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Introduction

The Bachelor of Science (Honours) in the School of Physical Sciences at the University of Adelaide is the gateway to increased job opportunities and to a great range of rewarding careers in research. Our teaching and research staff are international leaders in their fields of science. Join us for your Honours project and you will be a member of a research team working at the leading edge of geological and geophysical sciences. We offer two Honours programs: Honours Geology and Honours Geophysics.

This booklet includes the 2017 Honours research projects but we also encourage you to talk with staff as the projects listed in the booklet may not reflect all the projects available. We recommend that you consider the preferred field in geology or geophysics in which you would like to do a project and then get in contact with the academics who supervise projects in this field. You may also want to talk with current Honours students to find out what Honours is like from a student perspective.

The Australian School of Petroleum also offers an Honours degree in Petroleum Geology and Geophysics. If you are interested in this program please contact Dr Khalid Amrouch (kamourch@asp.adelaide.edu.au).

What is Honours like? As an Honours student you become a member of the School and a valued colleague. You will spend most of your time as part of a research group sharing goals, triumphs, disappointments and all of the other things that are part of the adventure of scientific research. For the first time, you become responsible for the outcome of your own scientific work. Honours students also partake in all aspects of the social life of the School. You will form friendships and professional associations that will last a lifetime.

The Honours degree will give you a thorough training in scientific methods and a detailed insight into geological and geophysical processes in the area of research that you pursue. The scientific approach to problem solving, maturity and self-discipline gained during the Honours year will equip you for a wide variety of careers. Many of our students elect to continue in the research domain by enrolling in the School's PhD programs. However, the analytical and communication skills that our students acquire have led other Honours graduates into a range of careers in many different fields and industries.

Juraj Farkas
Honours Coordinator
!! DISCLAMER !!

We are doing our best to bring together interesting and challenging projects that cover a wide range of interests and locations. These projects frequently require skills or qualities inherent to the project like willingness to work in remote areas or ability to drive a four wheel drive vehicle. Projects in this booklet are to be considered preliminary as contracts with companies may not have been signed yet, access to locations needs clearance, legal procedures need finalising. Therefore the projects described in this document, including project locations, conditions, offers of support and all other concessions are preliminary only and can be subject to changes beyond our control. Decision on allocation of a specific project to a student is to the discretion of the principal supervisor in consultation with the Head of Department of Earth Sciences.

It is the students’ responsibility to obtain the qualifications necessary to enrol in the Honours program. Under certain circumstances a student may need to complete additional coursework (e.g. Summer School) to fulfil the enrolment prerequisites. It is to the discretion of the principal supervisor to consider such students once they meet the enrolment requirements. Project allocation is non-transferable and there is no entitlement of a student to a selected project.
Choosing a research project

If you are thinking about doing Honours, it is a good idea to talk to current and past Honours students; they will give you frank and helpful advice.

It is sensible to identify **five projects** of interest in this booklet and then arrange to meet with the supervisor(s) to discuss in more detail. Remember that the supervisors mentioned in this booklet will not expect you to have a great deal of knowledge about their particular field(s) of research, so do not feel intimidated. It is also worth remembering that different supervisors have different ways of assigning projects. Some may use the first-in, first-served approach, while others may consider all inquiries before offering a project to a particular student. If you are genuinely interested in a project, make sure that you leave a contact number/email in case another student also expresses an interest.

If you are unsure of what project to do, it is advisable to start talking to supervisors that you would like to work with. It may also be the case that there are other potential projects that are not listed in this booklet. In addition, if you have a good idea that you would like to explore, by all means bring it to our attention.

Be aware that we are expecting a large Honours cohort in 2017 and there are only a limited number of students we can sensibly supervise. Honours acceptance will **require a minimum credit average** of third year marks in your major of choice. Thus for example, if you wish to undertake the Honours Geology course, the average of your marks in Igneous and Metamorphic Geology III, Tectonics III, Earth Systems History III and Field Geoscience III will have to be at least a credit. To be accepted into Honours Geophysics you must have a credit average in the Geophysics and Applied Geology major. Note: For those students undertaking the BSc. Minerals Geoscience program, you will be expected to have a credit average in any four geology subjects at third year level.
What is Honours all about?

The Honours year in the Department of Earth Sciences consists of a major research project, course work and field camps. The course work and field camps provide extra skills and resources, and a level of professional achievement that will form a significant part of your resume. Research projects are undertaken with the supervision of a staff member in the University, and sometimes also involves personnel from industry or other government organisations such as DSD and CSIRO. During your research project, you will have the opportunity to:

- Develop your own fieldwork program
- Travel to interesting and unique places
- Conduct laboratory analyses using state-of-the-art instrumentation
- Instigate computer analyses and modelling with industry-standard software
- Meet and network with industry and government scientists
- Attend and present results at conferences, workshops and meetings
- Write a scientific publication that can be developed into a refereed publication

The mix depends on the project and your own personal interests.

The major goal of the Honours programs is to equip you with a wide range of skills that will allow you to tackle graduate employment programs or further postgraduate research with confidence!

Why do Honours?

For many students, the decision to do Honours is a natural choice at the end of their Bachelor of Science degree. For those students who have decided that they are intrigued and fascinated by the process of research, Honours is the beginning of the business of becoming a scientist. For students who seek a career in industry, an Honours degree is usually the basic requirement for employment. Whether you have decided to do Honours as a prelude to seeking employment, or continuing in research, the decision to do Honours is not a trivial one, since it is a challenging year that will be associated with highs and lows. However, we expect it will also be the most interesting and rewarding of your University career.

When do you formally apply?

Between now and the end of semester you should start thinking about your Honours year. To be accepted into Honours in semester 1, 2017, you will need to have completed a degree by December 2016. It may be possible to pick up a few units in the Summer Semester 2017 (January-February) to complete your degree if you are short of units, but your results must be finalised so that you can be completed from your degree and enrolled into your Honours program by the end of February, 2017. If you have not completed your degree by December 2016 you must contact Jenny Reiners by email (jenny.reiners@adelaide.edu.au) to discuss your options.

It is not possible to start Honours mid-year. Therefore, if you are unable to complete your degree during the summer semester you will be required to start Honours in the following year (i.e. 2017 Honours intake).
To be definitely accepted into Honours you are formally required to have a Credit average in the third year topics that constitute the major in which you intend to do Honours (i.e. Geology or Geophysics and Applied Geology). If your application has been successful the Faculty will send you a conditional offer for Honours. Don't be concerned, as all students get a conditional offer until all results have been posted and the Faculty add the completion row to your transcript.

**OS-HELP Funding**

Financial assistance for students is available through OS-HELP. This is a loan scheme administered by the Department of Education that allows students to borrow up to $6,470 for a six month period overseas for a maximum of two study periods. Your OS-HELP is added to your accumulated HECS-HELP debt.

Go to the Global Learning website for information on eligibility. Further information about travelling to New Zealand and how to apply for OS-HELP funding will be sent to all applicants. [http://www.adelaide.edu.au/global-learning/funding/](http://www.adelaide.edu.au/global-learning/funding/)

**Important dates for Honours 2017**

**Closing Date:**
The closing date for your Expression of Interest (EOI) to be considered for the first round of offers is **Friday 28th October 2016**. Students will be notified of the outcome of their applications as soon as possible after the results of the third year subjects are finalised.


**Late applications:**
Late applications are not considered except in exceptional circumstances as we need to finalise bookings for the New Zealand Field trip in mid-December.

| Last Day to Lodge Honours Expression of Interest Form to the Faculty of Sciences Office (for First Round) | Friday 28th October 2016 |
| Date of Notification of Domestic Honours Offers | from Thursday 1st December 2016 |
| Date of Notification of International Honours Offers | from Thursday 3rd December 2016 |
| Prospective Honours Students to Submit Acceptance | no later than Friday 16th December 2016 |
| Honours Enrolments Commence | Early-Mid January 2017 (TBC) |
| Honours Studies Commence | Monday 30th January 2017 (TBC) |

*Note: All dates and times are preliminary and may still be subject to change*
Enrolment and induction

From Monday 30th January (TBC), you will formally start in one of the Honours programs and be introduced to the staff and facilities of the School and the University. **You MUST be at the University for this date.** Please make good (and efficient!) use of such facilities; we are all here to help as much as we can. Your supervisor will help you with any special needs that you may have.

Honours students will have swipe card access to the Honours Offices (211 and 211a) where there are hot desk computers, printing and scanning, and a landline telephone. There are also kitchen facilities (fridge, microwave and kettle) and couches. Honours students will have access to e-mail and MyUni facilities, as in previous years.

A number of Occupational Health and Safety courses will be prescribed for you. Occupational Health and Safety comprises of many things, including safe four-wheel driving, first-aid training, and laboratory and field safety courses. Make as much use of these courses as possible, they comprise a valuable part of your research training and will be an asset on your resume!

We also recommend that you undertake a number of academic courses that are run by the Graduate Centre or through the School. These include:

1. Research proposal as seminar &/or documents
2. Reviewing literature
3. Writing a journal article for publication
4. Endnote referencing

These courses are offered regularly by Researcher Education and Development (RED): [http://www.adelaide.edu.au/red/](http://www.adelaide.edu.au/red/)

Assessment breakdown

Both of our honours programs are composed of two undergraduate courses, one coursework based and the other research project based. To complete the honours degree you must perform satisfactorily in both courses.

<table>
<thead>
<tr>
<th>Program</th>
<th>Semester 1 2017</th>
<th>Semester 2 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honours Geology</td>
<td>Advanced Geology (Hons) Part I 4.5 Units</td>
<td>Advanced Geology (Hons) Part II 4.5 Units</td>
</tr>
<tr>
<td></td>
<td>Honours Geology Project Part I 7.5 Units</td>
<td>Honours Geology Project Part II 7.5 Units</td>
</tr>
<tr>
<td>Honours Geophysics</td>
<td>Advanced Geophysics (Hons) Part I 6 Units</td>
<td>Honours Geophysics Project Part I 6 Units</td>
</tr>
<tr>
<td></td>
<td>Advanced Geophysics (Hons) Part II 6 Units</td>
<td>Honours Geophysics Project Part II 6 Units</td>
</tr>
</tbody>
</table>
Advanced Geology (Hons) Part 1 and Part 2, and
Advanced Geophysics (Hons) Part 1 and Part 2

Advanced Geology (Hons) Part I and Part II (9 Units)
1. New Zealand trip “Continents on the move”
2. Two courses (Geoscience Data Analysis, and Project-Related Course)
3. Thesis Support Tasks
4. Research Seminars

Advanced Geophysics (Hons) Part I and Part II (12 Units)
1. New Zealand trip “Continents on the move”
2. Two courses (Geoscience Data Analysis, and Numerical Modelling Course)
3. Thesis Support Tasks
4. Research Seminars

New Zealand
Subject to confirmation, the Honours Geology and Geophysics students will have the
opportunity to attend an excursion to New Zealand as part of their course work. The dates
for this trip are yet to be determined but will take place in late February-early March.

Thesis support tasks
Throughout the year you have a number of Thesis Support Tasks to complete. The tasks
have been devised as exercises based on your project, which will enable you to proceed
through your project on time and with the full support and feedback from your supervisors.
Each task is outlined below.

<table>
<thead>
<tr>
<th>Thesis Support Session</th>
<th>Lecture Session*</th>
<th>Hand Up Task*</th>
<th>Feedback Due*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis &amp; Project Aims</td>
<td>7th Mar 2017</td>
<td>20th Mar 2017</td>
<td>3rd Apr 2017</td>
</tr>
<tr>
<td>Time Management</td>
<td>20th Mar 2017</td>
<td>10th Apr 2017</td>
<td>18th Apr 2017</td>
</tr>
<tr>
<td>Background &amp; Literature Review</td>
<td>27th Mar 2017</td>
<td>18th Apr 2017</td>
<td>2nd May 2017</td>
</tr>
<tr>
<td>Introduction</td>
<td>3rd Apr 2017</td>
<td>24th Apr 2017</td>
<td>8th May 2017</td>
</tr>
<tr>
<td>Bibliography</td>
<td>10th Apr 2017</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Methods</td>
<td>24th Apr 2017</td>
<td>15th May 2017</td>
<td>29th May 2017</td>
</tr>
<tr>
<td>Presenting your Results</td>
<td>17th Jul 2017</td>
<td>7th Aug 2017</td>
<td>21st Aug 2017</td>
</tr>
<tr>
<td>Results vs Discussion</td>
<td>14th Aug 2017</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Abstract</td>
<td>21st Aug 2017</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Presentation Skills</td>
<td>6th Nov 2017</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Dates subject to change. You will be informed in good time prior to these changes.

Research seminars
As an Honours student you are expected to get involved with the research community at the
University. You will be expected to attend the weekly research seminars, often presented by
our academic and research staff, postgraduate students, as well as national and international
visiting geologists and geophysicists. Your attendance at these seminars will be recorded
and written summaries of what you heard will be collected.

x
Honours Geology and Honours Geophysics projects

Research output from the project will be in the format of a scientific paper in the style of the Australian Journal of Earth Sciences (AJES). The aim is to encourage a conciseness of thought and expression that can be communicated to the wider scientific community. Most journal papers are of the order of 5000 to 8000 words (approximately 4-15 printed pages), typically with 5 to 15 figures. We anticipate that some research undertaken during the year may be published with very little modification, as has been the case in previous years. However, not all projects lead to publications and a successful Honours year is not dependent on achieving a publishable result. Projects vary in scope, funding and time. Some students combine summer vacation work with their Honours year. Assessment of your project is geared towards how you do your project, rather than the glittering outcomes; we are looking to see how you work in research!

Your final thesis (in digital manuscript format) will be submitted at the due date (Monday 16th October 2017) through MyUni. The advantages of this are that we significantly reduce the amount of paper involved in the process and that you will not need to worry about the printing. This online administration will also improve on your computer skills. To support you with this there are a number of seminars and workshops available at the University, for example on the use of EndNote, graphics software packages, desk top publishing and improving your skills at writing a thesis. There may be an opportunity to attend a conference during the year and maybe present your results to the wider community. Please talk to your supervisors about potential meetings.

At the end of your thesis year you will be required to present your final project, including your initial aims, methods, results and final conclusions. This oral presentation will be held during three full days of presentations (Monday 13th – Wednesday 15th November 2017). The audience will include the entire Honours group and staff and postgraduates of Geology and Geophysics, as well as any industry professionals involved with the Honours class throughout the year. The presentation will be 15 minutes in length followed by 5 minutes of questions from your examination panel.

Prizes
The School offers the prestigious Tate Medal as a prize for top Honours student.
Assessment

Grading
To graduate with an Honours degree, the student must submit all of the required work in both courses of the program that they are enrolled into (e.g. Advanced Geology (Hons) and Honours Geology Project). The individual items of assessment within both courses will be marked following the M10 mark scheme:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD</td>
<td>≥85%</td>
<td>High Distinction</td>
</tr>
<tr>
<td>D</td>
<td>75-84%</td>
<td>Distinction</td>
</tr>
<tr>
<td>C</td>
<td>65-74%</td>
<td>Credit</td>
</tr>
<tr>
<td>P</td>
<td>50-64%</td>
<td>Pass</td>
</tr>
<tr>
<td>Fail</td>
<td>≤49%</td>
<td>Fail</td>
</tr>
</tbody>
</table>

The final class of the degree will be determined by the assessments of both courses within the honours program following the GS5 mark scheme:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>≥80%</td>
<td>First Class</td>
</tr>
<tr>
<td>2A</td>
<td>70-79%</td>
<td>Upper Second Class</td>
</tr>
<tr>
<td>2B</td>
<td>60-69%</td>
<td>Lower Second Class</td>
</tr>
<tr>
<td>3</td>
<td>50-59%</td>
<td>Third Class</td>
</tr>
<tr>
<td>NAH</td>
<td>≤49%</td>
<td>Not Awarded</td>
</tr>
</tbody>
</table>

Banding for scholarship purposes will be determined by the School and the Discipline, based on Honours results over the last few years. It is important to know that the University only records the Classes above.

All assessment items will be assessed by the staff teaching those components of the course. However, the final thesis will be marked by two examiners.

Finalising the Honours year
The final step of your Honours year is to sign out. This will involve a number of steps, each of which will have to be confirmed by the respective person in charge. You will receive a list of sign out tasks after the Research Seminar and this list will have to be handed in to the main office. **Only once this sign out is complete will your Honours course be considered finished and results can then be finalised.**

Career paths
There is a general perception that your choice of Honours project will fix you to a certain career path. This is not the case: keep in mind that employers are looking for confident and capable people who have successfully tackled and completed a challenging project and professional coursework. You are most likely to be successful during Honours if you choose a research project that interests and motivates you.
If you are interested in continuing into research, or if during your Honours year you begin to enjoy the research experience, you may feel that your choice of project commits, or has committed you to a specialised area. However, the problem solving skills that you will learn, and the confidence gained from completing your Honours project means that you are well equipped to change direction to take advantage of new opportunities. The University’s scholarships page has more details on postgraduate research.

The Honours year in Geoscience is the professional year that gains you access to employment. Graduates have a wide range of career prospects, as shown below.

**The Honours year planner 2017**

**BSc. Honours Geology, BSc. Honours Geophysics**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 30th Jan 2017</td>
<td>Enrolment and Induction</td>
<td>You MUST be at the University to complete this</td>
</tr>
<tr>
<td>Mid Feb to Sep Dates TBC</td>
<td>New Zealand field camp</td>
<td>Continents on the move, more details early in the New Year</td>
</tr>
<tr>
<td></td>
<td>Honours course 1</td>
<td>Details TBA, but one course will be focused on “Geoscience Data Analysis”, and the second course will be thematically related to your specific projects.</td>
</tr>
<tr>
<td></td>
<td>Honours course 2</td>
<td></td>
</tr>
<tr>
<td>Feb to May</td>
<td>Geophysics courses</td>
<td><strong>Honours Geophysics students only</strong></td>
</tr>
<tr>
<td>Feb to Sep</td>
<td>Thesis Support Tasks</td>
<td>Oral presentation (marked) and report hand in</td>
</tr>
<tr>
<td>Feb to Oct</td>
<td>Research work</td>
<td>Including weekly seminar series</td>
</tr>
<tr>
<td>16th Oct 2017</td>
<td>Final thesis submission</td>
<td></td>
</tr>
<tr>
<td>13th–15th Nov 2017</td>
<td>Research Seminars</td>
<td>Includes questions from panel of examiners including Geology and Geophysics staff</td>
</tr>
<tr>
<td>Early Dec</td>
<td>Results posted</td>
<td></td>
</tr>
</tbody>
</table>
Honours Projects 2017
Reconstructing the Holocene volcanic history of SE Australia from distal cave sediments

PREREQUISITES
Enthusiasm, inquisitiveness and an interest in Quaternary palaeoenvironmental studies. Good numerical skills and a capacity to conduct meticulous laboratory research. There is no specific pre-requisite course, although Earth Systems History III would be beneficial.

SUPERVISORS
Dr Lee Arnold  08 8313 3758  lee.arnold@adelaide.edu.au
Dr Jonathan Tyler  08 8313 2810  jonathan.tyler@adelaide.edu.au
Dr Liz Reed  08 8313 3831  liz.reed@adelaide.edu.au

RESEARCH PROJECT
The fossil rich sediments of the Naracoorte Caves record major ecological turnovers and contain numerous tracers of regional environmental change spanning the last glacial-interglacial cycle. The location of these caves within the Newer Volcanic Province, which houses Australia’s youngest volcanoes, means they are also ideally placed for recording past volcanic activity across south-east Australia. This project will use Cryptotephra analysis – the detection and characterisation of diminutive traces of volcanic ash preserved within sediments – to examine key questions about climate and environmental change taking place in southern and eastern Australia during the last 12,000 years and beyond.

Fieldwork and sample collection will focus on three cave localities (Blanche Cave, Robertson Cave and Tantanoola Cave). The study will use a combination of Cryptotephra analysis, geochemical fingerprinting of volcanic glass, and OSL dating of host sediments to reconstruct precisely constrained volcanic histories for the region.

Left: View inside the Mt Schank cone, one of the youngest volcanoes on mainland Australia. Right: Late Pleistocene sediment sequence preserved in Blanche Cave, Naracoorte Caves.
Silver, lead, zinc and a touch of copper: Making granites for the non-IOCG deposits

PREREQUISITES
Igneous and Metamorphic Geology III

SUPERVISORS / PROJECT PARTNERS
Karin Barovich 08 8313 3870 karin.barovich@adelaide.edu.au
Justin Payne, UniSA justin.payne@unisa.edu.au
Claire Wade, GSSA claire.Wade@sa.gov.au
John Anderson, Investigator Resources

RESEARCH PROJECT
South Australian geology is famous for the giant Olympic Dam IOCG deposit and the synchronous voluminous Gawler Range Volcanics (GRV) and Hiltaba Suite magmatism. The spatial and temporal link between the IOCG deposits and magmatism is well established but it is not yet clear why different types of IOCG deposits, or even other, completely different deposit types (e.g. Pb-Zn, Ag, Au), are formed by the same event in different regions. This project forms part of a large Linkage Project funded by the Australian Research Council to investigate the links between the GRV/Hiltaba magmatism, the composition of the local crust and the types of deposit types that are found.

This particular project will investigate why we have a change in deposit style from the Gawler IOCG province to the southern GRV/Eyre Peninsula Ag-Pb-Zn dominated province. Previous research has highlighted differences between the granites of the central Gawler Au province and the eastern IOCG province but it is unknown if the differing granites cause the differing deposits or if they too are a function of some lower crustal process. This project will investigate the geochemistry and isotopes of the Hiltaba Suite intrusives in the Eyre Peninsula to refine our understanding of the nature of the intrusive rocks and the lower crust. The project will have co-supervisors at UniSA and the Geological Survey of South Australia. The ARC project, led by Justin Payne, is a joint collaboration by UniSA, UofA, GSSA and Investigator Resources and hence creates an excellent opportunity for exposure to a range of expertise for the student on this project.
Origin of high heat production (U-Th enriched) granite in the North Australian Craton

PRE-REQUISITES
Igneous and Metamorphic Geology III, and an interest in U-Th energy resources

SUPERVISORS / PROJECT PARTNERS
Prof Karin Barovich 08 8313 3870 karin.barovich@adelaide.edu.au
Prof Martin Hand martin.hand@adelaide.edu.au

RESEARCH PROJECT
A number of global compilations of geochemical data allow general constraints to be placed on the amount of U and Th in continental crust, and in particular concentrations of these elements in granitic rocks.

Compared to global norms, parts of the North Australia Craton are characterised by voluminous granitic rocks that typically contain between 3 and 5 times global averages in U-Th concentration. The conventional paradigm is that high U-Th granites arise from crustal recycling. However the existing data from the North Australian Craton suggests this paradigm is not correct. Instead increasing concentrations of U-Th appear correlated with increasing amount of mantle input, pointing to the systematic involvement of compositionally modified mantle.

The aim of this project is to investigate the origin of these granitic systems. The project will focus on a region in the southern part of the North Australian Craton where several generations of U-Th enriched granite spanning an age range of ~ 200 Ma have been generated in the same lithospheric column. The presence of a number of generations of high U-Th granite in the same lithospheric column provides a very rare opportunity to understand how the contributing reservoirs evolved and interacted through time.

The project outcomes will influence the way in which we understand the geochemical organisation of the crust and lithosphere. Additionally understanding better our U-Th endowment will also provide more detailed insights into Australia’s energy (U, Th and geothermal) resources.

Histogram of global modern continental surface heat flow data (McLaren et al., 2003). Heat-flow measurements are age grouped based on the timing of the last major tectonothermal event. The boxes are the age range and the average (± 1σ) of the data. On a global comparison, the Australian Proterozoic lithosphere is anomalously enriched in U and Th.
From gulf to gulf: Magmatism across the Yorke Peninsula and its role in IOCG systems

PRE-REQUISITES
Igneous and Metamorphic Geology III

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RESEARCH PROJECT
South Australian geology is famous for the giant Olympic Dam IOCG deposit and the synchronous voluminous Gawler Range Volcanics (GRV) and Hiltaba Suite magmatism. The spatial and temporal link between the IOCG deposits and magmatism is well established but it is not yet clear why different types of IOCG deposits, or even other, completely different deposit types (e.g. Pb-Zn, Ag, Au), are formed by the same event in different regions. This project forms part of a large Linkage Project funded by the Australian Research Council to investigate the links between the GRV/Hiltaba magmatism and the types of deposit types that are found.

This project will investigate the petrogenesis of the Hiltaba Suite on the Yorke Peninsula – home of the second oldest Cu mining district in Australia (only beaten by Burra/Kapunda). There has been little systematic study of the magmatism on Yorke Peninsula and how it relates to mineralisation further west and north on the Gawler Craton. This project will incorporate a mixture of field sampling, drill core investigations and isotopic and geochemical analysis to build upon recent work by UofA and GSSA researchers. The project will have co-supervisors at UniSA and the Geological Survey of South Australia. The ARC project, led by Justin Payne, is a collaboration by UniSA, UofA, Monash University, GSSA and exploration companies and hence creates an excellent opportunity for exposure to a range of expertise and experiences.
Reworking the Northern Eyre Peninsula; Thermal history of the Central Gawler Craton

PREREQUISITES
Completed the Geology Major with a credit average. But most importantly, enthusiasm for research in thermochronology. This project would suit someone interested in tectonics research as well as aspiring mineral explorers.

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RESEARCH PROJECT
Recent drilling in the Northern Eyre Peninsula by the Geological Survey of SA in combination with mineral explorers and the Deep Exploration Technologies CRC has provided a wonderful resource of new deep cores through the highly explorative northern Eyre Peninsula. Mineralisation in the region is structurally controlled and formed within a few kilometres of the palaeo-surface. This project will, by integrating depth constrained apatite samples that will be analysed for both fission tracks and U-Pb, investigate the thermal history of the southern Gawler Range Volcanics. From this we aim to interpret times of hydrothermal (possibly mineralising) fluid flow and fault reactivation leading to differential exhumation. The project forms a part of large project to understand the mineral system of the region. It also continues and endeavour with the Geological Survey to understand the exhumation and thermal history of the Gawler Craton.

Figure 1 (left): The central Gawler Craton with the mineral systems. The region of interest for this project is the southern margin of the Gawler Range Volcanics.

Figure 2 (below): Colliform textures in the new core from the southern margin of the Gawler Range Volcanics.
How did we get into a Snowball Earth? Isotopic stratigraphy of Burra Group Dolostones, Willouran Ranges

PREREQUISITES
Completed the Geology Major with a credit average. But most importantly, enthusiasm for research in chemical and sedimentary geology applied to the Earth system. This project would suit someone interested in further research as well looking at employment.

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Nature Foundation SA

RESEARCH PROJECT
Dolostones of the Burra Group directly underlie rocks that were deposited in one of the most curious time periods of Earth history—the Cryogenian. As the name suggests, this was a time of extreme cold that lasted something like 80-100 Ma and may well have involved the complete freezing of the planet (i.e. the Snowball Earth). This project will look at the isotopic geochemistry of these carbonates at Termination Hill, in the Willouran Ranges, where a beautifully exposed section should reveal isotopic changes that we aim to use, firstly to confirm the age by using Sr isotopes (which change uniformly through the Neoproterozoic), then use C and O isotopes as proxies for biological activity and temperature. Additional isotopes of Ca will be attempted to better constrain the water geochemistry directly before the onset of the Icehouse world. Nd isotopes from shales will be used to examine the role of basalt weathering. Fieldwork will be included at Witchelina station.

The base of the Cryogenian succession with Termination Hill in the background. Carbonates of the Burra Group underlie the Yudnamutna sub-group rocks to the right. The boundary represents a sharp transition from warm to cold environments and this project aims to shed light on how this happened.
Delineating MesoArchaean metamorphism in the Mercara Belt, India

PREREQUISITES
Completed the Geology Major with a credit average. But most importantly, enthusiasm for research in tectonics, structural geology and metamorphism. This project would suit someone interested in further research as well looking at employment in geoscience industries.

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RESEARCH PROJECT
The Mercara Belt of SW India is a high-strain zone between the Coorg Block (the oldest crust of India, stretching back to the Palaeoarchaean) in the south and the Dharwar craton to the north. Recent age determinations from metasedimentary rocks within the belt have shown that metamorphism in this belt occurred at ca. 3.1 Ga, and all indications are that this metamorphism involved considerable crustal thickening. High pressure metamorphism hasn’t been reported to have affected rocks earlier than about 2.45 Ga, so if this is HP metamorphism, this study will change the way that we think about how the Archaean world. The project involves one week fieldwork in India, for which a contribution to the flights will be sort from the successful applicant.

Figure 1 (left): Outcrops in the Mercara Belt of SW India – Mesoarchaean high pressure metamorphism???.

Figure 2 (below): Garnet+kyanite paragneiss from the Coorg Block. A metasedimentary rock known as a khondalite in India.
Unravelling the geography of the base of the Centralian Superbasin

PREREQUISITES
Completed the Geology Major with a credit average. But most importantly, enthusiasm for research in basin analysis. This project would suit someone interested in research in basin analysis as well as aspiring petroleum geologists.

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Chris Edgoose and Dorothy Close (NTGS)
This project will also benefit from the expertise of Prof Martin Hand and Dr Justin Payne (UniSA)
Funded by the Northern Territory Geological Survey

RESEARCH PROJECT
The Heavitree Quartzite is the iconic rock formation in the Western MacDonald Ranges and forms the gorges at Alice Springs. It, and its corollaries, also form the basal formations of the huge late Proterozoic Centralian Superbasin. The Heavitree Quartzite is also considered a petroleum reservoir target in the Amadeus Basin. But, much confusion and controversy exists as to how old the Heavitree Quartzite actually is, and also where it was sourced from. In this project you will analyse a range of samples from throughout the Amadeus Basin to examine spatial provenance changes in zircons by looking at their ages and trace element compositions. These will be compared with possible source areas to develop a paleogeographic map of the nature of this part of Australia way back in the Neoproterozoic.

Figure 1: The stupendous Heavitree Quartzite beautifully exposed at Ormiston Gorge; an iconic Australia rock unit, but one that is poorly understood. This project aims to learn much about its significance.
How is there still billion year old petroleum in NT?
Thermal history of the Beetaloo Basin.

PREREQUISITES
Completed the Geology Major with a credit average. But most importantly, enthusiasm for research in basin analysis. This project would suit someone interested in research in basin analysis as well as aspiring petroleum geologists.

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NTGS (Drs Chris Edgoose, Dorothy Close)
This project is funded by SANTOS and is in conjunction with the NT Geological Survey

RESEARCH PROJECT
The Beetaloo Basin is a part of the huge McArthur Basin and preserves the world’s most unconventional petroleum play. Not only are there extensive petroleum reserves in tight reservoirs that are also the hydrocarbon source, but the rocks were deposited over a billion years ago. This is a rare chance to be involved in the understanding of a whole new petroleum system—that of truly ancient hydrocarbon formation, and more importantly, preservation.

This project will look at the temperature-time history of three wells in the buried Beetaloo Basin that form a N-S transect through the basin. Samples will be collected from various depths in the cores, apatites separated from them and time-temperature estimates obtained by undertaking fission-track analysis on the samples. These will be complemented by undertaking illite crystallinity analysis of shales throughout the same cores to provide independent maximum temperature estimates. The data will be modelled to develop a thermal evolution model and provide exhumation estimates for the basin. These data are directly relevant to understanding the preservation of this remarkable petroleum system.

Figure 1: The guesstimated extent of the vast McArthur Basin system, with the Beetaloo Basin forming a ‘duck’-like shape in the middle. The three wells that will be examined in this study are marked with orange circles.
The Derim Derim Event of Northern Australia

PREREQUISITES
Completed the Geology Major with a credit average. But most importantly, enthusiasm for research in chemical and igneous geology applied to the Earth system. This project would suit someone interested in further research as well looking at employment in the petroleum or minerals industry.

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RESEARCH PROJECT
The Derim Derim dolerite is a suite of magmatic sills with an age of 1324 ± 4 Myr that intrude late Mesoproterozoic sediments of the Roper Group, McArthur Basin. While intersected by numerous mineral and petroleum wells, no volcanic equivalents have been identified. These sills intrude at multiple stratigraphic levels within the Roper Group and represent the most obvious thermal event to have affected the basin, consequently they may be an important control on the thermal maturity of hydrocarbons developed within this basin.

In spite of a lack of detailed geochemistry, the Derim Derim dolerite has been proposed to be a remnant of a wide spread Continental Flood Basalt Province, possibly associated with the breakup of the Nuna supercontinent. Consequently, an understanding of the Derim Derim has implications for tectonic reconstructions.

This project will involve the detailed geochemical and petrographic study of the Derim Derim dolerite to elucidate the petrogenesis of this enigmatic suite of magmatic rocks. Furthermore, cross correlations between their geographical and stratigraphic distribution with hydrocarbon characteristics (i.e. published rock-eval data) of high TOC shales intruded by these sills will be used to provide insight into the impact of the Derim Derim event on the hydrocarbon potential of the basin. The overriding theme of this project is to provide a basis for understanding the tectono-thermal evolution of the Roper Group, McArthur Basin.

Figure 1 (Left) Contact of Derim Derim sills with ~1.4 Gyr high TOC black shales of the Velkerri Formation. (Right) Derim Derim sill exposed below the ~1.3 Gyr Sherwin Iron Formation.
Neoproterozoic stratigraphy of Amadeus Basin: Constraints from Strontium isotopes (\(^{87}\text{Sr}/^{86}\text{Sr}\))

**PREREQUISITES**
There are no specific pre-requisite courses, although completion of either Geochemistry II or Earth Systems History III would be useful.

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**RESEARCH PROJECT**
The Amadeus Basin in central Australia, with proven petroleum systems, covers an area of about 170 000 km\(^2\) and contains strata of the Neoproterozoic to Paleozoic ages, including also the “Snowball Earth” event, and thus represents a unique and continuous archive of the Earth’s system evolution spanning almost 500 million years. Due to the lack of macrofossils, the Neoproterozoic intra-basin correlation and biostratigraphy is problematic and relies primarily on the Acritarchs (organic microfossils), which however have considerable limitations. Hence, it is important to develop alternative and more robust correlative tools, and the strontium isotope (\(^{87}\text{Sr}/^{86}\text{Sr}\)) stratigraphy (i.e., SIS) of Neoproterozoic sedimentary carbonates offers possible benefits and solutions. Firstly, the “global” marine \(^{87}\text{Sr}/^{86}\text{Sr}\) reference curve shows a systematic and monotonous increase during the Neoproterozoic (see Figure), which makes this time interval and ideal target for the SIS applications. Secondly, there are numerous presumably marine Neoproterozoic carbonate sequences preserved in the Amadeus Basin (i.e., Jonny’s Creek, Aralka, Olympic, Julie Formations), which thus provide potentially useful archives of \(^{87}\text{Sr}/^{86}\text{Sr}\). Preliminary data (collected at UQ) indicate that the most suitable and best-preserved carbonate units for future SIS studies are the Ringwood Member in the Aralka Formation, and partly also Olympic Fm., as these yielded \(^{87}\text{Sr}/^{86}\text{Sr}\) that are identical or very close to the “global” seawater Sr isotope reference curve. Thus, the aim of this project is to perform more detail \(^{87}\text{Sr}/^{86}\text{Sr}\) studies on these carbonates, and sample them both *laterally* and *vertically* at higher resolution from different parts of the basin. The acquired data will be then used for (i) the intra-basin correlation purposes, and/or (ii) to infer changes in palaeo-depositional environments across the basin (i.e., open marine vs. restricted settings). Overall, this project will involve laboratory work using state-of-the-art instrumentations, and a fieldwork in the Northern Territory, including sample collection from outcrops and NTGS drill cores.

**Figures:** Left = Strontium isotope curve \((^{87}\text{Sr}/^{86}\text{Sr})\) of the Neoproterozoic seawater. Right = The location of the Amadeus Basin (after Phelps, 2015, Halverson et al., 2007).
Biogenesis of landscapes - geochemistry meets biology and the story of isotopes

PREREQUISITES
There are no specific pre-requisite courses, although completion of either Geochemistry II or Earth Systems History III would be useful.

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RESEARCH PROJECT
The landscape of South West Western Australia (WA) hosts unique vegetation and is globally recognised as an important evolutionary “hotspot”. It is generally assumed that the vegetation has adapted to the hostile soil and regolith landscape. However, a new theory – the Phytotarium concept – turns this ‘on its head’. The idea is that the landscape we see today is the result of the ongoing action of plants and microbes that have ‘engineered’ the soil and regolith to suit their needs. Hence, biota may have a direct influence on the underlying geological features and it is this hypothesis that will be put to the test in this project. This radical new concept has its basis as a Darwinian interpretation of pedogenesis and landscape evolution. Thus it’s not that plants have adapted to the geology, rather the geology has been adapted/modified by the plants. To test the “biogenesis” origin of selected landscape features, included cemented soils and hard-grounds developed on Quaternary dunes near Chillinup Lake in WA (see Figure), this project will employ isotope systems of alkaline earth metals as natural tracers. Specifically, we will measure stable and radiogenic calcium and strontium isotopes in the main geogenic and biological sources and reservoirs of Ca and Sr in the studied soil-plant ecosystem, including bedrock, mineral soil, ground/soil waters, concretions, roots, plants, sap, and local atmospheric deposition. Such isotope fingerprinting of plant-available sources, will in turn allow us to further constrain the biogeochemical pathways of Ca and Sr at this site, and ultimately to evaluate the role of “biogenesis” on landscape evolution. Overall, this interdisciplinary project will involve both laboratory work and fieldwork in WA, offering hands-on experience in modern analytical techniques, geochemical modelling, and collaborations with CSIRO.

Figures: An image showing a gradual development of soils on the Quaternary dunes, near the Lake Chillinup, WA. Right: The study site near Chillinup Nature Reserve.
Reconstructing the hydrological history of the Coorong Lagoon: Constraints from Sr isotopes

PREREQUISITES
There are no specific pre-requisite courses, although Introduction to Geochemistry, and/or Earth System History would be useful.

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RESEARCH PROJECT
The ongoing hydrological and geochemical changes occurring in the Coorong Lagoon, specifically a progressive salinization driven primarily by a limited inflow of freshwater from the Murray River due to excess of water usage and the effects of climate change, represent a major environmental concern. The aim of this project is to reconstruct past salinity variations in the Coorong geological history (i.e. the last ca. 8000 yrs), before the human activities altered the natural balance of this lagoon system. This information will, in turn, help us to predict the resilience of this marine-estuarine ecosystem to future salinity fluctuations. The project will employ state-of-the-art research techniques, specifically the analysis of strontium ($^{87}$Sr/$^{87}$Sr) isotopes in well-dated and preserved fossil calcitic shells, sampled from drill-cores from the Coorong Lagoon, which will be used as natural archives of past salinity changes. In addition, a multi-proxy approach based on $\delta^{18}$O and $^{87}$Sr/$^{87}$Sr tracers will be used to test and further constrain the relative importance of salinity versus temperature changes on the oxygen isotope record of the fossil shells. Unlike $\delta^{18}$O, which is sensitive to both temperature changes and salinity variations, the $^{87}$Sr/$^{87}$Sr proxy in carbonate shells is insensitive to past seawater temperatures and basically reflects the relative changes in the openness versus restriction of the lagoon with respect to an open ocean, and these are parameters that in turn control the salinities within the lagoon. Overall, this project will involve both laboratory work (i.e., sampling of drill cores and isotope analysis) and also additional fieldwork in the Coorong Lagoon.

Figures (Left): Sediment drill cores; (Centre) Aerial view on the Coorong region; (Right) Schematic cross-section of the Coorong Lagoon. Sources: P. Ellis, Van der Borch et al., 1975.
Isotope chemostratigraphy of Mid-Proterozoic carbonates in the greater McArthur Basin, NT

PREREQUISITES
There are no specific pre-requisite courses, although completion of either Geochemistry II or Earth Systems History III would be useful.

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RESEARCH PROJECT
Future advances in the exploration of Proterozoic depositional systems require the development of new and alternative correlative tools that are independent of the biostratigraphy, as the latter is limited by poor preservation of reliable microfossils (i.e., Acritarchs) and the lack of coeval macrofossils. Isotope chemostratigraphy, based on traditional and novel proxies, provides alternative means for an intra-basin correlation. The greater McArthur Basin, with proven world’s oldest hydrocarbon reserves, comprises Paleo- to Mesoproterozoic successions of the McArthur and Birrindudu Basins, likely linked in the subsurface (see Figure). The mid-Proterozoic carbonate record in these basins is dominated by dolostones, originally formed in various shallow-marine, lagoonal and sabkha/playa environments. Importantly, our preliminary isotope data ($\delta^{13}C$, $\delta^{18}O$, $^{87}Sr/^{86}Sr$) from a drill core Lv09001 in the McArthur Basin, which comprises dolomites and organic rich shales (Barney Creek Fm., ~1640 Ma), showed systematic variations in the above proxies that are tightly coupled to changes in local depositional environment, interpreted as oscillations between relatively open-marine (oxic) to more restricted (anoxic) conditions. The aim of this project is to test whether the above isotope changes can be traced across the greater McArthur Basin, and this will be tested via the analysis of presumably coeval sedimentary sequence (i.e., Lymbunia Group, dated at ~1640 Ma) exposed in the adjacent Birrindudu Basin. This university-industry funded project will be done in collaboration with Santos Ltd., thus providing unique opportunity for (i) networking, (ii) hands-on experience with modern instrumentations and isotope analytical techniques, and also (iii) a fieldwork and rock sampling in the Northern Territory.

FIGURES: Left = The greater McArthur Basin (blue outline), with McArthur and Birrindudu Basins. Centre and Right = Mid-Proterozoic dolomites of the McArthur and Balma Groups.
A novel method for Potassium-Calcium (K-Ca) dating of igneous and authigenic Minerals

PREREQUISITES
There are no specific pre-requisite courses, although completion of either Geochemistry II or Earth Systems History III would be useful.

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Project Partners: Agilent Technology (Fred Fryer), UniSA (Susie Ritch)

RESEARCH PROJECT
Reliable dating of igneous and sedimentary rocks is essential for the calibration of geological time scale and for the absolute age determination of major tectonic and depositional events throughout the Earth’s history. Such geochronological constraints are particularly important for the studies and exploration of Proterozoic basins, which cannot rely on biostratigraphy due to a lack of reliable macrofossil record. The intra-basin correlation and burial histories in Proterozoic basins can, however, be constrained via dating of selected authigenic minerals, which readily form either during the sediment depositions (i.e., glauconite), and/or during the later stages of sediment diagenesis and recrystallization (i.e., illite). This project will use a new technology, i.e., the newly installed triple quadrupole ICP MS instrument (Agilent 8900), coupled with a thermal ionisation mass spectrometer (TIMS Phoenix), to acquire high-precision K-Ca isotope data on selected samples of K-rich minerals. The K-Ca dating method will be firstly tested and validated on samples of mineral separates (i.e., biotite, muscovite, feldspar) from K-rich granite with well-constrained crystallisation age. Overall, this project will involve both laboratory and fieldwork (i.e., sampling of granite, authigenic clays) and will use the state-of-the-art analytical instrumentation available at the Uni Adelaide and UniSA, with the potential for future applications in basic and applied research. These include the K-Ca geochronology of igneous/metamorphic and tectonic events, and/or the intra-basin correlation studies relevant to hydrocarbon exploration in the Proterozoic depositional systems.

FIGURES: Left = green authigenic glauconite minerals in a thin-section of sandstone, Centre = Australian Proterozoic Basins, Right = Agilent 8900 instrument (a triple quadrupole ICP MS).
Origin of primary sedimentary Magnesites: constraints from Magnesium isotopes ($\delta^{26}$Mg)

PREREQUISITES
There are no specific pre-requisite courses, although completion of either Geochemistry II or Earth Systems History III would be useful.

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Project partners: Nature Foundation SA and CSIRO Isotope Laboratories

RESEARCH PROJECT
Although the exact origin of magnesite deposits (MgCO3) remains controversial, there are three main types of geological settings where the formation of magnesite has been documented, and these include: (i) rare sediment-hosted deposits of Precambrian ages, (ii) modern and extremely localised deposits in alkaline and ephemeral coastal lakes, and/or (iii) deposits that form in association with ultramafic complexes of all geological ages. The aim of this project is to apply novel and traditional isotope proxies, specifically magnesium, carbon and oxygen isotopes ($\delta^{26}$Mg, $\delta^{13}$C, $\delta^{18}$O), to further constrain the origin, physico-chemical conditions, and the depositional environment of Precambrian and modern sedimentary magnesites.

The former will be sampled in beautifully exposed Neoperoterozoic sections of the Willouran Ranges in the northern Flinders Ranges (see figures) with documented occurrences of extremely rare ‘primary’ carbonate-hosted sedimentary magnesites, which presumably formed directly from the Neoperoterozoic seawater (and/or modified seawater-derived brines) in evaporative shallow-water marine settings. The present-day magnesite deposits will be sampled in modern ephemeral lakes in the Coorong region (see figure), and these will be used as modern analogues for the origin of Neoproterozoic magnesites with implications for the plausible physico-chemical conditions of the coeval seawater. Such new constraints on the Precambrian ocean chemistry may shed more light on the yet unresolved “Magnesite problem”, and the acquired Mg, C and O isotope data can aid also in future exploration strategies for other larger strata-bound magnesite deposits of economic significance. Overall, this project will involve fieldwork in both the Willouran Ranges and the Coorong region, and it will also offer hands on experience in novel analytical techniques, using instrumentations at the Uni. Adelaide and CSIRO Waite Campus.

Late Delamerian post-orogenic extension and core complex, Kangaroo Island

PREREQUISITES
Geology Major and experience and enthusiasm for structural fieldwork and an interest in petrology/geochemistry!

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RESEARCH PROJECT
In the Australian margin of newly amalgamated Gondwanaland the Mid- to Late Cambrian Delamerian Orogen formed due to initiation of western Pacific subduction. The termination of the Delamerian orogeny was marked by latest Cambrian to Early Ordovician extension and exhumation (at ~490 Ma). It is possible that the spectacular migmatite sequences beautifully exposed on the southern coast of Kangaroo Island represent upper mid crustal complexes exhumed on normal detachment faults as metamorphic core complexes. Classic more modern analogues of this process are well described from Naxos in the Greek Aegean or from the US Basin and Range province. This project particularly seeks the “smoking gun” for this hypothesis... this being the identification of key controlling normal detachment fault/shear zone(s). This will require some traverses and structural mapping of outcrops in in-land creeks as well as coastal shore platforms. As well as some geochemistry and petrology, the project will also involve some thermo-geochronology (to examine exhumation histories).

Figure 1: Migmatite S. coast KI with late dyke and extensional flat-lying fabric …Is this the lower plate of KI Core Complex?
The timing and structural history of the Delamerian Orogeny based on the Monarto Granite and associated mafic rocks close to Murray Bridge

PREREQUISITES
Geology Major and experience and enthusiasm for structural fieldwork and an interest in petrology/geochemistry!

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RESEARCH PROJECT
This project will be based on fantastic outcrops of interlayered sheet-like mafic amphibolites and granites at the Kinchina Quarry near Monarto and in excellent exposed cuttings along a nearby disused railway. The Monarto granite is a fine to medium-grained granite intruded as 1-3 meter sheets and interleaved with sheets of similar thickness of mafic sills (see photos below) These intrude migmatitic Kanmantoo (Early Cambrian) sediments and have metamorphic fabrics and are folded. These are subsequently intruded by younger felsic intrusions. The project will use these unique exposures to define the relationship between the timing and composition of magma production and of structural deformation to the tectonic evolution of the Delamerian Orogeny and the development of subduction and subsequent slab rollback and tear-off. The project will require detailed mapping of quarry faces and of vertical railway cuttings and then followed up with geochronologic determinations as well as lab based geochemistry. The locations are close to Adelaide and are easily visited from an Adelaide base

Figure 1: Folded interlayering of granite, mafic rock and meta sediments in the Kanchina quarry near Murray Bridge
Unravelling the Thermal Evolution of the Amadeus Basin (Central Australia)

PREREQUISITES
Completed the Geology Major with a credit average. But most importantly, enthusiasm for research in thermal history and basin analysis. This project would suit aspiring petroleum geologists as well as students seeking postgraduate studies.

SUPERVISORS / PROJECT PARTNERS
Dr Stijn Glorie 08 8313 2206 stijn.glorie@adelaide.edu.au
Professor Alan Collins 08 8313 3174 alan.collins@adelaide.edu.au
Northern Territory Geological Survey (Chris Edgoose, Nigel Donnellan, Verity Normington, Dorothy Close)
This project is funded by the Northern Territory Geological Survey

RESEARCH PROJECT
The Amadeus Basin of Central Australia contains a complex series of sedimentary rocks dating back to the early Neoproterozoic. It started life as a part the vast Centralian Superbasin, but was isolated by the Ediacaran/Cambrian Petermann Orogeny to its south and the Palaeozoic Alice Springs Orogeny to its north. It is a producing petroleum basin with considerable on-going exploration activity. In this study we aim to examine the thermal (temperature-time) evolution of the basin using apatite fission track thermochronology. Vertical sampling profiles within drill cores will be analysed and modelled to work out the timing and magnitude of maximum burial temperatures. Given the thermal sensitivity of the applied method (~120-60°C) spanning the so-called ‘oil-window’, the student will have data to assess hydrocarbon prospectivity of the study area. Additional apatite U-Pb data will be used as a provenance tool towards integrated basin analysis.

THIS PROJECT INVOLVES:
- Drill core sampling and apatite separation
- Apatite `double dating` (U-Pb + fission track)
- Thermal history modelling using QtQT software
- Maximum burial depth, sample integration and basin analysis

Figure: example of a thermal history model derived using QTQt software on apatite fission track data. The model shows maximum burial at ~50Ma to ~100°C followed by rapid cooling to the surface. The student will use drill core samples to reconstruct similar models for the Amadeus Basin
Uncovering the low temperature thermal history of Queen Mary Land Antarctica

PREREQUISITES
Completed the Geology Major with a credit average. But most importantly, enthusiasm for research in thermochronology. This project would suit someone with ambitions for postgraduate studies in tectonics/thermochronology

SUPERVISORS
Dr Stijn Glorie 08 8313 2206 stijn.glorie@adelaide.edu.au
Prof. Martin Hand 08 8313 5324 martin.hand@adelaide.edu.au

RESEARCH PROJECT
Step into the footsteps of Douglas Mawson and other great South Australian Antarctic explorers and work on their samples taken from unique places within Antarctica to reveal the low-temperature thermal history of Queen Mary Land, Antarctica. In comparison with the more accessible continents, very little is known about the thermal evolution and exhumation history of most of Antarctica. This study will apply apatite fission track thermochronology to reconstruct the thermotectonic history of Queen Mary Land, which occupies a critical region at the interface between Archean and Proterozoic lithospheric domains. The project will potentially lead to the recognition of as yet undiscovered tectonic events, stored in the Antarctic apatite record. This is a unique opportunity to explore a largely untouched territory using archived samples, and will be the start of a more extensive appraisal of the low-temperature thermal evolution of the Antarctic continent.

THIS PROJECT INVOLVES:
- Mineral separation and apatite mounting
- Apatite double dating using Autoscan + LAICPMS instrumentation
- Thermal history modelling and integration with heat flow models

Figure: study area (red zone), field picture and example of fission tracks in apatite to be used in this project.
Constraining the India-Eurasia collision using major faults within Pakistan

PREREQUISITES
Completed the Geology Major with a credit average. But most importantly, enthusiasm for research in thermochronology. This project would suit someone with ambitions for postgraduate studies in tectonics/thermochronology

SUPERVISORS / PROJECT PARTNERS
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A/Prof Muhammad Ishaq Kakar, University of Balochistan, Pakistan

RESEARCH PROJECT
The India-Eurasia collision shaped the currently highest mountains on our planet and yet its dynamics are still poorly understood. In particular, how strain was propagated away from the collision zone to structurally weak terranes such as Balochistan (Pakistan-Afghanistan border area) is yet to be resolved. This study will focus on a number of rock samples, taken near ophiolitic fault zones within Balochistan, Pakistan, aiming to shed light on the timing of fault reactivation in response to the India-Eurasia collision. Apatites will be separated and ‘double dated’ by fission track and U-Pb thermochronology. Some additional U-Th-Sm/He data will be obtained via the John De Laeter Centre at Curtin University. Results will be modelled and integrated with previous studies in the framework of a larger project that aims to map out the thermal history of Central Asia (ARC DP project).

THIS PROJECT INVOLVES:
- Mineral separation and apatite mounting
- Apatite double dating using Autoscan + LAICPMS instrumentation
- Thermal history modelling where applicable

Figure: Balochistan study area (red zone with yellow pins being the sample locations for this study) to the northwest of the Himalayas
The tectonic evolution of the Fischer Terrane, East Antarctica

PREREQUISITES
Demonstrated strong competence (ie D or HD) in Igneous & Metamorphic Geology III and an interest in tectonic processes.

SUPERVISORS / RESEARCH GROUP
Prof. Martin Hand 08 8313 5324 martin.hand@adelaide.edu.au
Dr Laura Morrissey laura.morrissey@adelaide.edu.au
Continental Evolution Research Group, CERG (1 post-doc, 7 current PhD students)

RESEARCH PROJECT
The Prince Charles Mountains (PCMs) stretch for 600 km and provide a cross section through the edge of the East Antarctic Shield. The northern PCMs (nPCMs) form part of the Rayner Complex, which is proposed to be the continuation of the ultrahigh-temperature Eastern Ghats terrane in India. This terrane was metamorphosed at c. 1000–900 Ma and records some of the highest known temperatures for crustal metamorphism. The southern PCM (sPCM) are Archean–Paleoproterozoic rocks that record a distinctly different tectono-metamorphic history. Between the high temperature rocks of the nPCM and the Archean sPCM is the enigmatic Fisher Terrane. The Fisher Terrane comprises c. 1300 Ma intermediate and mafic rocks and probably represents an active continental margin or a collage of island arcs. There is limited systematic geochronology and no metamorphic constraints from the Fisher Terrane. The role that the Fisher Terrane played in the tectonic evolution of the region remains unclear, but it may record a phase of arc accretion that was responsible for the collisional metamorphism recorded in the nPCM.

This project will use legacy samples collected in the late 1980s and early 1990s to investigate the tectonic evolution of the Fisher Terrane. The project will involve metamorphic geology (petrology and P–T work), U–Pb geochronology and Lu–Hf analyses of zircon from different lithologies in the Fisher Terrane and petrology to constrain the origin and metamorphic evolution of the Fisher Terrane. The overall goal of the project is to understand the role of the Fisher Terrane in the assembly of Antarctica.

Figure: left: Geological map of the North Prince Charles Mountains, Antarctica showing location of the Fischer Terrane. Right: Southern margin of Fischer Massif.
**Cold and deep, the record of subduction-related metamorphism on the Gondwanan margin**

**PREREQUISITES**
Demonstrated strong competence (ie D or HD) in Igneous & Metamorphic Geology III and an interest in tectonic processes.

**SUPERVISORS / RESEARCH GROUP**
Prof. Martin Hand 08 8313 5324 martin.hand@adelaide.edu.au
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Continental Evolution Research Group, (1 post-doc, 7 current PhD students)

**RESEARCH PROJECT**
There are two projects available. The eastern margin of Gondwana records a long history of subduction associated tectonism that built the Tasman and New England orogenic belts between ~ 500-250 Ma ago. This system evolved during the progressive roll back of subduction in the western pacific. The controlling subduction system is still present today, running through New Zealand the Tonga-Kermandac arc and its continuation north and westward.

In eastern Australia the record of subduction related metamorphism is most evident in the southern New England fold belt where domains of transitional blueschist facies metamorphism record refrigerated P-T conditions over the interval ~ 320-280 Ma. This interval of time also records a complex evolution where subduction-related rocks that formed in the forearc rapidly migrated to a back arc setting as the subduction system rolled oceanward. Metamorphically this is expressed as high-temperature overprinting and partial melting of the blueschist assemblages.

While the existence of blueschist-style metamorphism is known, there has been essentially no modern work done. Additionally, significant areas of the southern New England fold belt have had no metamorphic evolution whatsoever, and therefore the extent of blueschist metamorphism may have been significantly underestimated. Furthermore, constraints on the rate of subduction roll back are poor, but readily addressed by targeted geochronology. This project would involve field sampling. The analytics of the project will utilise scanning electron microscopy, laser ablation mass spectrometry, electron microprobe analysis; and thermobarometry will involve use of software.

Figure: Left: Southern New England fold belt (subduction rocks are in light grey). Right: zoned glaucophane crystal in metabasalt from the central Tablelands Complex.
Compositional structure of the solar nebular: insights from Pallasite meteorites derived from destruction of proto-planets

PREREQUISITES
Solid competence in Igneous & Metamorphic Geology III. An understanding of chemistry would also be very useful, as well as an interest in cool stuff, the solar system and everything.

SUPERVISORS / RESEARCH GROUP
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Dr Tom Raimondo tom.raimondo@unisa.edu.au
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Continental Evolution Research Group, CERG (1 post-doc, 7 current PhD students)

RESEARCH PROJECT
Pallasite meteorites belong to the class of iron-stony meteorites, and typically consist of large crystals of olivine enclosed within a matrix of iron and nickel. They are among the rarest of meteorite classes, with only 62 known examples of the approximately 40000 meteorites that have been found. Pallasites are also considered to be the most beautiful of the meteorite classes (Figure below). They are thought to be derived from the where olivine crystals accumulated at the interface between a silicate magma ocean and an underlying liquid metal outer core of a proto-planet (Figure) that was large enough to undergo gravitationally induced differentiation.

This project will involve undertaking laser ablation trace element mapping and determination of oxygen isotopic composition of olivine crystals from a number of different Pallasite meteorites to examine the relationship between trace element concentrations and oxygen isotope compositions. The existence of oxygen isotopic anomalies in meteorites has been well established, but a great deal can be learned about chemical processes in the early solar system by combining oxygen isotopic compositions as fingerprints from different parts of the solar nebular, with trace element concentrations. The aim of this project therefore is to determine if systematic patterns exist between trace element chemistry and oxygen isotopes in pallasite meteorites as a means to explore the geochemical structure of the proto solar system.

Figure: Left: Model for the formation of the parental source for pallasite meteorites (McKibbin et al 2013). Right: Brenham Pallasite showing olivine phenocrysts with iron-nickel matrix (field of view = 10cm).
High grade metamorphism – testing models for continental collision verse continental extension

PREREQUISITES
Demonstrated strong competence (ie D or HD) in Igneous & Metamorphic Geology III and an interest in tectonic processes.

SUPERVISORS / RESEARCH GROUP
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Continental Evolution Research Group, CERG (1 post-doc, 7 current PhD students)

RESEARCH PROJECT
High temperature metamorphism represents thermally extreme conditions in the crust, and has been the focus of much work to examine how such conditions can be obtained. Fundamentally debate has centred on whether high-temperature metamorphism arises from predominantly collisional processes, or those linked to crustal extension. The difference between these scenarios has dramatic consequences for the way in which high-temperature metamorphism is used to understand the formation and evolution of orogenic belts, and for the way we envisage continental volumes to form.

The aim of this project is to quantify the high-temperature metamorphic record within the Aileron Terrane on the southern margin of the North Australian craton. Metamorphism along this margin has long been considered to record the collision/accretion of continental ribbons onto proto cratonic Australia at around 1700 Ma ago (Figure 1). However, deformation and metamorphism is also temporally associated with the development of large and long-lived extensional basins and abundant mafic magmatism that spans the orogenic interval. An alternative hypothesis is that the metamorphism records the extraction of pieces of continental lithosphere from the nucleus of proto Australia, forming a highly extended system of continental ribbons, similar to Zealandia, which rifted away from Australia around 70 Ma ago (Figure 2).

The project will involve field work focused on determining the kinematics of large-scale high-temperature shear zones within the Aileron Terrane (Figure 1). The structural framework will be allied with phase diagram thermobarometry and U-Pb geochronology with the specific aim of constraining the $P-T$–time history from metapelitic and metabasic rocks and testing the hypothesis that the tectonic record is extensional.
Thermal time scales during orogeny: using garnet to interrogate metamorphic temperature-time histories

PREREQUISITES
Demonstrated strong competence (ie D or HD) in Igneous & Metamorphic Geology III and an interest in tectonic processes.

SUPERVISORS / RESEARCH GROUP
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Continental Evolution Research Group, CERG (1 post-doc, 7 current PhD students)

RESEARCH PROJECT
The metamorphic time scales of orogeny can be determined in a number of ways: (1) direct geochronological constraints, (2) lithospheric thermal numerical modelling, (3) stratigraphic and igneous cross cutting relationships. However another way to determine thermal time scales is to interrogate the compositional record of garnet, specifically to determine the how the composition records the diffusion of elements into and out of the garnet. Diffusion of elements is controlled by the rate and magnitude of temperature change. Therefore compositional zoning in garnet can be used as a temperature-time clock that records how the thermal regime revolved.

The aim of this project is to determine the temperature evolution in the core of 450-300 Ma Alice Springs orogen in central Australia. This enigmatic and apparently very long-lived orogenic system formed well away from the active plate margin. There has been considerable research undertaken to understand why deformation would have focused into the continental interior. One possibility is that deformation was localised into areas of the lithosphere that were anomalously hot. However it is not clear if temperatures remained continuously high, or if there were cycles of heating and cooling. Because garnet zoning patterns will be quantitatively different for (a) long and continuously hot, verse (b) short-lived heating and cooling cycles, garnet compositions within the orogenic core will have recorded the thermal dynamics. The project will involve phase diagram thermobarometry and obtaining mineral compositional data with the specific aim of constraining the P–T–time history of the orogenic core. The project will also involve fieldwork.

(a) Mg zoning in garnet in contact with cordierite. (b) Computed cooling rates based on Mg zoning in (a).
Crustal heat production constraints for Antarctica: thermal boundary conditions for ice sheet modelling

PREREQUISITES
An interest in critical Earth Science problems and a desire to help inform the future. Some background in maths would be advantageous.

SUPERVISORS / RESEARCH GROUP
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Dr Derrick Hasterok derrick.hasterok@adelaide.edu.au
Continental Evolution Research Group, CERG (1 post-doc, 7 current PhD students)

RESEARCH PROJECT
The evolution of the Antarctic ice sheet is arguably the most important control on the interplay between sea level change, oceanic circulation and climate. A critical yet poorly constrained parameter in modelling the ice sheet's behaviour is the heat supplied to the base of the ice from the underlying lithosphere. This sub-glacial heat flux determines basal ice temperatures which directly affect ice sheet behaviour. The importance of this parameter is evident in the figure below (modified from Llubes et al 2006) which shows the computed temperatures at the base of the ice sheet for two different uniform magnitudes of heat flux. For a heat flux of 40 milliwatts per meter squared (mWm\(^{-2}\)) most of the base of the ice sheet is well below 0°C. For a basal heat flux of 60mWm\(^{-2}\), large areas of the basal ice are at melting point, and the ice sheet is thermally vulnerable. For reference, Australia’s heat flux ranges between 40-120mWm\(^{-2}\), with large regions characterised by fluxes greater than 80mWm\(^{-2}\). These heat flux variations are reflected in the heat generation rates of the rocks themselves. If significant areas of Antarctica were similarly elevated in heat flux to parts of Australia, as is likely due to their shared geological evolution, the ice sheet would be extremely vulnerable to a warming ocean, with the result that rapid loss of inland ice could occur if the floating ice shelves collapsed, leading to dramatic increases in sea level.

The aim of this project is to determine the crustal heat generation rates for a series of regions across Antarctica. We will use a newly developed experimental procedure that rapidly determines the U-Th-K content of samples that have been collected by historical expeditions. The data will allow us to determine the heat generation rates of the Antartica crust, and means we will be able to thermally characterise regions of different age and geological evolution. The data will form an important input into a larger project aimed at creating a crustal heat flux model for Antarctica. This heat flux model will provide a constrained thermal boundary condition for models investigating the ice sheet's long term evolution and resultant projections of climate and sea level change.
Reconstructing past plate configurations using radiogenic heat production

PREREQUISITES
Tectonics III and/or Geophysics III (open to Geology and GAG majors)

SUPERVISORS
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Alan Collins 08 8313 3174 alan.collins@adelaide.edu.au

RESEARCH PROJECT
Over a few billion years of continental evolution, plate tectonics has brought plates together and broken them into pieces many times, creating a complicated jigsaw puzzle that spans 4-dimensions. Add the processes of sedimentation, erosion and metamorphism and the existing continental architecture is a mess. This has left us with the difficult task of reconstructing past plate configurations using a complex and limited dataset that is increasingly challenging the further back in time one tries to go. This project will use geochemical, geophysical, structural and geochronologic data to reconstruct the past history of Gondwana (a supercontinent ~570 to 510 Ma). Specifically this project will focus on developing a new techniques to use radiogenic heat production and surface heat flow observations to refine and/or discriminate between reconstructions of portions of India, Madagascar and Africa.

As part of this project, you will learn to use Software for reconstructing past plate motions, develop a geochemical database, and learn to some simple thermal modelling techniques.

Figure: A reconstruction of central Gondwana
Hot (& high)?

PREREQUISITES
Geophysics III

SUPERVISORS
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Graham Heinson 08 8313 5377 graham.heinson@adelaide.edu.au

RESEARCH PROJECT
Elevation is one of the most simplistic geophysical observations we can make and often overlooked when developing models of the interior. Elevation represents the balance between buoyancy forces (thermal and compositional) and flexure in response to loads (strength of the lithosphere). Disequilibrium elevations can result from changes in any of these variables often related to mantle level geodynamic processes or resulting from tectonic processes. The focus of this project is to develop a model of the compositional and thermal effects on elevation across the Australian (or any other) continent and identify regions with disequilibrium elevations.

The aim of the project is two fold: (1) develop a model of compositional buoyancy across a continent to reveal thermal and disequilibrium contributions to elevation; and (2) develop a three-dimensional model of heat production of the lithosphere to improve the utility and/or confidence of heat flow as a predictor of the thermal state of the lithosphere. As part of this project, you will gain familiarity with seismic models of crustal structure, physical properties of rocks, the distribution of heat producing elements within the lithosphere, and Earth’s heat loss. You will contribute to developing databases (heat flow, heat production, and rock type/properties) that will be of use well into the future. Training will be provided for programming, modelling, and visualisation (Matlab/Python, GIS, GMT).

Figure: An example of using thermal isostasy derived models (b,c) to test hypotheses related to volcanism of the eastern Australian margin.
A tale of missing heat

PREREQUISITES
Geophysics III or familiarity with numerical modelling techniques

SUPERVISORS
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RESEARCH PROJECT
Heat flow observations show an extreme deficit due to vigorous hydrothermal circulation at the mid-ocean ridge. This deficit continues until ~65 Ma at which point heat flow is indistinguishable from physically based cooling models. Globally, this power deficit totals nearly 30% (8×10^{12} watts) of the heat lost through the ocean floor. Because heat flow is measured near the surface and the heat extraction is distributed vertically, there is a time lag between the cooling of the subsurface and the thermal response at the surface. A single model developed independently of observations provides an estimate of the lag time but is based on a single set of model assumptions. The goal of your project will be to develop a suite of numerical models that fit heat flow observations. By doing so, you will provide estimates (and uncertainties) for the depth extent of circulation and magnitude of heat extraction from young oceanic lithosphere as a function of time.

Training will be provided for programming and numerical modelling (Matlab/Python/C).

Figure: The process of heat transport in young oceanic lithosphere. Hydrothermal circulation in the oceans redistributes ~8 TW (8×10^{12} watts).
**Radioactive**

**PREREQUISITES**
Geophysics III or Tectonics III (open to Geology and GAG Majors)

**SUPERVISORS**
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**RESEARCH PROJECT**
Heat generated by radioactive decay within the lithosphere accounts for 40% of heat loss through the continents, but it varies greatly by region---perhaps as little as 10% to as much as 70%! Most of our models of crustal heat generation are based on surface observations; however, the distribution of heat producing elements (HPEs: U, Th, and K) affects temperatures throughout the lithosphere, which in turn determines lithospheric thickness. So we desperately need better models of lithospheric heat generation. Your task will be to develop a 3-dimensional model of heat production based on observations and geophysical and petrologic proxies.

The geographical and/or topical focus area may be tailored to your interests. Possible topics include:

- chemical differentiation of Precambrian environments;
- sources of anomalously high heat loss in Australia’s interior;
- lower crustal heat generation: reasonable estimates and the effect on tectonic stability?;
- the evolution of HPEs through geologic history (see figure below); and
- the relative role of heat production in active tectonic environments.

![Heat Flow vs Tectonic Age](image)

Figure: The present day global heat flow function of thermo-tectonic age displays a curious repeated pattern of surface heat flow. One possible avenue can focus on this unexpected result.
Variable: Heat production from the micro to macro scale

PREREQUISITES
Geophysics III (Stats recommended)

SUPERVISORS
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RESEARCH PROJECT
How many analyses and what type of sampling produce a representative estimate of heat production and its variability? In this project, you will explore this issue by making surveys at several spatial scales from aerial, outcrop, hand sample, and geochemical analyses.

Radioactive decay of uranium and thorium provide most of the heat generation within rocks. Because both of these elements are found in trace quantities, geochemical samples are subject to a “nugget” effect, i.e., one sample may be high while another low from the same hand specimen. Likewise, selection of the hand specimen and outcrop from which the hand specimens are chosen are variable. So how representative are our data? At what point does an average of the data represent the average of a formation useful for modelling? How many samples do we need to collect to reasonably characterize the average? Since few studies include a comprehensive exploration of heat generation within a study area, your results will have significant ramifications for geothermal models of the lithosphere. In addition, the nature of U and Th variability may also be extended to trace elements, potentially affecting the way geochemists must sample rocks for reliable analyses.

Figure: Heat production variability. (a) Heat production of granodiorite from the Sierra Nevada Batholith. Note heat production varies over an order of magnitude. (b) Theoretical estimation of mean heat production from different sample sizes (e.g. pick three rocks, how likely is it to represent the average?).
A new thermal conductivity model

PREREQUISITES
Geophysics III, (Maths IA and IB recommended)

SUPERVISORS
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Martin Hand 08 8313 5324 martin.hand@adelaide.edu.au

RESEARCH PROJECT
Frankly, this project sounds as boring as dirt, but if successful, it has a potentially very high impact.

Thermal conductivity is an essential physical property required to model heat flow and temperature in the Earth’s interior. Without good estimates, we can be off by hundreds of degrees (we’re usually not quite that bad). Laboratory measurements of rocks allow us to estimate many physical properties on the basis of their mineralogic or major oxide composition alone. However, it is very difficult to do so for thermal conductivity due to the lack of the right type(s) of data. In this project, you will develop two new methods to estimate the thermal conductivity of plutonic rocks based on their mineralogy and major oxide composition. This project will require measuring a wide range of plutonic rocks for (1) thermal conductivity measurements using an optical thermal conductivity scanner, (2) major element chemistry using XRF data, and (3) modal mineralogy using either thin-sections or new core scanning technology such as QEMSCAN. A mineralogical model for thermal conductivity will then be constructed using inverse methods and tears. The results of your model will likely be incorporated into many future geodynamic and geophysical models for years to come.

Figure: Starting from rocks like that on the left, you could develop a model like the one on the right that allows for reliable estimation of thermal conductivity as well as develop relationships to other physical properties such as P-wave velocity.
Getting more from AusLAMP

**PREREQUISITES**
Geophysics 3, with an interest in field surveys, data processing and modelling (more than one student as this is a BIG program)

**SUPERVISORS / PROJECT PARTNERS**
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**RESEARCH PROJECT**
A significant challenge for the global mineral exploration industry is to identify the deep signature of world-class mineral deposits and the conceptual understanding of the scale at which mineral systems operate. The ultimate objective driving developments in this research direction has been articulated by the Australian Academy of Sciences, with the statement: “To target major new economic mineral deposits under cover, the global mineral exploration industry needs a better understanding of the architecture of the whole lithosphere that focuses magmas and fluids to produce large deposits or deposit clusters.” (UNCOVER, Searching the Deep Earth 2012). Magnetotellurics (MT) is a deep-imaging technique that can determine the electrical resistivity of Earth’s crust and mantle laterally and vertically, and to depths of hundreds of kilometres. The resistivity of Earth materials is dependent on the temperature and movement of fluids, and so by mapping the Earth in three dimensions we image the Earth’s history.

To image the structure of the continent to depths of hundred kilometres requires a grid of MT sites across the nation. The Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP) is an ambitious program to obtain a complete set of magnetotelluric site measurements with spacing on average 55 km. Logistics of the survey are onerous; equipment needs to be deployed on the ground for about three weeks, often in very remote locations. Crews work using cars and helicopters, and generally only deploy two sites per day. With over 2800 sites to cover the country, the program will take over a decade to complete. Since 2014, over 350 new sites have been completed (as above).

We are mostly modelling data using the ModEM 3D inversion code (Egbert and Kelbert, 2012; Kelbert et al., 2014) but there are other approaches that may equally fit the data well.

In this project we will compare AusLAMP outputs using ModEM with other available codes, notably different 2D and 3D inversions, thin-sheet inversions and other numerical methods. The aim of this project is to better understand the AusLAMP data and get more useful geological insights.
Understanding MT models: Joint inversion and model uncertainty

PREREQUISITES
Geophysics 3 and a strong interest in numerical modelling

SUPERVISORS
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Adam Luo adam.luo@adelaide.du.au

RESEARCH PROJECT
In numerical modelling, with the new generation of computers, we can increasingly generate more complex 2D and 3D inversions from any set of data. But have we really made any progress?

Two key aspects of modelling still elude us:

(1) How much confidence can we have on any part of the model; and
(2) How does it relate to any other geophysical or geochemical data?

In other words, what should we believe from the models?

In this study, we’ll use simple 1D, 1D anisotropic, and 2D model algorithms to better understand MT data. Bootstrap methods will be used to quantify uncertainty on model parameters. Joint inversion will be examined using a combination of parameter and structural approaches.

Our goal will be to better explain what we can determine of the sub-surface and link this with other information.

![MT Resistivity Cross Section](image)

*Figure 1: A beautiful MT resistivity cross section across Olympic Dam. However, is it the truth?*
The response of monazite and zircon to metamorphism

PREREQUISITES
Interest in metamorphic geology and tectonic processes, and competence in Igneous & Metamorphic Geology III

SUPERVISORS / RESEARCH GROUP
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Continental Evolution Research Group, CERG (1 post-doc, 7 current PhD students)

RESEARCH PROJECT
Monazite and zircon are U–Th bearing accessory minerals that are essential in determining the timing and duration of igneous and high-grade metamorphic conditions. However, because monazite and zircon have different chemical behaviours during high-temperature processes, they record different parts of the thermal history. Zircon is generally less chemically reactive than monazite, and therefore zircons that already exist in a rock are more resistant to recording new thermal events compared to monazite. However, the specific conditions that control the reactivity of monazite and zircon, and therefore their ability to grow during metamorphic events are still very poorly understood. This is surprising given the immense effort and expense (hundreds of millions of dollars and person hours) that has gone into analysing these minerals for geochronology.

The aim of this project is to analyse the U–Pb isotopic compositions of zircon and monazite from the same samples to determine what they record during the evolution of a single tectonic event. An additional aim of the project is to analysis monazite and zircon from interlayered rocks of different composition that share the same thermal history to determine the effect of rock composition on the chemical behaviour of zircon and monazite and therefore the effect of rock composition on what the age data obtained from these minerals means about the timing and duration of tectonic event. The projects will involve phase diagram thermobarometry to constrain the P–T conditions associated with zircon and monazite growth, as well as obviously, U-Pb age data from monazite and zircon.

Figure: Electron microscope images of zircon and monazite in samples of high-grade metapelite. The grains are sitting next to each other, but do they record the same thing?
Metamorphic conditions of Gondwana amalgamation: an Antarctic perspective

PREREQUISITES
Demonstrated strong competence (ie D or HD) in Igneous & Metamorphic Geology III and an interest in tectonic processes.

SUPERVISORS / RESEARCH GROUP
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Continental Evolution Research Group, CERG (1 post-doc, 7 current PhD students)

RESEARCH PROJECT
There are two projects available. The amalgamation of Antarctica during the c. 500–600 Ma Pan-African Event involved collision of the Prydz Bay region of east Antarctica with India. The paucity of outcrop in Antarctica makes Prydz Bay a critical location for constraining Gondwana-related amalgamation processes. To that end, the granulite facies exposures in Prydz Bay have been studied in some detail. However, despite their importance, there remains no detailed modern work aimed at constraining the pressure–temperature–time evolution of these rocks. As a consequence, there is considerable conjecture about the timescale of orogenesis and the metamorphic P–T path.

Prydz Bay records ultrahigh-temperature (>900 °C) metamorphism and as a result contains very spectacular metapelitic and partially melted metabasic rocks. Both projects will involve phase diagram thermobarometry and obtain U-Pb age data with the specific aim of constraining the P–T–time history from metapelitic and metabasic rocks. The analytics of the project will utilise scanning electron microscopy, laser ablation mass spectrometry, electron microprobe analysis; and thermobarometry will involve use of software. The project outcome will be resolution of conjecture about timing and timescale of granulite facies metamorphism during Gondwana amalgamation.

Figure: left: Prydz Bay; middle: garnet-bearing metabasite in outcrop; right: location of Prydz Bay and project areas.
Behaviour of metamorphic monazite during prograde metamorphism and partial melting

PREREQUISITES
Demonstrated strong competence (ie D or HD) in Igneous & Metamorphic Geology III and an interest in tectonic processes.

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RESEARCH PROJECT
Monazite, ([LREE,Y,Th,U,Ca][Si,P]O4), is an extremely important mineral for obtaining U–Pb age data from rocks. Age data provides crucial information about timescales and rates of high-temperature metamorphic and tectonic processes. However, this is only the case if it is known where along a rocks P–T evolution path monazite grew. In addition, monazite is the most common reservoir of thorium (Th) in Earth’s crust, and thus controls on monazite growth are important in the context of understanding the distribution of radiogenic heat production. This project is part of a larger, ongoing PhD and federally-funded Australian Research Council project that seeks to develop a predictive framework that systematically links Th and uranium (U) concentration and radiogenic heat production in Earth’s crust to the primary mineralogical, melt and rock compositional controls on the stability of Th–U-bearing phases.

The aim of this project is to characterise the composition, abundance and age of Th–U-bearing minerals in rocks from rocks of low-amphibolite through to granulite-facies metamorphic grade, in a pressure–temperature context, in order to constrain the metamorphic mineral reactions that produce and destroy monazite. Samples for the project are from the world famous Ivrea–Verbano Zone in Italy. The analytical program will involve petrography and use of scanning electron microscopes (SEMs), electron microprobe and lasers. The output for the project will be a comprehensive compositional and age dataset and the outcome will be a much-enhanced understanding of the metamorphic behaviour of monazite and other Th–U minerals. This will provide vital information required to link monazite age and compositional information to specific points along a rocks P–T path.

Figures: left: Geological map of the Ivrea-Verbano zone, Italy exposing a near full crustal section. Right: Th-variation in monazite (cool colours are Th-poor, hot colours are Th-rich).
Refining the temporal and physical record of metamorphism during the Delamerian Orogeny

PREREQUISITES
Demonstrated strong competence (ie D or HD) in Igneous & Metamorphic Geology III and an interest in tectonic processes.

SUPERVISORS / RESEARCH GROUP
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RESEARCH PROJECT
The Ross-Delamerian Orogen is a large orogenic belt that developed diachronously along the eastern margin of Gondwana between c.580-480 Ma. Metamorphism involved high geothermal gradients resulting in low-pressure high-temperature metamorphism and abundant magmatism. In South Australia, the Ross-Delamerian system is well exposed on the Fleurieu Pensinula and Kangaroo Island. This proximity has resulted in a wealth of work focused on the deformational, metamorphic and igneous evolution of the orogen. However there is essentially no quantitative work on the metamorphic evolution, nor are there direct high-temperature metamorphic age constraints. Existing age constraints come from stratigraphic and igneous rock relationships, the latter of which are often ambiguous. These have been used to suggest that deformation was finished by 493 ± 1 Ma (Foden et al. 2006). However recent monazite U-Pb data acquired by us (Bockmann unpublished; 2016), from pristine granulite facies metapelite at in the Eastern Mt Loftey Ranges gives an age of 483 ± 4 Ma. This is significantly younger than the inferred end of tectonism, and suggests the duration of high-temperature metamorphism is much longer than previously thought.

The aim of this project is to: (1) systematically determine the age of syn-metamorphic monazite at different metamorphic grades within the Delamerian Orogen and (2) to use mineral equilibria forward modelling to determine the P-T evolution of the age constrained rocks. The result will be a spatial and temporal model for the thermal evolution of Delamerian segment of Ross-Delamerian Orogen. The project will involve phase diagram thermobarometry and obtaining U-Pb age data with the specific aim of constraining the P–T–time history from metapelitic and rocks. The project will involve fieldwork, and has the great advantage that the field areas are readily accessible.

Cordierite-orthopyroxene-spinel-bearing metapelite
Reedy Creek.
Cordierite-orthopyroxene bearing metapelite
Reedy Creek.
Fluid flow through fractures in Australian sedimentary basins

PREREQUISITES
Structural Geology II, Tectonics III and/or Minerals and Energy Resources III.

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RESEARCH PROJECT
Faults and fractures can control the leakage and migration of fluid in the subsurface (e.g. water, CO₂ and hydrocarbons). Fluid flow through fractures results in cementation of those fractures, which may result in those fractures behaving as baffles to fluid flow in the subsurface. Predicting fluid flow through fracture systems is vital for the water resource, petroleum, uranium and geothermal industries, as well as understanding natural hazards (i.e. earthquakes). More than this the geochemical and geomechanical signature of fracture cements provides an understanding of palaeostress and of basin fluids through time, allowing for an understanding of basin evolution. This is particularly important for the petroleum and uranium industries.

This project will use core samples from fractured rock in the Perth, Amadeus, Surat and Bowen basins to determine the geomechanical and geochemical signature of naturally occurring fracture cements. The project may utilise the Calcite Stress Inversion Technique, isotope analysis, mineral mapping and petrology. The findings will be used to make detailed interpretations of fracture genesis and basin evolution.

Figure: Thin section of a cemented fracture from the Otway Basin displaying several crack-seal events inferring several fluid flow events during the basin’s history.
Was Earth really a snowball?
Detailed facies analysis and 3D modelling of the Elatina Formation, Pichi Richi

PREREQUISITES
Structural Geology II, Sedimentary Geology II, Earth Systems History III.

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RESEARCH PROJECT
The Elatina Formation crops out at Pichi Richi Pass in the southern Flinders Ranges. As a whole the Elatina Formation is believed to have been deposited under glacially influenced conditions (Lemon & Gostin, 1990), representing the Marinoan Glaciation occurring some 650 million years ago. The Marinoan Glaciation is consistent with Snowball Earth theory, where it is considered that Earth was completely covered in ice caps from the poles to the equator (Hoffman et al., 1998). However, outcrops just in Pichi Richi Pass alone suggest otherwise. A complete ice cap would result in closed oceans with no free air surface to generate waves and currents implying that deposition would only be by pelagic processes. At Pichi Richi there is evidence that the Elatina Formation was deposited by many varying currents from shallow marine currents that generated sequences with trough cross-bedding with heavy mineral lamellae to thinly bedding tidal rhythmites (Williams, 1981). This project aims to map out the variability of the depositional environment during the Marinoan Glaciation and build a 3D model of the palaeogeographic environments for the Elatina Formation to understand the complex depositional system of the Snowball Earth. This project will combine field mapping, sedimentary logging, drone photography, structural restoration and 3D modelling using Petrel. This project is for TWO students that will work on different outcrops within Pichi Richi Pass and further north in the Flinders Ranges.

Figure: Measuring the orientation of bedding at Pichi Richi Pass.
Alteration mineralogy and distal footprints of mineralisation in the Ernest Henry near-mine environment, NW Queensland

PREREQUISITES
Mineral and Energy Resources III, interest in ore deposit geology and geochemistry. Cover letter and C.V. required demonstrating willingness to work in mining industry.

SUPERVISORS / PROJECT PARTNERS
Richard Lilly 08 8313 0686 richard.lilly@adelaide.edu.au
Calum Fullelove (MIM RD Exploration Geologist)

RESEARCH PROJECT
This study will complete detailed geochemical characterisation of alteration minerals from several near-mine exploration targets close to the Ernest Henry (Cu-Au) Mine. This project will build on previous detailed ore and alteration paragenetic studies and aims to be able to provide a set of field-practical tests to help field geologists to determine mineralogy on a series of key alteration minerals that are common within both mineralised and unmineralised target areas. The project will also compile top-of-basement geochemical data for the near-mine area to assess alteration zonation and distal footprints.

Research methods will include drill core inspection and sampling, paragenesis studies using optical microscopy, secondary electron microscopy (SEM) and compositional analysis using Mineral Liberation Analysis (MLA) and LA-ICP-MS.

Fieldwork expenses and logistics will be covered by Mount Isa Mines and fieldwork is expected to last for between 2 and 3 weeks during March-April 2017.

Figure 1, Cloncurry is renowned for its complex overprinting alteration halos (left). This project aims to characterise different near-mine alteration halos to aid the evaluation of prospectivity for several advanced exploration targets.
Geochemical characteristics of pyrite at the Ernest Henry (Cu-Au) deposit, NW Queensland

PREREQUISITES
Mineral and Energy Resources III, interest in ore deposit geology and geochemistry. Cover letter and C.V. required demonstrating willingness to work in mining industry.

SUPERVISORS / PROJECT PARTNERS
Richard Lilly 08 8313 0686 richard.lilly@adelaide.edu.au
Brad Miller (Ernest Henry Senior Geologist)

RESEARCH PROJECT
Recent research has identified several features within the Ernest Henry (Cu-Au) ore body that require the currently accepted ore deposit model to be reviewed. This project will focus on geochemical variation between the ‘Ernie Junior’ ore body, the ‘Interlens’ structural feature and several near-mine exploration targets. Careful analysis of existing and newly collected core samples will establish if any geochemical variation exists between pyrite species from each location and whether these can be used as a vector to mineralisation.

Research methods will include drill core inspection and sampling, paragenesis studies using optical microscopy, secondary electron microscopy (SEM) and compositional analysis using Mineral Liberation Analysis (MLA) and LA-ICP-MS.

This project is a wonderful opportunity for a student to work in collaboration with mine geologists at a significant Australian IOCG deposit and to gain invaluable experience in the mining industry. Fieldwork expenses and logistics will be covered by Mount Isa Mines and is expected to last for ~2 weeks during March-April 2017.

Figure 1, A) Ernest Henry underground mine cross section with Inter-lens and Ernie Junior, B) Ernest Henry open pit, C) Typical Ernest Henry (Cu-Au) ore hosted in Proterozoic volcanics.
Geochemical variation of pyrite at the Mount Isa (Cu-Zn-Pb) deposit, NW Queensland

PREREQUISITES
Mineral and Energy Resources III, interest in ore deposit geology and geochemistry. Cover letter and C.V. required demonstrating willingness to work in mining industry.

SUPERVISORS / PROJECT PARTNERS
Richard Lilly 08 8313 0686 richard.lilly@adelaide.edu.au
Dan Taylor (Mount Isa Mines Project Geologist)

RESEARCH PROJECT
This study will complete detailed geochemical characterisation of trace element geochemistry of pyrite from different ore bodies of the giant Mount Isa copper system, building from work completed during 2016. Establishing the differences in trace element geochemistry will establish whether the Cu and Zn-Pb ore bodies were formed coevally from the same hyper-saline fluids, or whether there were episodic ore forming events from an evolving fluid source. Defining the individual signatures of the different ore bodies will have direct implications for potential depth extensions to the ore body and for near mine exploration.

Research methods will include drill core inspection and sampling, paragenesis studies using optical microscopy, secondary electron microscopy (SEM) and compositional analysis using Mineral Liberation Analysis (MLA) and LA-ICP-MS.

This project is a fantastic opportunity for a student to gain invaluable experience in the mining industry. Fieldwork expenses and logistics will be covered by Mount Isa Mines and is expected to last for ~2 weeks during March-April 2017.

Note: Because a large number of samples are currently held by the department this project also has the option to be completed entirely in Adelaide with no fieldwork component.

Figure 1, A) Mount Isa Mines underground copper operation with the ore bodies (pink shell is 2.5% Cu cut-off). The project aims identify geochemical variation within the individual ore bodies to aid understanding of how the deposit formed.
Geochemical characteristics and paragenesis of the Lady Loretta (Zn-Pb-Ag) deposit, NW Queensland

PREREQUISITES
Mineral and Energy Resources III, interest in ore deposit geology and geochemistry. Cover letter and C.V. required demonstrating willingness to work in mining industry.

SUPERVISORS / PROJECT PARTNERS
Richard Lilly 08 8313 0686 richard.lilly@adelaide.edu.au
Nick Spanswick (Lady Loretta Senior Geologist)

RESEARCH PROJECT
The Lady Loretta Zn-Pb (Ag) deposit in North West Queensland is believed to be a member of the Mount Isa SEDEX style of mineral system. However, very little research has been conducted on the ore body and no ore deposit model specific to Lady Loretta has ever been generated. Establishing the mineralogical and alteration paragenesis and the generation of 3D geochemical constraints on ore zonation (using Leapfrog) will enable a model of ore genesis to be established. Data from Lady Loretta will also be compared to other district Zn-Pb deposits and will have operational and exploration implications.

Research methods will include drill core inspection and sampling, paragenesis studies using optical microscopy, secondary electron microscopy (SEM) and compositional analysis using Mineral Liberation Analysis (MLA) and LA-ICP-MS.

This project is a wonderful opportunity for a student to work in collaboration with mine geologists. Fieldwork expenses and logistics will be covered by Mount Isa Mines and is expected to last for ~3 weeks during March-April 2017.

Figure 1, geological setting and cross-section of the high-grade Lady Loretta Deposit. The 1990 resource estimate was 8.3Mt at 18.4% Zn, 8.5% Pb and 125g/t Ag (with 12% Zn equiv cut off), which equates to an ore body containing at least 40% combined sphalerite and galena. This project aims to generate the first ore deposit model for this high-grade system.
Rainforest structure from the isotope ratios of leaves

PREREQUISITES
Desirable courses: Geochemistry II, Earth Systems History III.
Desirable background: Botany, Ecology.
Laboratory and field experience appreciated but not required.

SUPERVISORS / PROJECT PARTNERS
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RESEARCH PROJECT
Forests are often categorized in terms of their structure and whether the uppermost layer of foliage, called the canopy, is open or closed. The degree to which a canopy is closed controls the penetration of light, relative humidity and concentration of CO₂ in the lower parts of the forest. This in turns influences plant and animal communities, nutrient cycling and the interaction of the forest with climate through evapotranspiration, albedo and carbon cycling. The degree of closure of the canopy also influences the carbon isotope signatures of the plants. As a consequence, it is possible, in theory, to use the carbon isotope signature of fossil leaves to reconstruct the degree to which ancient forests were open or closed. Reconstructing ancient canopy structure has implications for understanding the evolution of ecosystems and their influence on biogeochemical cycles and climate over geologic time.

The application of carbon isotope ratios of plants to reconstructing ancient forest structure has been developed based on modern day forests in North America and Central America. Therefore, an Australian calibration is needed for Australian fossil floras. This project aims to develop this isotopic proxy for Australian forests by analysing leaves from the JCU Daintree Rainforest Observatory in Queensland.

Figure: Daintree Rainforest Understory (left) and Canopy Crane (right).
Climate change and the extinction of Australian megafauna: evidence from cave sediments

PREREQUISITES
Desirable courses: Geochemistry II, Earth Systems History III.
Desirable background: Climate Change, Chemistry, Ecology.
Laboratory experience appreciated but not required.

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RESEARCH PROJECT
The cause of the extinction of the Australian megafauna 40-50 thousand years ago is an area of vigorous debate. Humans have been implicated as a possible culprit through hunting or alteration of the vegetation through fire. An alternative hypothesis is that climate change drove these large animals to extinction. The aim of this project is to explore the evidence for climate and ecosystem change preserved in the isotope ratios of fossil rat teeth and/or snails from South Australian cave deposits. Those caves represent some of the most important archives of megafaunal bones in Australia, and this is therefore an opportunity to make a direct assessment of the role of climate change in mass extinction. Oxygen isotope ratios will be measured to reconstruct surface water conditions and carbon isotope ratios will be measured to reconstruct the photosynthetic pathway of the rat/snail diet.

The emphasis will be on isotopic analysis with potential opportunities for field work on Kangaroo Island or Naracoorte Caves. Two student projects will be available in this area.

Figure: Pleistocene megafauna assemblage from Victoria Fossil Cave, Naracoorte. Image from Liz Reed, e-Science, July 2015.
Do plant waxes record their environment?

PREREQUISITES
Desirable courses: Geochemistry II, Earth Systems History III.
Desirable background: Botany, Ecology.
Laboratory and field experience appreciated but not required.

SUPERVISORS / PROJECT PARTNERS
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RESEARCH PROJECT
The waxes that protect plant leaves contain compounds that can be preserved in sedimentary rocks for hundreds of millions of years. These leaf wax compounds are used in palaeoenvironmental research to reconstruct vegetation and climate. Interpreting leaf wax records in the geologic past requires an understanding of how these signatures are controlled in the modern. We have demonstrated that the leaf wax composition of sticky hop bush, Dodonaea viscosa, varies in response to aridity across South Australia. The unsolved question is whether the pattern we observe in different populations is genetically fixed (e.g. the result of natural selection) or plastic (e.g. able to change in direct response to climate). To test this, we have collected leaves and seeds of wild plants from across a range of aridity conditions. We then grew these seeds into plants in a greenhouse. The plants grown from seed in a common greenhouse environment have different genotypes but a common climate. If the differences in the wild plants are found in the greenhouse plants, then the waxes are genetically rather than environmentally controlled. If the greenhouse plants have the same composition in spite of having different genotypes, this would provide evidence that the plants alter their composition in direct response to their environment. This project will tackle these fundamental questions about how plants produce signatures that are interpreted in terms of palaeoclimate and palaeoecology.

Figure: Greenhouse experiment to examine the controls on plant wax composition.
Coulomb stress models for earthquake interaction and forecasting

PREREQUISITES
Good computer skills including the willingness to learn and use Matlab

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RESEARCH PROJECT
Coulomb stress changes following moderate to large earthquakes affect the timing and location of subsequent events. For instance, stress changes from the 2010 Darfield earthquake triggered an earthquake 5 months later which badly damaged Christchurch. A range of projects are available to investigate various aspects of Coulomb triggering including the benefit of including fault information in Coulomb maps, the circumstances in which these stress changes trigger large events, and the extent to which they can be combined with statistical models to forecast earthquake rates.

Map of Coulomb stress changes due to the M = 6.5 Cook Strait earthquake. Red and yellow areas experienced stress changes that could trigger further earthquakes. The black star indicates the epicentre of the M = 6.5 Grassmere earthquake which was likely triggered by the change in stress.
Reconstructing past polar jet dynamics via sea spray traces in Antarctic lake sediments

PREREQUISITES
Ideal but not prerequisite: Geochemistry 2 and Earth Systems History 3.

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RESEARCH PROJECT
The large scale wind pattern known as the Southern Polar Jet plays a critical role in the global climate system: it determines the amount of precipitation in the mostly arid southern continents; it drives ocean upwelling, which in turn drives CO₂ capture/release by the Southern Ocean; and it effects the production and distribution of marine aerosols, which act to cool climate by shading incoming sunlight.

Determining the long term patterns of variability in the Southern Polar Jet over decades-centuries is challenging due to an absence of records beyond the last ~ 50 years. However, it is proposed that the position and strength of the Polar Jet is reflected by chemical traces of sea spray preserved within lake sediments in coastal Antarctica.

Here, we will explore that prospect using unique sediment core samples from two lakes in Lützow Holm Bay, Antarctica (see Rudd et al. 2016 for more background). Inductively coupled plasma mass spectrometry (ICP-MS) will be used to measure the concentrations of trace elements that are uniquely associated with marine aerosols. Additional analyses could include mineral grain size analyses to determine patterns of past dust deposition.

Modelling isotopes in global rainfall

PREREQUISITES
Ideal but not prerequisite: Geochemistry 2 and Earth Systems History 3.

SUPERVISORS
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RESEARCH PROJECT
The oxygen and hydrogen isotope composition of precipitation (δ¹⁸O₀, δ²H) are key geochemical tracers, used to reconstruct past climates (e.g. from ice cores, speleothems, lake sediments) and to trace hydrological processes. Despite this, the causal relationships between δ¹⁸O₀ and climate variability are poorly constrained, both from a physical and statistical point of view. Part of the problem is that global monitoring networks sample rainfall on a monthly basis, and thus fail to capture patterns on the hourly-daily timescales that actually matter for rainfall events. Studies which do examine daily scale variability (e.g. Tyler et al. 2015) highlight inconsistencies with common assumptions applied to much palaeoclimate research. It is proposed that by studying isotope patterns on daily timescales, we might better understand the mechanisms that drive changes over thousand-year timescales.

In this project we will mine the extensive global database of monitored isotopes in rainfall (Global Network Isotopes in Precipitation). We will also establish a southeastern Australia monitoring network to collect new data for our region. We will employ a novel approach, outlined by Fischer and Baldini (2011), to identify the daily scale predictors of δ¹⁸O₀, based on monthly scale monitoring data. We will test the hypotheses that statistical relationships vary both geographically (e.g. with latitude) and with season.

Although this project will involve some field and lab work, it would principally suit a student with an interest in desk based ‘big data’ statistical programming, mapping and modelling, applied to fundamental questions in climatology and geochemistry. The student will gain training and experience in computational techniques, which are transferrable to a wide range of research and career pathways.

Geochemical fingerprinting ‘young’ volcanic ash in south-eastern Australia

PREREQUISITES
Ideal but not prerequisite: Geochemistry 2 and Earth Systems History 3.

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RESEARCH PROJECT
When a volcano erupts, traces of ash (tephra) disperse widely, crossing oceans and sometimes even circumnavigating hemispheres. When these tephra accumulate in marine and terrestrial sediments, they provide invaluable time-parallel marker horizons, or isochrons, which can be used to correlate geographically distant sedimentary sequences. Tephra isochrons are particularly useful when correlating records of past climate and palaeontological change – for example to examine the relative timing of Quaternary climate change and mass extinction in Australia.

The use of tephra to correlate and date sediments (tephrostratigraphy) has received limited attention in Australia to date. For example, the recent discovery of ~5000 year old volcanic glass shards in lake sediments in Victoria (Smith et al. 2016) is a first for Australia. Those glass shards are thought to have originated from either the Mt. Gambier or Mt. Schank, South Australia, Australia’s youngest volcanoes. However, deciphering the origin of volcanic glass shards in sediments requires a fingerprint: a geochemical signature unique to a particular volcano or eruption.

This project will entail the identification of geochemical fingerprints for several volcanoes in the Newer Volcanic Province (NVP) of Victoria and South Australia, all of which are younger than 100,000 years old. Previous research indicates that the major elemental composition of NVP tephra are not always unique, therefore, we will explore the use of trace elemental and isotope geochemistry. The project will include some fieldwork, followed by lab intensive geochemical analyses to provide essential groundwork for the application of tephrostratigraphy in Australia.