EESC1150

Planet Earth

Session 2, In person-scheduled-weekday, North Ryde 2022

School of Natural Sciences

Contents

General Information

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Credit points
10

Prerequisites

Corequisites

Co-badged status

Unit description
We invite you to meet our planet Earth and discover the processes which influence every aspect of our society, from the distribution of habitable environments, natural hazards and critical resources for our renewable future. Immerse yourself in and explore things that happened millions to billions of years ago and are recorded in the vast time capsules of Earth - its rocks. This introductory unit is suitable for all students including those wanting to try a natural science. It explores the composition and structure of our planet and the dynamic processes that change our environment. The unit provides a strong background for further studies in earth and environmental sciences as well as biology, chemistry, physics and archaeology. This unit involves an adventurous day trip across the Blue Mountains and pairs well with ENVS1017 The Living Environment and EESC1160 Blue Planet: Climate, Oceans and Life.

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:

ULO1: synthesise knowledge of how our planet works to draw meaningful conclusions about Earth processes.

ULO2: apply skills in map reading and analysis to draw cross-sections and interpret Earth history.

ULO3: demonstrate mineral identification skills in field and laboratory settings to define rock types and understand their tectonic context.

ULO4: draw on Earth and Environmental knowledge by evaluating possible solutions to complex problems and justifying the selected best solution.

ULO5: display independent, team and communication skills, to actively engage in learning.

General Assessment Information

Student Engagement in 100-level Units

In an effort to develop good study skills from the outset, the Faculty of Science and Engineering have made participation compulsory for 100 level units - this is now a hurdle assessment for the unit i.e., you must comply with this requirement to pass the unit.

While we expect 100% attendance at all lectures/workshops and practical laboratory classes to guarantee a successful outcome, the hurdle assessment in this unit requires that you attend and participate in at least 10 out of the 13 weekly lectures/workshops and practical laboratory

classes. Your tutor will provide you with further details on what we define as participation.

Please contact your convenor [nathan.daczko@mq.edu.au] as soon as possible if you have difficulty attending and participating in any classes. We will endevour to enable you to attend a practical class later in the week. If there are circumstances that mean you miss a class, you can apply for a disruption to studies request through ask.mq.edu.au and if approved this practical will be removed from your record of absences.

Late Assessment Submission Penalty

From 1 July 2022, Students enrolled in Session based units with written assessments will have the following university standard late penalty applied. Please see https://students.mq.edu.au/study/assessment-exams/assessments for more information.

Unless a Special Consideration request has been submitted and approved, a 5% penalty (of the total possible mark) will be applied each day a written assessment is not submitted, up until the 7th day (including weekends). After the 7th day, a grade of '0' will be awarded even if the assessment is submitted. Submission time for all written assessments is set at 11:55 pm. A 1-hour grace period is provided to students who experience a technical concern.

For any late submission of time-sensitive tasks, such as scheduled tests/exams, performance assessments/presentations, and/or scheduled practical assessments/labs, students need to submit an application for Special Consideration.

Assessments where Late Submissions will be accepted

In this unit, late submissions will accepted for all assessments following the standard late penalties described above. The dates for submission of assessment tasks are listed on the schedule. ***Students must keep a photocopy of their reports.***

Assessment Tasks

Name	Weighting	Hurdle	Due
Case Study 1 and 2	30%	No	components due at start of workshops in Week 3, 5, 7, 12
Multiple Quizzes	20%	No	Weekly (see iLearn for times)
Final Examination	50%	No	To be advised once the examinations timetable is drawn up
Workshop / Practical Participation	0%	Yes	Weekly

Case Study 1 and 2

Assessment Type [1]: Case study/analysis
Indicative Time on Task [2]: 35 hours
Due: **components due at start of workshops in Week 3, 5, 7, 12**

Weighting: **30%**

Each case study links theoretical concepts and practical situations using real-world scenarios and problems. Students will analyse, evaluate and relate ideas to each case and propose a solution to the problem posed. See iLearn for details of the two case studies.

On successful completion you will be able to:

- synthesise knowledge of how our planet works to draw meaningful conclusions about Earth processes.
- apply skills in map reading and analysis to draw cross-sections and interpret Earth history.
- demonstrate mineral identification skills in field and laboratory settings to define rock types and understand their tectonic context.
- draw on Earth and Environmental knowledge by evaluating possible solutions to complex problems and justifying the selected best solution.
- display independent, team and communication skills, to actively engage in learning.

Multiple Quizzes

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 20 hours
Due: **Weekly (see iLearn for times)**
Weighting: **20%**

The quizzes test knowledge and may be online or in-class. See iLearn for a detailed list of quizzes in this unit.

On successful completion you will be able to:

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- draw on Earth and Environmental knowledge by evaluating possible solutions to complex

problems and justifying the selected best solution.
- display independent, team and communication skills, to actively engage in learning.

Final Examination

Assessment Type [1]: Examination
Indicative Time on Task [2]: 20 hours
Due: **To be advised once the examinations timetable is drawn up**
Weighting: **50%**

The final examination requires students to apply the new skills and knowledge developed in this unit.

On successful completion you will be able to:
- apply skills in map reading and analysis to draw cross-sections and interpret Earth history.
- demonstrate mineral identification skills in field and laboratory settings to define rock types and understand their tectonic context.

Workshop / Practical Participation

Assessment Type [1]: Participatory task
Indicative Time on Task [2]: 0 hours
Due: **Weekly**
Weighting: **0%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

The participatory task is a hurdle assessment and requires participation in more than 75% of workshops / practical classes. Participation is documented via a weekly individual blog in iLearn.

On successful completion you will be able to:
- synthesise knowledge of how our planet works to draw meaningful conclusions about Earth processes.
- apply skills in map reading and analysis to draw cross-sections and interpret Earth history.
- demonstrate mineral identification skills in field and laboratory settings to define rock

types and understand their tectonic context.

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[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

INTRODUCTION

Planet Earth is a hands on unit of study, that sets out to acquaint you with the essential features of the materials that constitute the Earth, processes that shape the Earth's surface, and the interaction of people and the geologic environment. The unit is an **introduction to geology** and not only forms the vital stepping stone for future studies in Earth and Environmental Science, but also sets out to give students from other disciplines a basic understanding of the physical Earth that will be helpful in studies and careers in environmental science, geomorphology, biology, geodesy, gemology and economics.

We aim to help you develop the skills necessary for study of the physical Earth. By the end of the unit, you should have the skills to:

- Make critical observations of geology for yourself
- Identify minerals and rocks
- Determine geometric relationships between rock units, as depicted on simple geological maps
- Use geological information to better understand the physical Earth

These different threads come together via an understanding of the cyclic nature of rock-forming and rock degrading processes of our planet, in terms of the Plate Tectonic Theory.

Geology is a vital, living science that touches our everyday lives. For example, materials such as diamonds, natural resources and energy are essential to our modern civilisation, and precious stones add to our appreciation of nature's beauty. Processes such as volcanism, earthquakes, landslides and erosion may dramatically affect our well being. Knowledge you gain of these materials and processes, based on scientific approaches of observation, testing and evaluation, will assist you towards a better understanding of this planet, Earth.

STUDY PROGRAM

Students coming into this unit have a variety of backgrounds, since there are no set pre-requisites. Some of you will have no geology or physical geography at all in your previous studies, others will have taken Earth and Environmental Science at HSC level. However,

previous studies in geology and related subjects are not necessary and in terms of your geological knowledge, by the end of this unit it should not matter what background you had before you started. In spite of this, inevitably in the early stages some of you might find many more new concepts to come to grips with than others. DO NOT BE DISCOURAGED, as by persevering into the unit of study, you will gain the satisfaction of seeing how the pieces of the overall Earth puzzle start to come together.

This unit concentrates on five major themes that will be explored and revisited in various ways throughout the unit. These themes include:

- Deep time (prehistorical and ancient geological past)
- Plate tectonics
- The rock cycle
- Geological skills e.g. mapping and mineral/rock recognition
- How geoscience can be used to solve some of the problems of the 21st century

There are three modules that investigate different aspects of geoscience. The main ideas and objectives for the modules are:

Module 1: Tools of Geoscience (approximately one-third of the unit)

By the end of this unit students should be able to:

- Understand that the rocks we see today have undergone change through geologic time and are still undergoing change (this is known as the rock-cycle)
- Recognise that there are 3 main groups of rocks (igneous, sedimentary and metamorphic) and be able to distinguish typical hand specimen examples of each type (Note: this skill will be reinforced throughout the unit)
- Understand the basic concepts of the plate tectonic theory and appreciate that it is the major unifying idea of geoscience
- Describe the main tools of geoscience and give examples of how they are used: e.g. mapping, satellite imagery, air photos, geophysical investigations, Geographic Information Systems (GIS)
- Read and interpret topographic maps, and understand how contours are constructed and how to interpret them
- Use geological maps including legends, scales, grid references, etc. to solve simple problems and navigate
- Understand that maps are two dimensional representations of a three dimensional world, and the graphical techniques that are used to illustrate what is under the surface (e.g. making and interpreting geological cross sections)
- Explain the sequence of events that led to the geological configuration of an area (geological history)

Module 2: Hot Rocks (approximately one-third of the unit)

By the end of this unit students should be able to:

- Analyse volcanic processes, the landforms produced, and volcanic hazards
- Account for differences between volcanoes in terms of lava type (chemistry, appearance, explosiveness, etc) and their geographic position in relation to plate tectonic theory (e.g. boundary, intra-plate, etc)
- Examine intrusive igneous processes (e.g. magma composition and behaviour), and the features these processes produce
- Recognise common volcanic and intrusive igneous rocks and be able to use a classification scheme to identify them; interpret the origin of igneous rocks from hand specimens and field relations
- Describe and appreciate the significance of deeper Earth processes (e.g. mantle plumes)
- Understand the impact of plate tectonic theory on igneous processes
- Identify the main silicate rock-forming minerals
- Comprehend the basic chemical structure of the main groups of minerals (e.g. silica tetrahedra) and how this structure determines their appearance and physical properties
- Illustrate how knowledge of igneous processes can be useful to people (e.g. natural resources and energy; building materials)

Module 3: Rocks Under Stress and Deep Earth (approximately one-third of the unit)

By the end of this unit students should be able to:

- Comprehend that metamorphism causes change to existing rocks by the application of heat and pressure
- Comprehend that rocks slowly change form and shape under the application of forces
- Match parent rocks with metamorphosed equivalents
- Establish that rock microstructure and the existence of particular minerals indicate that rocks have undergone change
- Discern the difference between contact and regional metamorphism and be able to distinguish this difference in hand specimens showing a visible difference
- Understand the concept of metamorphic grade
- Use and interpret geological maps with intrusive rock bodies and simple structural features
- Describe how knowledge of metamorphic processes can be of benefit to people
- Understand the relationship between metamorphism, deformation and plate tectonic

theory

- Understand how geophysics is used to understand the deep Earth and to monitor geological hazards

STUDENT LEARNING EXPERIENCES

This unit can be seen as two interconnected streams. A lecture/workshop stream involving short presentations and hands on activities that will give a broad overview of the topic, provide background information and introduce new ideas and concepts that link in with the other stream. Parallel to the lecture/workshop stream are a series of laboratory and field-based activities and case study workshops.

There will be two case studies. These case studies will be extended inquiries into real geo-scientific problems, extending over several weeks. These problems are different to the ones that you would typically find in textbooks, and more closely resemble the investigations that scientists face in the real world, with many interacting factors and a number of possible solutions.

Each of the case studies 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 such as problem solving, teamwork, communication, accessing and evaluating information and in using scientific approaches to solve problems.

You will be working individually or in small teams for each case study, both in attempting to solve the problem and to produce a final report. The reports will be awarded marks for your individual synthesis. You will be expected to do substantial research outside of the scheduled time (e.g. library and/or web-based literature search).

FIELD TRIPS

During this unit of study you will be required to participate in two field trips: one on-campus (in-person) and one off-campus (virtual if COVID-impacted). These excursions form an essential part of the unit and give you an introduction to field geology. You should take special note of the following:

Equipment: The basic requirements are a hand lens, magnet, and some method of testing mineral hardness (e.g. a pocket knife, copper coin, etc.). Buy a geological hammer only if you intend to continue in a geological field. As the weather is not always kind, note taking can be a problem if ballpoint or ink pens are used. Pencils are recommended. Bring several, and keep them sharp. Learn to be neat and tidy in these initial stages, and form a good habit early. It is much easier to discipline yourself now than to change habits later.

Clothing: Everyone has their own idea of comfort, but some common features of field clothing are obvious. Wear sensible, tough footwear, such as boots or strong sneakers. Thongs, fashion shoes and street shoes are useless and unacceptable. We will be walking over some irregular rock outcrops and may be in snake-infested areas. We cannot guarantee good quality weather; so you should have waterproof clothing. Long trousers, such as jeans, are safer than shorts. Bring a hat and sunscreen.

TEXTS AND REFERENCES

Unit of study booklet

This is available through iLearn and contains the lecture/workshop activities, laboratory practicals and case study assignments. The booklet is essential for you to have to follow the unit. You must print this yourself. The completed worksheets are invaluable as an aid during revision for the examination.

Textbook

The recommended text is:

Tarbuck, E.J., Lutgens, F.K. and Tasa, D. (2016). Earth: An introduction to Physical Geology (12th Global). Pearson . ISBN 9781292161839

This gives more background information, often written from a different perspective from the workshops and practical class notes. It also contains photographs and diagrams for use in the workshops and laboratory exercises. In the library you may find several other basic textbooks on Physical Geology that will be of use to you. The other text mentioned is Merali, Z. and Skinner B.J. Visualizing Earth Science. Wiley. ISBN 978-0-471-74705-5.

Reading List

You may find the following books helpful for reference. They should provide useful supportive material to the workshops, case studies and laboratory exercises, and supplement the prescribed textbook and the Unit of Study booklet.

Dynamic Earth is a subject relying heavily on observation, so it will be of great help to look at a variety of illustrations of the features that are covered in the unit of study. The books listed below are generally well illustrated, with striking colour photographs and diagrams.

** indicates a book in Special Reserve in the Library; * indicates a book on 3-day loan.

**Branagan, D.F. and Packham, G.H., 2000. Field geology of NSW. NSW Dept of Mineral Resources. Sydney. QE45.B7

*Busch, R.M., Tarbuck, E.J. and Lutgens, F.K, 1993. A study guide to accompany "The earth — an introduction to physical geology". Merrill. QE28.2.T37

*Cattermole, P., 2000. Building Planet Earth. Cambridge University Press. QE26.2.C384

*Hamblin, W.K. 1998. Earth's Dynamic Systems. Macmillan (8th Ed.) QE28.2.H35

*Hamblin, W.K. and Howard, J.D. 1995. Exercises in Physical Geology. QE28.2.H36

**Herbert, C. and Helby, R., 1980. A Guide to the Sydney Basin. Geological Survey of NSW Bulletin 26. QE341.N4

**Kimberley, M.M and Kimberley, S.J. 1995. Study guide to Skinner/Porter's The Dynamic Earth: an introduction to physical geology. Third Edition. Wiley (3rd Ed) QE28.2K56

*Merritts, D.J., De Wet, A., and Menking, K., 1998. Environmental Geology: an earth system science approach. Freeman, New York. QE38.M47

*Monroe, J.S. and Wicander, R. 1992 Physical Geology — exploring the earth. Harper

Educational Publ.; West Publ. Co St. Paul. QE28.2.M655

*Montgomery, C.W., 1993. Physical Geology. Wm C. Brown (3rd Ed.) QE28.2.M66

*Morrison, R., 1988. Voyage of the Great Southern Ark. Ure Smith Press. QE340.M67

*Morton, R.D., 1995. Student's Companion to Skinner and Porter's The Dynamic Earth; an introduction to Physical Geology, Third Edition. Wiley QE28.2.S552

*Murck, B.W., Skinner, B.J. and Porter, S.C., 1996. Environmental Geology. Wiley and Sons, New York. QE38.M87/1996

*Plummer, C.C. and McGeary, D., 1999. Physical Geology. Wm C. Brown Publ., Iowa (8th Ed.). QE28.2.P58

*Press, F. and Siever, R. 1998. Understanding Earth. Freeman, New York (2nd Ed.) (replaces Earth, 4th Ed.). QE28.P9

**Scheibner, E., 1999. The geological evolution of New South Wales. Dept of Mineral Resources. QE341.S296

**Skinner, B.J. and Porter, S.C., 2000. The Dynamic Earth: an introduction to physical geology. Wiley , 4th Ed. QE28.2.S55

**Skinner, B.J., Porter, S.C. and Botkin, D.B., 1999. The Blue Planet. Wiley , 2nd Ed. QB631.S57

*Smith, D.G., 1981. The Cambridge Encyclopedia of Earth Sciences Cambridge Univ. Press, Cambridge. QE26.2.C35

*Stanley, S.M., 1989. Earth and life through time. W.H. Freeman and Company, N.Y. QE28.3.S73

*Tarbuck, E.J., Lutgens, F.K. and Tasa, D. (2016). Earth: An introduction to Physical Geology (12th Global). Pearson . ISBN 9781292161839

**Van Andel, T.H., 1994. New views of an old planet: continental drift and the history of the earth. Cambridge Univ. Press, Cambridge (2nd Ed.). QE26.2.V36

*Veevers, J.J., 2000. Billion-year earth history of Australia and neighbours in Gondwanaland. GEMOC Press, Sydney. QE340.B55

CD-ROMS

**Dunning, J and Onesti, L.J., 1998. Earth Matters. Freeman and Co., New York. QE38.D8

**Tasa, D., 1999. Illustrated dictionary of earth science. Tasa Graphic Arts. QE5.I45

Library Loans

The Library at Macquarie will have provided you with information on library loans. The procedures differ for metropolitan and country students. Please familiarise yourself with the procedures appropriate in your case. If you have any enquiries contact the Library on (02) 9850-7500.

Unit Schedule

SCHEDULE:

Date	Week	Workshop (compulsory participation) Mon 11–1 [14SCO 163]	Laboratory Practical (compulsory participation) Many day options [11WW 210]	
25 Jul	1	A tour of Planet Earth [Nathan Daczko] (1.4, 1.6, 2, 9.5)*	Practical 1: Topographic Maps	Volcanoes Case Study
1 Aug	**2**	Minerals [Tracy Rushmer] (3)	Practical 2: Campus Excursion	
8 Aug	**3**	The Deep Earth-Volcano Connection [Chris Firth] (4, 5)	Practical 3: Geological Map Reading	
15 Aug	**4**	Explosive Volcanism and Hazards [Chris Firth] (4, 5)	Practical 4: Minerals	
22 Aug	**5**	Supervolcanoes and Below [Chris Firth] (4, 5)	Practical 5: Mafic and Intermediate Igneous Rocks	
29 Aug	**6**	Metamorphism [Nathan Daczko] (8)	Practical 6: Felsic Igneous Rocks	
5 Sep	**7**	Crustal Deformation [Nathan Daczko] (10, 14)	Practical 7: Metamorphic Minerals	
		Session 2 break (Field trip 15 or 16 Sep)		
26 Sep	**8**	Sedimentary Processes [Olivier Alard] (7, 23.2)	Practical 8: Metamorphic Rocks	Hartley Case Study
3 Oct	**9**	Geochemical Tools and Dating the Earth [Olivier Alard] (9.4, PDF of chapter in iLearn)	Practical 9: Geological Cross Sections	
10 Oct	**10**	Earth's Interior [Olivier Alard] (11,12)	Practical 10: Geological History	
17 Oct	**11**	Understanding the Earth System [Olivier Alard] (22)	Practical 11: Exam Revision – Rocks and Minerals	

24 Oct	**12**	Exam Revision [Nathan Daczko]	Practical 12: Geo Jeopardy	
31 Oct	**13**	No classes	No classes	

*Numbers in brackets represent chapters from *Earth: An introduction to Physical Geology*

IMPORTANT DATES:

Week 3 – at start of your Workshop: Part A of Volcanoes Case Study is due

Week 5 – at start of your Workshop: Part B of Volcanoes Case Study is due

Week 7 – at start of your Workshop: Part C of Volcanoes Case Study is due

During session 2 break: Thursday 15th OR Friday 16th September: Full-day fieldtrip to Hartley

Week 12 – at start of your Workshop: Report for Hartley Case Study is due and in class Quiz

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

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policies.mq.edu.au). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Assessment Procedure
- Complaints Resolution Procedure for Students and Members of the Public
- Special Consideration Policy

Students seeking more policy resources can visit Student Policies (https://students.mq.edu.au/support/study/policies). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

To find other policies relating to Teaching and Learning, visit Policy Central (https://policies.mq.edu.au) and use the search tool.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/admin/other-resources/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) 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 or if you are a Global MBA student contact globalmba.support@mq.edu.au

Academic Integrity

At Macquarie, we believe academic integrity – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free online writing and maths support, academic skills development and wellbeing consultations.

Student Support

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

The Writing Centre

The Writing Centre provides resources to develop your English language proficiency, academic writing, and communication skills.

- Workshops
- Chat with a WriteWISE peer writing leader
- Access StudyWISE
- Upload an assignment to Studiosity
- Complete the Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Macquarie University offers a range of Student Support Services including:

- IT Support
- Accessibility and disability support with study

- Mental health support
- Safety support to respond to bullying, harassment, sexual harassment and sexual assault
- Social support including information about finances, tenancy and legal issues

Student Enquiries

Got a question? Ask us via AskMQ, or contact Service Connect.

Changes to the Special Consideration Policy which will take effect from S2

Please note, changes to the special consideration policy/procedure were approved by Senate on 24 May 2022. The most significant changes are the use of statements of fact rather than other documentation and the inclusion of "circumstances or events which are anticipated but unable to be changed". These changes will take effect from 25 July 2022.

https://policies.mq.edu.au/document/view.php?id=136&version=2

Special Considerations are checked by the central assessment team. If the SC meets the appropriate criteria, then it **must be** accepted by the team and will be forwarded to the unit convenor to action. If the SC doesn't meet the appropriate criteria, it is rejected and does not go to the unit convenor. It is the role of the central assessment team to accept or reject SCs. It is the role of the unit convenor to recommend the remedy. SCs need to be actioned by UCs within 5 working days.

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.

Changes from Previous Offering

Two key messages: (1) lecture/workshops are available on campus or online [We recommend the on campus class] and (2) the field trip may be taken virtually if needed.

This year sees our fifth year of some significant changes to the EESC1150 offering and we ask for your patience and feedback. There have been major changes to the content delivery format to incorporate more hands on activities in the lecture/workshop and laboratory components. Participation in both the lecture/workshop and the laboratory practical components is compulsory. We have shortened the laboratory practical component from 3 hours to 2 hours following feedback from students.

Swapping traditional lectures for novel two-hour workshops has seen a dramatic improvement in first year geology students' engagement, depth of learning and final grades. The lecture/workshops—which involve 10 to 15 minute 'mini-lectures' interspersed with object-based and active learning exercises—are conducted in the new active learning spaces at Macquarie. First year geology is ideal for object-based and active learning as it is strongly skills-based with

students learning how to identify minerals and rock types, think in three dimensions and understand geophysical principles. Each week a mystery box is placed on each of the tables that contains the workshop objects and instructions for the activities. Our goal is to deliver new information that advances the students' learning, while including a process of immediate feedback on the effectiveness of their learning during the activities. We found that since the changes were implemented in 2018, the object-based and active learning stimulated discussion, group work and lateral thinking at each table, along with excellent engagement with the workshop leader and tutors. The objects enhanced the delivery of unit-specific knowledge while also improving students' generic skills such as communication, teamwork, and observational and drawing ability. The results from recent years showed the success of the new format. The failure rate dropped from around 20 per cent to less than five per cent of the cohort, and the percentage of students scoring a distinction or high distinction jumped from approximately a quarter to more than half the class.