



GEOS207

Field and Laboratory Studies in Geoscience

S1 Day 2016

Dept of Earth and Planetary Sciences

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Disclaimer

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General Information

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Credit points

3

Prerequisites

GEOS125

Corequisites

Co-badged status

Unit description

This unit integrates projects, lectures and laboratory classes to develop theoretical knowledge and hands-on experience needed to map, describe and interpret rocks in the field and laboratory. Field studies involve remote sensing methods, conventional air photo interpretation and ground-based observations of rock types, rock structures and the relationship between geology and topography. Laboratory studies include the preparation of materials for optical and X-ray diffraction studies and the identification of minerals using these methods.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at <https://www.mq.edu.au/study/calendar-of-dates>

Learning Outcomes

On successful completion of this unit, you will be able to:

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to typify the bedrock controls on landforms and geomorphology
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
- Develop the skills needed to interpret the significance of microstructures in geoscience materials
- Develop the skills needed to undertake projects of a complex nature
- Develop the skills needed to report on the results of common geochemical laboratory techniques such as x-ray diffraction, x-ray fluorescence, and electron microprobe analysis
- Develop the skills needed to describe and analyse simple field structures, including strike/dip of inclined strata, angular relations across unconformities, the style and attitude of folds, and the types of faults and their displacement
- Develop the skills needed to interpret cross-cutting relationships in the field and laboratory to determine the sequence of geoscience events for a given problem
- Understand how to apply geoscientific principles to understanding the world around you
- Understand how to access, use and synthesise appropriate information
- Develop effective team work skills
- Understand how to present ideas clearly with supporting evidence in a number of formats

General Assessment Information

The assessment consists of several components, listed below.

Case study	20%
Online quizzes	20%
Final examination	60%

Assessment Tasks

Name	Weighting	Due
Forensic science part 1	5%	Monday Week 4
Forensic science part 2	5%	Monday Week 7
Forensic science part 3	10%	Monday Week 10
Weekly Quizzes	20%	Each week
Final examination	60%	Examination period

Forensic science part 1

Due: **Monday Week 4**

Weighting: **5%**

Part 1: Online quiz – download the questions, make the calculations (mineral classifications from EMP and U-Pb data plotting to determine dates) and then complete the quiz (25% of case study)

On successful completion you will be able to:

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
- Develop the skills needed to interpret the significance of microstructures in geoscience materials
- Develop the skills needed to undertake projects of a complex nature
- Develop the skills needed to report on the results of common geochemical laboratory techniques such as x-ray diffraction, x-ray fluorescence, and electron microprobe analysis
- Understand how to apply geoscientific principles to understanding the world around you
- Understand how to access, use and synthesise appropriate information
- Understand how to present ideas clearly with supporting evidence in a number of formats

Forensic science part 2

Due: **Monday Week 7**

Weighting: **5%**

Part 2: Rock table, XRF data and petrographic description (25% of case study)

o Complete the table downloadable from iLearn, with the descriptive geologic sample names (e.g. biotite-muscovite schist) you have determined for the unknown rocks from your petrographic analysis and which unit it most likely matches on the geologic map (if any)

o Plot the XRF data onto the exploration classification figure provided o Write one full petrographic description – with copious illustrations

On successful completion you will be able to:

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
- Develop the skills needed to interpret the significance of microstructures in geoscience materials
- Develop the skills needed to undertake projects of a complex nature
- Develop the skills needed to report on the results of common geochemical laboratory techniques such as x-ray diffraction, x-ray fluorescence, and electron microprobe analysis
- Understand how to apply geoscientific principles to understanding the world around you
- Understand how to access, use and synthesise appropriate information
- Understand how to present ideas clearly with supporting evidence in a number of formats

Forensic science part 3

Due: **Monday Week 10**

Weighting: **10%**

Part 3: History table and report: Interpretation of the geological history of the area (40% of case study) and your main results in the form of a two-page report to the police (10% of case study)

o Complete the A3 size table by hand (download from iLearn), neatly filled out or type into the cells in Excel

o The two-page report should piece together your analysis of the map, the one page from the victim's notebook, the geophysics interpretation, the thin sections, the sand samples and XRF data. Some questions to consider:

- How many unique rock types are there?
- What are the rock types and their mineralogy?
- Do the rock types link to the map or not?

- Are the rock types restricted to a certain area on the map?
 - Why, in your opinion, did the geologist have that rock in their car?
 - Do any of the rocks match the murder weapon or those used to weigh down the body?
 - Does any of the rock analysis help with motive or piecing together the how/where/when of the murder and disposal of the body?
 - What were the various sand grains?
 - Are they specific to any of the samples analysed petrographically or on the map or have they been kicking around the Earth's surface for a while (stable)?
 - Does any of the sand help with motive or piecing together the how/where/when of the murder and disposal of the body?
 - Who should the police arrest and why?
 - Is there a consistent story or are there multiple options?
 - What further investigations or queries should the police make and why?
 - If given more time and a further \$10,000 consulting fee (wow – you are expensive), what further analyses might you do to clinch a conviction for the police once an arrest was made?
- N.B. Marks will be deducted for reports that are too long – clear and succinct writing is an important skill, valued by professionals. It may take you a few drafts to rewrite your text and fit all of the information into the page limit.

On successful completion you will be able to:

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to typify the bedrock controls on landforms and geomorphology
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
- Develop the skills needed to interpret the significance of microstructures in geoscience materials

- Develop the skills needed to undertake projects of a complex nature
- Develop the skills needed to report on the results of common geochemical laboratory techniques such as x-ray diffraction, x-ray fluorescence, and electron microprobe analysis
- Develop the skills needed to describe and analyse simple field structures, including strike/dip of inclined strata, angular relations across unconformities, the style and attitude of folds, and the types of faults and their displacement
- Develop the skills needed to interpret cross-cutting relationships in the field and laboratory to determine the sequence of geoscience events for a given problem
- Understand how to apply geoscientific principles to understanding the world around you
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- Develop effective team work skills
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Weekly Quizzes

Due: **Each week**

Weighting: **20%**

There will be a series of online quizzes each week. The questions are drawn from the information given in lectures and the unit reader booklet. iLearn has details of which lectures and what part of the booklet the questions are drawn from. You will also be required to complete a Virtual Petrographic Microscope or stereonet task each week and submit your answers in the weekly quiz.

On successful completion you will be able to:

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to typify the bedrock controls on landforms and geomorphology
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
- Develop the skills needed to interpret the significance of microstructures in geoscience materials
- Develop the skills needed to describe and analyse simple field structures, including strike/dip of inclined strata, angular relations across unconformities, the style and attitude of folds, and the types of faults and their displacement
- Develop the skills needed to interpret cross-cutting relationships in the field and

laboratory to determine the sequence of geoscience events for a given problem

- Understand how to apply geoscientific principles to understanding the world around you
- Understand how to access, use and synthesise appropriate information

Final examination

Due: **Examination period**

Weighting: **60%**

The final exam will cover material from the lectures, class practical exercises and case studies. Questions will draw on information and ideas from the whole unit to give an integrated view of the unit. The exam will include questions that ask you to apply your knowledge to interpret and solve problems. You will be allowed to take one A4 page of notes into the exam, otherwise it is closed book.

On successful completion you will be able to:

- Develop the skills needed to typify the bedrock controls on landforms and geomorphology
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
- Develop the skills needed to interpret the significance of microstructures in geoscience materials
- Develop the skills needed to report on the results of common geochemical laboratory techniques such as x-ray diffraction, x-ray fluorescence, and electron microprobe analysis
- Develop the skills needed to describe and analyse simple field structures, including strike/dip of inclined strata, angular relations across unconformities, the style and attitude of folds, and the types of faults and their displacement
- Develop the skills needed to interpret cross-cutting relationships in the field and laboratory to determine the sequence of geoscience events for a given problem
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Delivery and Resources

This unit can be seen as three interconnected streams. A lecture stream will give a broad overview of the topics, provide background information and introduce new ideas and concepts that link in with the laboratory practical and case study streams.

There will be one case study submitted in parts throughout the semester. The case study is an extended enquiry into a real geo-scientific problem. This problem is different to the ones that you would typically find in textbooks, and more closely resembles the investigations that scientists face in the real world, with many interacting factors and a number of possible solutions.

The case study will allow you to explore the ideas in depth and will provide an effective and, we hope, enjoyable method of learning. There is also the added benefit of providing you with opportunities to develop generic skills and graduate capabilities such as problem solving, teamwork, communication, accessing and evaluating information and in using scientific approaches to solve problems.

You will be working individually for the case study, both in attempting to solve the problem and to produce a final report. However, you are encouraged to consult with others in the class and to help each other with the work, although, final reports should be done individually. You will be expected to do substantial research outside of the scheduled time (e.g. library and/or web-based literature search, data processing and plotting).

Technology that we will use involves laboratory equipment including petrographic microscopes and geochemical instruments housed in the Geochemical Analysis Unit (GAU) such as the electron microprobe (EMP) and scanning electron microscope (SEM).

Time Allocation

According to Macquarie University guidelines, you are required to spend 39 hours of study per credit point. For GEOS207 this works out to approximately four hours per week at the lecture/laboratory sessions, and approximately six hours per week doing at home study. Conscientious use of this time, particularly if it is spread over the whole semester will provide its reward.

Unit Schedule

Note: the lectures will not be delivered live. Rather, you should listen to the recorded lectures and post questions in iLearn by Tuesday midnight, to be answered in the lecture time slot.

	Lecture 1a (recorded) Thursday 9-10 (E8A 386)	Lecture 1b (recorded) Thursday 10-11 (E8A 386)	Practical session Thursday 1-3 or 3-5 (E5A 210)
Week 1 Aug. 4	Unit overview & introduction to microscopy ND	Mineral identification & Virtual Petrographic Microscope ND	Practical 1: Transmitted light microscopy RF
Week 2 Aug. 11	Mineral groups RF	Crystal systems & Minerals RF	Practical 2: Plane-polarised light microscopy RF

Week 3 Aug. 18	Laboratory analysis of rocks <i>NP</i>	Classification of garnet, feldspar and amphibole <i>ND</i>	Practical 3: Crossed-polarised light microscopy <i>RF</i>
Week 4 Aug. 25	Reading the conditions of igneous crystallisation <i>RF</i>	Petrographic descriptions <i>ND</i>	Practical 4: Special microscope techniques <i>RF</i>
Week 5 Sept. 1	Interplay between structure and relief – bows and vees <i>ND</i>	Folding is ubiquitous <i>ND</i>	Practical 5: Stereographic projection <i>ND</i>
Week 6 Sept. 8	Minor field structures <i>ND</i>	Fault rocks and structures <i>ND</i>	Practical 6: p-analysis of folds <i>ND</i>
Week 7 Sept. 15	Significance of gaps in the geological record <i>ND</i>	Field structures of igneous rocks (clash with external on campus) <i>RF</i>	Practical 7: Geological history 1 (clash with external on campus) <i>ND</i>
Week 8 Oct. 6	<i>NO CLASSES</i>	<i>NO CLASSES</i>	<i>[At home exercise] Practical 8: Virtual Petrographic Microscope</i>
Week 9 Oct. 13	Discovering past events on maps - practice <i>ND</i>	Introduction to economic geology <i>ES</i>	Practical 10: Analysing unknown thin sections <i>RF</i>
Week 10 Oct. 20	<i>NO CLASSES</i>	<i>NO CLASSES</i>	<i>[At home exercise] Practical 13: Virtual Petrographic Microscope</i>
Week 11 Oct. 27	Metallic ore deposits and their field relations <i>ES</i>	Crystal systems & Miller indices <i>RF</i>	Practical 11: Metamorphic rock microscopy <i>RF</i>
Week 12 Nov. 3	Metamorphic microstructure <i>ND</i>	Microstructure of deformed rocks <i>ND</i>	Practical 9: Geological history 2 <i>ND</i>

Week 13 Nov. 10	Metamorphism <i>ND</i>	Revision <i>ND</i>	Practical 12: Advanced microscopy RF
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IMPORTANT DATES:

Every week – Online quiz

EXTERNAL on campus Saturday 20 August 9am - 4pm E5A 210

Week 4 – Wednesday 24 August 5pm: Forensic Science Case Study Part 1 (Online quiz)

Week 7 – Wednesday 14 September 5pm: Forensic Science Case Study Part 2 (Rock table, XRF data and Petrographic description)

EXTERNAL on campus Thursday 22 and Friday 23 September 9am - 4pm E5A 210

Week 10 – Wednesday 19 October 5pm: Forensic Science Case Study Part 3 (History table and report)

Exam: To be advised once the examinations timetable is drawn up

Policies and Procedures

Macquarie University policies and procedures are accessible from [Policy Central](#). Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

New Assessment Policy in effect from Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy_2016.html. For more information visit http://students.mq.edu.au/events/2016/07/19/new_assessment_policy_in_place_from_session_2/

Assessment Policy prior to Session 2 2016 <http://mq.edu.au/policy/docs/assessment/policy.html>

Grading Policy prior to Session 2 2016 <http://mq.edu.au/policy/docs/grading/policy.html>

Grade Appeal Policy <http://mq.edu.au/policy/docs/gradeappeal/policy.html>

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

In addition, a number of other policies can be found in the [Learning and Teaching Category](#) of Policy Central.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of

Conduct: https://students.mq.edu.au/support/student_conduct/

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in [eStudent](#). For more information visit <ask.mq.edu.au>.

Student Support

Macquarie University provides a range of support services for students. For details, visit <http://students.mq.edu.au/support/>

Learning Skills

Learning Skills (<mq.edu.au/learningskills>) provides academic writing resources and study strategies to improve your marks and take control of your study.

- [Workshops](#)
- [StudyWise](#)
- [Academic Integrity Module for Students](#)
- [Ask a Learning Adviser](#)

Student Services and Support

Students with a disability are encouraged to contact the [Disability Service](#) who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at <ask.mq.edu.au>

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the [Acceptable Use of IT Resources Policy](#). The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to typify the bedrock controls on landforms and geomorphology
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
- Develop the skills needed to interpret the significance of microstructures in geoscience materials
- Develop the skills needed to undertake projects of a complex nature
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- Develop the skills needed to interpret cross-cutting relationships in the field and laboratory to determine the sequence of geoscience events for a given problem
- Understand how to apply geoscientific principles to understanding the world around you
- Understand how to access, use and synthesise appropriate information
- Develop effective team work skills
- Understand how to present ideas clearly with supporting evidence in a number of formats

Assessment tasks

- Forensic science part 1
- Forensic science part 2
- Forensic science part 3
- Weekly Quizzes
- Final examination

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
- Develop the skills needed to undertake projects of a complex nature
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Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- Develop the skills needed to undertake projects of a complex nature
- Develop the skills needed to report on the results of common geochemical laboratory

techniques such as x-ray diffraction, x-ray fluorescence, and electron microprobe analysis

- Understand how to apply geoscientific principles to understanding the world around you
- Understand how to access, use and synthesise appropriate information
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Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to typify the bedrock controls on landforms and geomorphology
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
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- Develop the skills needed to interpret cross-cutting relationships in the field and laboratory to determine the sequence of geoscience events for a given problem
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Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to typify the bedrock controls on landforms and geomorphology
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
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- Develop the skills needed to interpret cross-cutting relationships in the field and laboratory to determine the sequence of geoscience events for a given problem
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Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to typify the bedrock controls on landforms and geomorphology
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
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of folds, and the types of faults and their displacement

- Develop the skills needed to interpret cross-cutting relationships in the field and laboratory to determine the sequence of geoscience events for a given problem
- Understand how to apply geoscientific principles to understanding the world around you
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Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Develop the skills needed to undertake projects of a complex nature
- Develop the skills needed to report on the results of common geochemical laboratory techniques such as x-ray diffraction, x-ray fluorescence, and electron microprobe analysis
- Develop the skills needed to describe and analyse simple field structures, including strike/dip of inclined strata, angular relations across unconformities, the style and attitude of folds, and the types of faults and their displacement
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Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning outcomes

- Develop the skills needed to undertake projects of a complex nature
- Develop the skills needed to report on the results of common geochemical laboratory techniques such as x-ray diffraction, x-ray fluorescence, and electron microprobe analysis
- Understand how to apply geoscientific principles to understanding the world around you
- Understand how to access, use and synthesise appropriate information
- Develop effective team work skills
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Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and

country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcomes

- Develop the skills needed to select appropriate techniques to characterise and analyse geoscience materials (e.g. rocks, minerals, soils, etc)
- Develop the skills needed to typify the bedrock controls on landforms and geomorphology
- Develop the skills needed to utilise the power of back-scattered electron microscopy and petrographic microscopic analysis of thin sections
- Develop the skills needed to interpret the significance of microstructures in geoscience materials
- Develop the skills needed to undertake projects of a complex nature
- Develop the skills needed to report on the results of common geochemical laboratory techniques such as x-ray diffraction, x-ray fluorescence, and electron microprobe analysis
- Develop the skills needed to describe and analyse simple field structures, including strike/dip of inclined strata, angular relations across unconformities, the style and attitude of folds, and the types of faults and their displacement
- Understand how to apply geoscientific principles to understanding the world around you
- Understand how to access, use and synthesise appropriate information
- Develop effective team work skills
- Understand how to present ideas clearly with supporting evidence in a number of formats

Assessment tasks

- Forensic science part 1
- Forensic science part 2
- Forensic science part 3
- Weekly Quizzes
- Final examination

Changes from Previous Offering

We are interested in your ideas about how the unit is progressing and how it can be improved. At certain points during the semester, you will be invited to fill out a brief survey (1 page) or have a class discussion to give us some feedback on how you find the unit content and presentation methods. There will also be opportunities at the end of the unit to give an overall impression. If

you have any particular comments (good and bad) or ideas on how to make the unit better, please let your tutor know. There have been many changes made to previous offerings over the past few years based on student feedback. For example, the first case study assignment has been deleted and the other case study is now spread out over the semester with parts of the case study due every few weeks. This allowed us to bring the deadlines of each part forward to get their deadlines out of the times students indicated they had a high assignment load. To accommodate this change we have also moved some of the microscope practical classes to the end of the unit to bring forward the map interpretation aspects. In another example, we introduced the online quizzes in 2009 following feedback from students who requested a more structured guide to their at home study time. Most students find this very useful as it makes them read the background notes, allowing them to get more out of the practical classes. In 2013, we introduced the virtual petrographic microscope and associated online quizzes. Compared with previous classes, the 2013 class performed better in the final examination, correctly identifying 81% of the minerals on average. In addition, the percentage of students correctly identifying 100% of the minerals in the examination increased from 11% in the 2011 examination to 24% in 2013. We also introduced practice stereonet problems to the online quizzes in 2013. The performance on the stereonet question in the final examination improved from an average score of 42% in the 2011 examination to 59% in 2013. The results demonstrate that the introduction of practice problems improves examination scores. In order to accommodate some staff shortages in 2016, we will run the unit in mixed mode, whereby you are asked to listen to the lecture recording from 2015 and post questions online that will be addressed during the lecture slot. Additionally, the field trip to Hill End has been cancelled in 2016 to address issues of workload.