather systems and sail the boat fast downwind. This plan however, was cut short by days of little wind, so the next 48 hours were spent motoring some 400 miles further out into the ocean in search of the new start line. Finally, we were off!

Sailing up around Labrador flirting with the iceberg limit, not far from where the Titanic lay in wreck, the eerie Grand Banks veiling us in fog for what seemed like forever and 5 days later we finally got our first rays of sunlight in some time. The watch system we employed had us sailing for 2 days alternating 4 hours on, 4 hours off, followed by a day of ‘Mother Watch’ which consisted of cooking and cleaning on the boat, this repeated until we reached Lizard point. Nobody slept for more than 4 or 5 hours at a time throughout the entire crossing and as Watch Leader I was awake for upwards of 24 hours without rest when rough weather ensued and assistance was needed.

We were blessed with fair-weather, and downwind sailing most of the way, managing to hold our large asymmetric spinnaker for days until the first of many tears occurred. With winds gusting up to 50 mph on some nights and leaks springing every other day, describing the experience in detail would sure deter any foolhardy adventurer.

However, the nights spent hand-sewing sails back together, were all worth it as we came across the line in 27 knots of wind, with maximum possible sail area up- we had crossed the pond in the fastest time! The champagne was opened and we set a course for Plymouth to recover, then finally across to Le Havre for in-port celebrations.
My year abroad in Berkeley was one of the most memorable and rewarding experiences of my life. Berkeley is a beautiful campus and exciting place to be a student and only short distances from some of the most amazing places (and geology!) in the US. I was impressed by the diversity in the student body and how Berkeley seems to gather some of the world’s brightest minds in all disciplines, not just science.

The work was challenging: on top of lectures, I was part of a Seismology research group conducting independent research throughout the year (the Earth Imaging Group lead by Prof. Richard Allen). In December 2017, my research from my year abroad was presented at the American Geological Union (AGU) conference. Studying at Berkeley will give you the opportunity to engage in real research and take part in discussion groups with world-leading geologists and geophysicists (through graduate seminars). I also truly enjoyed the modules I took at Berkeley, learning about topics not necessarily covered at Imperial in third year, such as Carbon Capture and Storage or Planetary Astrophysics. All classes were small (on average 15 students) and I enjoyed the freedom I had in my module selection. Be prepared to work a lot on assessed coursework (approximately one coursework a week per module), as the assessment system in the US differs significantly from Imperial’s.

My best experiences of my year abroad were my travels in California: exploring the Bay Area and San Francisco, hiking in Yosemite, skiing in Lake Tahoe or road-tripping down to Santa Barbara and Los Angeles... living the “American Dream”! Discovering the American collegiate culture such as the football games was also definitely a highlight.

The process of applying to the Year Abroad Programme at Berkeley was quite straightforward: obtain a first in your first and second years, write a motivation letter and have an interview. If you get the chance to go to Berkeley, take it – it’ll be one of the best years of your life!
Lecturer Profile

We see our lecturers at least once a week but we don’t always get to hear about the research they are doing at the moment, or what they did before they arrived at Imperial. We hope to change that in this section, we get to know lecturers very well on field trips but we want to share all the amazing work that goes on in the department as well as papers to look out for in the future!
Professor Joanna Morgan is a Geophysics lecturer within the department. Before coming to Imperial she completed her undergraduate degree in Geophysics from Southampton, worked as a field geophysicist in Australia and worked as an engineer for the oil company, Schlumberger. She specialises in seismology and has and has co-led two seismic experiments across the Chicxulub impact crater in Mexico, resolving a debate on the size and morphology of the impact crater in the process. Jo was one of the chief scientists on the IODP 364 Expedition to drill into the crater’s peak ring in 2016. As a member of the Imperial 3D full-waveform inversion group (alongside Professor Mike Warner, Dr Rebecca Bell and Dr Gerard Gorman), Professor Morgan and other members of the department have begun applying this new technology from the group to research including the Chicxulub crater, mid-ocean ridges, Santorini and most recently the Hikurangi subduction zone in New Zealand.

Here is a little more about her work from Professor Joanna Morgan:

I am working on three main projects at the moment: 1) the Chicxulub impact; 2) the Santorini volcano; and 3) the Hikurangi subduction zone. In all three projects we are, or soon will be, using full-waveform inversions of seismic data to produce high-resolution images of seismic velocity. In the case of the Chicxulub project, we used our velocity model along with reflection data to select a drill site at a location where we would stand a good chance of recovering the earliest Paleocene sedimentary rocks; expedition scientists are currently using these rocks to document the recovery of life at ground zero. In ESE, Gareth Collins used numerical simulations to distinguish between competing models of large crater formation, and Natalia Artemieva (PSI) and I have generated better estimates of the climatic gases released by this impact. The target of the seismic survey across Santorini is the magma plumbing system beneath this active volcano. Activity in 2011 suggests magma has moved up to 4-6 km beneath the surface, and the objectives of this joint project with researchers from the Universities of Oregon, Athens and Thessaloniki, are to quantify the volume of melt stored as well as investigate magma storage in the deeper crust. Within ESE I am working with Michele Paulatto, and the questions we are trying to answer with full-waveform inversion include: is the melt stored at several levels, is there a continuous mush zone, where does differentiation occur, and can we say anything about the likelihood of an eruption. For the Hikurangi project, led by Rebecca Bell, a large group of ESE staff and PhD students went to New Zealand over Christmas and New Year to install land seismometers around Gisbourne. At the same time seismometers were placed offshore on the ocean bottom, and then a ship with towed airguns and a 6-km streamer acquired reflection data over the last month. The shots from this marine survey were also recorded on all the seismometers to generate a vast refraction dataset across the Hikurangi subduction zone. Our aim is to use full waveform inversion of these data to obtain a high-resolution map of physical properties across the subduction zone, to better understand why there is an abrupt change in seismic behaviour from stick slip to slow slip as the subducting slab approaches North Island.
Special thanks to:

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