FHEQ Level 5: Year 2
Geology & Geoscience
Module Catalogue
2018-2019

Keele University

Work Portfolio

You should retain all of your coursework from Level 5 (Year 2) onwards that has been marked and returned to you. You will be required to resubmit all of this work in a portfolio in both in early May 2019 and 2020 for scrutiny by the External Examiners. MGeoscience students will also submit their final portfolios prior to graduation in 2021.

The information provided in this handbook was correct at the time of writing. Students should, however, regularly consult the Geology and Geoscience notice boards, their electronic mail account and both Geography, Geology and the Environment and the Planning and Academic Administration web pages for new information and changes to procedures. In addition, this handbook does not replace the entries in the University Prospectus and Calendar, which are authoritative statements. In case of conflict, University regulations take priority. If you require the Handbook or any other materials in an alternative format, please let us know. The statements of School policy in this Handbook are made in good faith. It may however be necessary from time to time to vary courses, procedures, and other arrangements.

Last Update August 31, 2018

Contents

Sustainability Statement

In 2015 the United Nations adopted 17 sustainability goals to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable development agenda. Each goal has specific targets to be achieved by 2030.

Understanding geological phenomena and the Earth through deep time are fundamental to the delivery of the United Nations Sustainable Development Goals. A knowledge of the Earth's resources, processes and history is essential to understand how any changes in our economic or societal behaviour may impact upon the environment (and vice versa).

The geology programmes at Keele will highlight the links between geology and the UN sustainability goals so that you will not only become aware of these sustainability concepts but are able to use and disseminate that knowledge as geologists towards a more sustainable future.

At Level 5 (Year 2) you will have the opportunity to learn how several aspects of the geosciences directly affect our social and economic status. We recommended you familiarise yourself with the United Nations Sustainable Development Goals and how they relate to geology. www.un.org/sustainabledevelopment/sustainable-development-goals/

ESC-20001 (Autumn Semester: Geology & Geoscience)

Module Title: Igneous and Metamorphic Petrology
Module Tutors: Dr Ralf Gertisser (Igneous Petrology)
Dr Ralf Halama (Metamorphic Petrology; Module co-ordinator)

Module Outline

This module provides the students with the opportunity to apply geochemistry and simple experimental systems to an understanding of igneous rock suites and the petrogenesis of igneous rocks on a global scale. Isotopic techniques for magma source identification and age dating are introduced. Metamorphosed rocks are studied in detail to show how the influence of initial rock composition (protolith), fluid migration (metasomatism) and varying temperature and pressure dictate the metamorphic mineral assemblage.

Aims

The module aims to introduce students to the fundamentals of igneous and metamorphic petrology, including and understanding of the importance of mineralogy and rock texture to the interpretation of igneous and metamorphic rocks and an appreciation of the links between petrology/geochemistry and geodynamics (plate tectonics).

Intended Learning Outcomes

At the end of the module students should be able to:

- describe, evaluate and interpret the origin and evolution of igneous rocks using geochemical data;
- describe, evaluate and interpret magma formation in a global geodynamic context;
- apply proficiently phase diagrams to understand igneous and metamorphic processes;
- identify minerals and rocks, with an assessment of their igneous or metamorphic environment;
- describe, evaluate and interpret how mineral assemblages relate to chemical composition and pressure-temperature conditions of metamorphic rock formation;
- demonstrate awareness and critically evaluate the links between metamorphic processes and plate tectonics through geological time.

Skills

Students who successfully complete this module will be able to:

- describe, analyse and interpret igneous and metamorphic rocks;
- demonstrate numeracy and data manipulation skills;
- use appropriate charts and graphs to display numerical data effectively;
- demonstrate information technology skills through use of web-based teaching resources and specific computer programs.

Formative Assessment

De-briefing sessions at end of practical classes; Discussion of material on one-to-one basis during practical classes; Practical exercises conducted via tutor/student class 'question and answer' dialogue; short problem-based practical exercises.

Summative Assessment

Method

Practical assignment - Igneous and Metamorphic Petrology (60%), including:

- Practical book: Igneous Petrology (25%)
- Field course: Shap Granite (10%)
- Practical test: Metamorphic Petrology (25%)

2-hour written examination at end of course (40%)

Dates

Practical book: Igneous Petrology: Wednesday, Week 7
Field course: Shap Granite: Saturday, End of Week 6
Practical test: Metamorphic Petrology: Week 12
Written Examination (2-hour unseen exam): January 2019

On-line resources

Located on the Keele Virtual Learning Environment

Recommended reading: ESC-20001 Reading List

DEER, W.A., HOWIE, R.A., ZUSSMAN, J. An Introduction to the rock-forming minerals. Mineralogical Society, 3rd edition.
FROST, B.R., FROST, C.D. Essentials of Igneous and Metamorphic Petrology. Cambridge University Press.
KLEIN, C., PHILPOTTS, A.R. Earth materials: introduction to mineralogy and petrology. Cambridge University Press.
ROLLINSON, H. Using geochemical data. Longman.
WILSON, M. Igneous petrogenesis. Unwin Hyman.
WINTER, J.D. An introduction to igneous and metamorphic petrology. Prentice Hall.

Wk	Lecture Titles (2 lectures per week)	Tutor (s)
Igneous Petrology		
1	Introduction to module	RG
2	Geochemical characteristics of igneous rocks as petrogenetic indicators I: major elements	RG
	Geochemical characteristics of igneous rocks as petrogenetic indicators II: trace elements	RG
3	Geochemical characteristics of igneous rocks as petrogenetic indicators III: isotopes	RG
	The Earth mantle and the generation of basaltic magmas	RG
4	Diversification of magmas	RG
	Phase diagrams in igneous systems	RG
5	Mid-ocean ridge and ocean island basalts	RG
	Subduction-related magmatism	RG
6	Continental alkaline magmatism	RG
	Petrogenesis of granitoid rocks	RG
7	No lectures (Shap field course, Saturday, End of Week 6)	

Metamorphic Petrology

8	Fundamentals of metamorphic petrology	RH
	Metamorphism of mafic rocks	RH
9	Metamorphism of mudrock	RH
	Metamorphism of impure limestones	RH
10	Thermodynamics of metamorphic systems	RH
	Geothermobarometry	RH
11	Fluids and metasomatism	RH
	Dating metamorphism	RH
12	Deformation and metamorphism	RH
	No lecture	

Wk	**Practical Classes**	**Tutor (s)**
Igneous Petrology		
1	Induction Week: No Practical Class	
2	Igneous petrology – practical 1	RG
3	Igneous petrology – practical 2	RG
4	Igneous petrology – practical 3	RG
5	Igneous petrology – practical 4	RG
6	Igneous petrology – practical 5	RG
7	No practical (Shap field course, Saturday, End of Week 6)	
Metamorphic Petrology		
8	Metamorphic petrology - practical 1	RH
9	Metamorphic petrology - practical 2	RH
10	Metamorphic petrology - practical 3	RH
11	Metamorphic petrology - practical 4	RH
12	Practical test	RH

ESC-20039 (Autumn Semester: Geology & Geoscience)

Module Title: **Advanced Structural Geology and Geological Mapping Training**

Module Tutors: **Dr Steven Rogers (co-ordinator), Dr Stuart Clarke & Dr Stuart Egan**

Module Outline

This module combines two important aspects of geological study, Structural Geology and Geological Mapping Training. In the Structural Geology component of the module, a combination of lectures and practical classes are used to enable students to investigate the behaviour of rocks when deformed and the methods used to study their deformation. A series of lectures are used to provide knowledge and understanding of well-established principles in structural geology, while the practical classes focus on the methodologies used for the interpretation, analysis and visualisation of structural data. The practical classes place emphasis on the use of computing techniques for digital geological mapping, structural analysis and visualisation, including the use of Geographical/Geological Information Systems (GIS).

The Geological Mapping Training part of the module is mainly based on a residential field course that takes place immediately before the start of the second year and covers the techniques used to make a geological map. On the first two days, students are instructed in a number of small groups in the basic principles of geological mapping. Staff and demonstrators ensure that everyone has a firm understanding of the operation of the compass/clinometer, of the techniques for establishing topographical location, and the way in which information should be recorded in field notebooks and on the map. For the remainder of the field course students work in pairs and make a detailed geological map of an area of about 1.5 km^2. Mapping pairs are allocated to work on adjoining areas of relatively mountainous terrain. Each pair is accompanied for half a day by a member of staff or demonstrator, who will observe their performance and help with any problems that may arise. Aerial photograph interpretation is also covered on the course. Evening classes take place at the accommodation centre to "ink in" the day's work, to study problematical rock types, to discuss progress with staff, and for highlighting any difficulties that may have been encountered. All staff are present throughout the evening sessions and short informal talks are given on a variety of mapping topics.

There are close links between both parts of the module such that students make use of some of the field data collected during the mapping training exercise within the practical classes related to advanced structural geology.

Aims

To develop knowledge of structural geology in the context of quantitative geoscience; to provide instruction and supervision in the techniques for making a geological map in the field.

Intended Learning Outcomes

At the end of the module students should be able to:

- Demonstrate knowledge and critical understanding of well-established principles in structural geology.
- Perform geometrical exercises, and apply field and laboratory techniques used in the analysis and quantification of rock deformation.
- Be able to apply simple mathematical calculations to structural data and have a critical awareness of their advantages and limitations.
- Demonstrate understanding of the techniques for making a geological map in the field.
- Gain additional experience in identifying a variety of sedimentary and igneous rocks, along with an understanding of the processes that have generated them.
- Demonstrate knowledge and understanding of aerial photograph interpretation, the acquisition of structural data in the field, and the use of navigation and safety/risk assessment procedures in mountainous terrain.
- Demonstrate further development of report writing and data presentation skills.

Skills

Structural Geology: Acquire the ability to carry out graphical exercises, record observations neatly and systematically, perform simple mathematical calculations and visualise data in three-dimensions, use of GIS techniques for digital geological mapping, structural analysis and visualisation.

Geological Mapping: the identification of varied rock types, mapping features, field relationships, acquiring and analysing structural data etc.; Location and navigation in the field, including the use of GPS; Igneous and volcanic rock types – identification and processes; Aerial photograph interpretation; Report writing; Safety/risk assessment procedures in mountainous terrain.

Formative Assessment

Discussion of material on one-to-one basis during practical classes and in the field.

Summative Assessment

Method

Geological Mapping: Production of geological maps (field slip and fair copy), field notebook and 1500 word report, including cross-section, stratigraphic column and risk assessment (40%)

Structural Geology: Completion of data interpretation and analysis exercises set during advanced

Structural geology practical classes (20%)

Written Examination: 2 hour written examination at end of course (40%)

Dates

Geological Mapping related work – Field slip submitted on last day of field course, other assignments: End Week 8.

NB Any student obtaining an overall mark of less than 30% for the above assignments will fail module ESC-20039.

Structural Geology related work: End Week 12
Written Examination (2 hour unseen exam): January

Recommended reading
Please refer to online Library reading list available at: ESC-20039 Reading List

Wk	Lecture Titles (2 lectures per week)	Tutor
1 - 3	No lectures	
4	Fundamentals of Rock Mechanics	SLR
	Structural Mapping Techniques and Tools	SLR
5	Fold Mechanics	SLR
	Faults and Fractures	SLR
6	Shear Zones and Rock Fabrics	SLR
	Normal Faults	SLR
7	No lectures	
8	Thrust Faults	SLR
	Wrench Faults	SLR
9	Igneous intrusions and gravity controlled structures	SLR
	Plate Tectonics	SLR
10	Feedback session	SLR

Wk	Practical Classes	Tutor (s)
1	No Practical Class	
2	Field-course follow-up workshop 1	SSE/SMC
3	Field-course follow-up workshop 2	SSE/SMC
4	Introduction to ArcGIS: SW Morocco, Anti Atlas	SLR
5	ArcGIS and geological mapping: North Wales	SLR
6	Introduction to CorelDRAW: Digitising maps and figures	SLR
7	No practical class: assignment completion	
8	Structural geology orientation data	SLR
9	The use of stereonets in structural analysis	SLR
10	Faults and stresses; stress and igneous emplacement	SLR
11	Feedback session	SLR

Dates of Field Course

Location	Date	Leader
Snowdonia, North Wales	15 – 22nd September 2018 (last week of summer vacation)	Dr Stuart Egan

IMPORTANT!
All fieldwork is compulsory. Missing a field course without good cause will result in failure of the module and having to pass the field course assessments the following year. In order to pass this module, you must attain at least 30% for the field related assignments.

ESC-20036 (Autumn Semester: Geoscience only)

Module Title: Palaeoclimatology and Quaternary Studies
Module Tutors: Dr Stuart Egan (co-ordinator)
Dr Stuart Clarke, Dr Michael Montenari,
Dr Katie Szkornik and Dr Richard Waller

Module Outline

This module focuses on the occurrence, evidence for and possible causes of climate change over geological time. It also covers the study of Quaternary deposits and how they can be interpreted to understand the processes that caused their formation, as well as understanding them as indicators of palaeoenvironmental conditions. A one-day field excursion will be included to cover a variety of field techniques for mapping and interpreting superficial deposits.

Aims

To understand the occurrence, evidence for and possible causes of climate change over geological time; to study superficial deposits and how they can be mapped and interpreted to understand the processes that caused their formation, as well as understanding them as indicators of palaeoclimatic conditions.

Intended Learning Outcomes

At the end of the module students should be able to:

- Show knowledge and critical understanding of the occurrence and evidence for climate change in the geological record and to have an appreciation of the possible causes within an Earth System context.
- Demonstrate an understanding of the surface processes that have affected landscape development in the Quaternary/late Neogene.
- Identify, map and interpret superficial deposits using a variety of field and digital mapping/GIS techniques, and be able to critically analyse field observations, relating them to the processes that formed these deposits.

Skills

Description, mapping and analysis of superficial deposits; interpretation and analysis of palaeoclimatic data, including palaeoclimatic indicators and proxy records; sedimentology of superficial deposits; report writing skills; use of GIS for geological mapping.

Formative Assessment

Discussion of material on one-to-one basis during classes and in the field.

Summative Assessment

Method

Poster, plus oral presentation, on the use of proxy data in understanding past climate (25%).

Field course: 1500-word report, including supporting maps and figures related to field course (25%).

2-hour written examination at end of course (50%)

Dates

Poster submission and oral presentation – To take place during module class in Week 9.
Field course: 1500-word report, plus supporting maps, figures and notebook related to field course: End Week 12
Written Examination (2-hour unseen exam): January

Recommended reading:

Please refer to online Library reading available at: ESC-20036 Reading List.

Wk	Description (2 sessions per week)	Tutor (s)
1	No session	
2	Module Introduction	SSE
	Climate change during Earth history I: The origin of the Earth's atmosphere and climate	MM
3	Climate change during Earth history II: Snowball v. Slushball Earth	MM
	Climate change during Earth history III: causes of climate change	SSE
4	Climate change during Earth history IV: palaeoclimatic indicators	SSE
	Poster assignment briefing.	SSE
5	The Quaternary I: glacial processes and landscape evolution.	RIW
	The Quaternary II: Sea level change	KS
6	Field techniques for the description, mapping and analysis of superficial deposits	SMC/SSE
7	**Field Excursion (9th November 2018)**	SMC/SSE
8	Field Excursion Follow-up	SMC/SSE
9	Poster presentations - part 1	SSE
10	Poster presentations - part 2	SSE
11	Recent trends in climate change: global warming	SSE
12	Climate modelling	SSE

ESC-20054 (Autumn Semester: Geoscience only)

Module Title: Forensic & Historical Geoscience
Module Tutors: Dr Jamie K. Pringle (co-ordinator) and Guest Lectures

Module Outline

This module provides the Geoscience degree programme with stimulating applied topics & complementary subject matter to the course. It is divided into two complementary sections:

- Forensic Geoscience with emphasis on the forensic techniques that are used to locate burial material that may be of interest to law enforcement.
- Historical Geoscience with emphasis on both historical & modern uses of geoscience for applied purposes.

The further development of employability skills is also embedded within this module, including development of writing skills (technical reports), student-led group problem solving & computing skills.

Aims

To provide advanced knowledge & understanding of aspects of applied geoscience in forensic & historical contexts.

Intended Learning Outcomes

At the end of the module students should be able to:

- Use applied geoscience techniques that are utilised in the area of forensic investigations, as well as understanding their limitations.
- Describe the relevance of geoscience to a variety of applications.
- Effectively work as part of a student-led team to solve a geoscientific problem within a limited time frame.
- Use technical writing, numeracy, computing & presenting skills in the context of forensic and historical geoscience.

Skills

- Use a variety of geoforensic investigative equipment.
- Sensibly process, integrate & interpret a variety of geoforensic datasets.
- Apply geoscientific knowledge to historical applications.
- Write technical reports of a professional high standard.
- Research, compile & present a case study.
- Work effectively within a collaborative group.
- Develop and apply problem-solving skills.

Formative Assessment

Discussion of material on one-to-one basis during practical classes and in the field.

Summative Assessment

Method

Applied Geoforensics: Student-led, group problem-solving outdoor practical technical report (25%)
Historical Geoscience: Development of 2000-word technical report on selected case study (25%)
2-hour written examination at end of course (50%)

Dates
Applied Geoforensics technical report: End Week 7.
Historical Geoscience technical report: End Week 12
Written Examination (2-hour unseen exam): January

Recommended reading ESC-20054 Reading List
Doyle, P. 2017. Disputed Earth: geology and trench warfare on The Western Front 1914.18. Uniform Press. 978-1-910500-87-3.
Milsom & Eriksen, 2011. Field Geophysics. Wiley-Blackwell, 978-0-470-74984-5.
Ruffell & McKinley, 2008. Geoforensics. Wiley-Blackwell, ISBN 978-0-470-05735-3
Rose & Nathanail, 2000. Geology & Warfare. Geological Society of London, 1-86239-065-7.

Wk	**Lecture Titles**	**Tutor (s)**
1	No lecture	
2	Geoforensics in Law Enforcement	JKP
3	Search	JKP
4	Forensic Geophysics	JKP
5	External Guest Lecture	TBC
6	Trace Evidence	JKP
7	No classes: assignment completion	
8	Historical Geoscience 1: Romans to pre-1900	JKP
9	Historical Geoscience 2: WW1	JKP
10	Historical Geoscience 3: WW2	JKP
11	Historical Geoscience 4: Late 20th C & Future Roles	JKP
12	Guest Lecture	TBC

Wk	**Practical Classes**	**Tutor**
1	No Practical Class	
2-6	Student-led, group-problem solving practicals on simulated outdoor crime scene	JKP
7	No classes: assignment completion	
8	Medieval case studies	JKP
9	WW1 Flanders geoscience case study	JKP
10	WW2 UK & Normandy Invasion case studies	JKP
11	Late 20th Century case studies	JKP
12	Group discussions & revision classes	JKP

ESC-20002 (Spring Semester: Geology & Geoscience)

Module Title: Reconstructing Past Sedimentary Environments
Module Tutors: Dr Stuart M. Clarke (co-ordinator) & Dr Steven Rogers

Module Outline
This course demonstrates how the geomorphology of past sedimentary environments can be reconstructed from evidence in the rock record by using equivalent modern environments as a template.

Aims
The module aims to encourage a basic awareness of the use of sedimentological and stratigraphical methods in reconstructing environments of deposition.

Intended Learning Outcomes
Understanding of the concepts, principles and implications of facies analysis. To be able to review environments of sediment deposition and the facies relationships that result in the rock record. Understanding of the significance of Walther's principle of accumulation of sedimentary successions. Understand the basic effects of relative sea level change on sedimentary successions. Gain familiarity with techniques for the study of sedimentology and stratigraphy.

Skills
Logging, description and interpretation of sedimentary rock successions; undertaking a structured scientific investigation; teamwork; problem solving scenarios; likelihood assessment scenarios; fieldwork.

Formative Assessment
Assessment of practical notebooks; practical discussions and demonstrations; assessment in the field.

Summative Assessment
Method
Practical Lab work (20%)
Written work based on fieldwork (30%)
2 hour written examination (50%).

Dates
Field Trip: A Weekend in late February to early March - date TBC
Written work and labwork: Week 11 or 12
Written Examination (2 hour unseen exam): May

On-line resources
A KLE site forms an integrated part of this course and contains copies of lecture slides, practical questions, and supplementary information relating to the topics covered.

Recommended reading:

Key references:

Aitkenhead et al., The Pennines & adjacent areas. British Regional Geology 8. 4th Edition. British Geological Survey.

Collinson, J.D., Mountney, N.P. and Thompson, D.B., 2006. Sedimentary structures. Terra Publishing, England, third edition, 270 pages.

Nichols, G. 1999. Sedimentology and stratigraphy. Blackwell Science, Oxford, 355 pages.

Reading, H.G., 1996. Sedimentary environments: Processes, facies and stratigraphy. Blackwell Science, Oxford, 688 pages.

Walker, R.G. and James, N.P., 1992. Facies models: responses to sea-level change. Geological Association of Canada, Ontario, 409 pages.

Additional references:

Allen, P.A., 1997. Earth surface processes. Blackwell Science, Oxford, 404 pages.

Leeder, M.R., 1999. Sedimentology and sedimentary basins. Blackwell Science, Oxford, 592 pages.

Stow, D.A.V. Sedimentary rocks in the field. A colour guide. Manson Publishing

Tucker, M.E. and Wright, V.P., 1990. Carbonate Sedimentology. Blackwell Science, Oxford, 482 pages.

Tucker, M.E., 2001. Sedimentary Petrology. Blackwell Science, Oxford, 262 pages.

ALSO see additional references dealing with specific sedimentary environments recommended on a week-by-week basis.

Lecture Titles (2 lectures per week)	**Tutor**
Introduction: Sedimentology revisited	SMC
Facies Analysis 1: Beds and Bounding Surfaces	SMC
Facies Analysis 2: Principles & concepts	SMC
Fluvial environments I: Processes & modern systems	SMC
Fluvial environments II: Facies & stratigraphy	SMC
Aeolian Environments 1	SMC
Aeolian Environments 2	SMC
Arid Alluvial environments	SMC
Clastic coastal and shallow marine environments	SMC
Tidal & Esturine environments	SMC
Deltaic Environments	SMC
Deep Marine Environments	SMC
The Role of sediment supply	SMC
Palaeocurrent analysis	SMC
Carbonate Sediments	SLR
Controls on Carbonate Sediments	SLR
Modern Carbonates and Ancient Reefs and Mud Mounds	SLR
Shelf Carbonates	SLR
Deep Water Carbonates	SLR
Carbonate Successions and Cycles	SLR
Diagenesis and Dolomitisation	SLR
Evaporite Deposits	SLR
Linked depositional systems	SMC
Controls on depositional systems	SMC

Practical Classes	**Tutor**
Sedimentary processes revisited	SMC
Bedforms and flow	SMC
Facies Techniques	SMC
Fluvial facies models	SMC
Aeolian facies and models	SMC
Palaeogeographies	SMC
Palaeocurrent analysis	SMC
Sedimentary Petrography and Microfacies Analysis: An Intro	SLR
Reefs and Mounds (Petrography)	SLR
Shelf and Deep (Petrography)	SLR
SEM – Flipped class	SLR

Provisional Dates of Field Course

Location	Date	Leader
Mam Tor & Winnats Pass	March 2019	Dr Stuart Clarke & Dr Steven Rogers

As a major component of the module assessment relates to this field course, it is essential that you attend it.

ESC-20064 (Spring Semester: Geoscience only)

Module Title: Geochemistry
Module Tutors: Dr Ralf Halama (co-ordinator), Dr Adam Jeffery

Module Outline
This module will provide a broad introduction to the principles, applications and analytical techniques used in geochemistry. It will expose students to theoretical and practical examples of the use of geochemistry in the geological sciences through problem based practicals and report writing. It will enhance both laboratory and field skills and provide experience of geochemical techniques which are relevant to both academia and industry.

Aims
The module aims to provide students with a broad introduction to the principles, applications and analytical techniques used in geochemistry. It will expose students to theoretical and practical examples of the use of geochemistry in the geological sciences through problem based practicals. It will enhance both laboratory and field skills and provide experience of geochemical techniques which are relevant to both academia and industry.

Intended Learning Outcomes
At the end of the module students should be able to:

- Describe the chemical and physical mechanisms governing the transport and fractionation of the elements and isotopes covered with the aim to apply this knowledge to interpret future data sets.
- Assess, explain and interpret a geochemical data set in the style of a short report.
- Explain the uses of different analytical techniques available to geochemists.
- Name and explain the different isotope systems covered and recognise their uses.
- Analyse and interpret geochemical data.
- Explain the uses of different elements and isotopes in different geological settings will be achieved by assessments.

Formative Assessment
One-to -one discussion of practical material during practical classes

Summative Assessment
Practical Assessment weighted 50%

Practical test (25%): Assessment of the content covered in the practical exercises
SEM group report (25%): The SEM group report will be based on data acquired by the students at the in-house **S**canning **E**lectron **M**icroscope.

Exam weighted 50%

Two-hour unseen examination consisting of short answer and essay style questions.

Recommended Reading: ESC-20064 Reading List

Albarède, F. 2009. Geochemistry: An Introduction. Cambridge University Press, Cambridge. 342p.
White, W.M. 2013. Geochemistry. John Wiley & Sons, Chichester. 660p.
Misra, K.C. 2012. Introduction to Geochemistry. Principles and applications. Wiley-Blackwell.

Wk	Lecture / Practical Topic	Tutors
1	Introduction, Atoms & Elements	RH
2	The Nuclide Chart & Radioactive Decay	RH
3	Geochronology	RH
4	Mantle & Core	RH
5	Stable Isotopes	RH
6	Nucleosynthesis & Meteorites	RH
7	Analytical Methods	RH
8	Mineral Chemistry	AJ, RH
9	Thin section preparation & photomicroscope	AJ, RH
10	Scanning Electron Microscopy	AJ
11	Scanning Electron Microscopy	AJ
12	Scanning Electron Microscopy	AJ

ESC-20037 (Spring Semester: Geoscience only)

Module Title: Geoscience and Society
Module Tutors: Dr Ian G. Stimpson (co-ordinator)

Module Outline
The "Geoscience and Society" module develops an awareness of the essential contributions of geoscience to the economic, environmental and cultural needs of Society. It contains four main sections: "Georesources and Society" investigates the sustainability of energy and mineral resources (oil, gas, coal, geothermal; platinum, copper, gold, etc.), and other associated issues (radioactive waste disposal, carbon dioxide sequestration). "Geohazards and Society" studies the human impact of geological phenomena such as earthquakes, tsunamis, volcanoes, landslides and subsidence. "Geoscience and Health" examines topics such as asbestos, heavy metals and radon and diseases related to geology. "Geodiversity and Geoconservation" examines the designation and maintenance of sites important to geoscience (World Heritage, Geoparks, SSSIs, RIGS), together with their place in planning and public understanding of geoscience.

Aims
The module aims to develop an awareness of the essential contributions of geoscience to the economic, environmental and cultural needs of Society.

Intended Learning Outcomes
To be able to demonstrate, critically evaluate, communicate effectively and apply awareness and informed concern of Earth science challenges in the exploration for, and the development and exploitation of, Earth resources; geological aspects of human impacts on the environment; geohazards and their impacts on human societies, geodiversity; demand and scarcity; demand for, and consequences of, energy and material production and use, including alternatives; approaches to, and limitations of environmental management systems; role of institutions in regulation and management of the environment; environmental policy formulation, legislation and decision making.

Formative Assessment
Practical discussions and demonstrations; discussion in the field.

Summative Assessment
Method
Oral PowerPoint Presentation (15%)
Field course Poster & Site Documentation (35%)
Two hour written examination (50%).
Dates
PowerPoint and Presentation: End week 6 or 7
Poster & Site Documentation: End week 12
Written Examination (2-hour unseen exam): May

Recommended reading:
GRAY, M. (2013) Geodiversity: Valuing and Conserving Abiotic Nature, 2nd Edition, Wiley

Week	Lecture Titles	Tutor
1	Introduction to "Geoscience and Society"	IGS
Geoconservation & Geodiversity		
1	Introduction to geodiversity and geoconservation	IGS
2	Geoconservation framework and designation	IGS
Geoscience & Hazards		
2	Geoscience & Health	IGS
3	Subsidence Hazard	IGS
3	Landslide Hazard	IGS
4	Earthquake Hazard	IGS
4	Tsunami hazard	IGS
Geoscience & Energy		
5	Clean coal	IGS
5	Carbon Dioxide Sequestration	IGS
8	Geothermal Energy	IGS
8	Nuclear Power & Radioactive waste	IGS
9	Oil & Gas: conventional & unconventional	IGS
10	Geoengineering	IGS
Geoscience & Ethics		
10	Geoethics	IGS
Geosciences & Resources		
6 & 7	Resources Presentations	ALL

Week	Practical Classes	Tutor
1	Spring Water	IGS
2	Geoscience & Society Issues Discussion	ALL
3	Site Condition Monitoring	IGS
4	Resource Exercise Preparation	IGS
10	Field Course Preparation	IGS
11	Field Course Follow-Up Work	IGS

Dates of Field Course

Location	Date	Leader
Brown End	30 March 2019	Dr Ian Stimpson

IMPORTANT!

All fieldwork is compulsory. Missing a field course without good cause will result in failure of the module and having to pass the field course assessments the following year. In order to pass this module, you MUST attain at least 30% for the field related assignments.

ESC-20040 (Spring Semester: Geology & Geoscience)

Module Title: Geoscience Field Techniques
Module Tutors: Dr Jamie Pringle (co-ordinator) Dr Stuart M. Clarke, Dr Stuart Egan & Dr Ian G. Stimpson.

Module Outline

This module comprises four units, one is a lecture/practical format, one is based on a residential field course & two involve individual coursework:

- Unit A: Careers Preparation (lectures, workshop and personal research)
- Unit B: Geophysics Field techniques (lectures and associated practical classes).
- Unit C: Structural and sedimentological field techniques – Almeria (Geology) or Western USA (Geoscience) [residential field course].
- Unit D: Individual research (Independent mapping preparation OR Independent geophysics technique review plus fieldwork first aid training)

Summative Assessment:

Method

The allocation of marks for the overall assessment of the module is as follows:

- Unit A 5%
- Unit B 40%
- Unit C 40%
- Unit D 15%

On-line resources: Located on the Keele Virtual Learning Environment

Wk	Lecture Titles (2 lectures per week)	Tutor (s)
1	Introduction to course and requirements (inc. logistics)	JKP/SSE
	Briefing on Independent Literature review (Unit D)	IGS
2	General careers & geoscience careers (Unit A)	IGS
	Writing a CV & applying for jobs (Unit A)	IGS
3	Introduction to Field Geophysics	JKP
	Electrical methods / EM methods	JKP
4	Magnetics 1	JKP
	Magnetics 2	JKP
5	Utah/Almeria briefing (Unit C)	SMC/IGS
	Gravity	JKP
6	Ground-penetrating radar 1	JKP
	Ground-penetrating radar 2	JKP
7	Introduction to lithostratigraphic mapping	SMC
	Seismic methods	JKP
8	Surveying	JKP/BD
9	Geophysics Review	JKP

Wk	Taught Practical Classes	Tutor
UNIT D: Independent Mapping Preparation		
1	Fieldwork First Aid	External
2	Fieldwork First Aid	External
UNIT B: Environmental Geophysics		
3	Resistivity equipment, data processing & interpretation	JKP
4	Magnetics equipment, data processing & interpretation	JKP
5	Gravity equipment, data processing & interpretation	JKP
6	GPR equipment, data processing & interpretation	JKP
7	Seismic equipment, data processing & interpretation	JKP
8	Surveying equipment, data processing	JKP
9	Educational geoscience e-gaming	JKP
UNIT D: Independent Mapping Preparation		
10	Introduction to Lithostratigraphic mapping	SMC

UNIT A: Careers Preparation

Unit Tutor: Dr Ian G. Stimpson (co-ordinator)

Outline

Personal career development, including profiling and personal reflection.

Aims

For students to create a CV and covering letter for a job application.

Intended Learning Outcomes

Students will become familiar with writing and updating a CV and covering letter to assist them with potential summer placement or graduate job applications.

Summative Assessment

Method

Applying for a job as a geoscientist (role researching, drafting a CV and covering letter) (5%)

Dates

Completion of CV & Covering letter: End week 5

On-line resources: Located on the Keele Virtual Learning Environment.

UNIT B: Near Surface Geophysics Field Techniques

Unit Tutor: Dr Jamie Pringle (module co-ordinator)

Outline

The fundamental principles, applications and issues of near-surface site problems and their potential geophysical field solutions will be developed. Field-based practical classes will develop an understanding of near-surface geophysical exploration techniques, with associated laboratory elements of data processing and interpretation that will aid students' understanding of practical solutions.

Aims
This section of the module aims to introduce key concepts in near-surface geophysics through both theory & practice.

Intended Learning Outcomes
- Be able to operate near-surface geophysical equipment and be able to process the resulting data and sensibly interpret it.
- Be able to design an appropriate survey for an environmental or geotechnical investigation.

Skills
Operation of near-surface geophysical equipment and processing and sensible interpretation of the resulting data; use of numerical techniques; learning of interpretive skills.

Formative Assessment
Discussions during practical demonstrations, sessions and debriefing at the end of the practical sessions.

Summative Assessment
Method
Submission of practical exercises (40%).

Dates
Practical exercises- all will be assessed

On-line resources: Located on the Keele Virtual Learning Environment

Recommended Reading
Milsom, J. & Eriksen, A., 2011, Field Geophysics, 4th Ed., Geological Field Guide Series, John Wiley & Sons Ltd.
Reynolds, J. M., 2011, An introduction to Applied and Environmental geophysics, 2nd Ed., Wiley.

UNIT C: Geology Field Techniques - Overseas field course
Unit Tutor: Dr Stuart Clarke (module co-ordinator), Dr Stuart Egan and Dr Ian Stimpson

Outline
This unit involves a residential field course, either to Almeria at Easter or to the Western USA in early summer.

Aims
The course aims to demonstrate the structure, development and sedimentary basin fill of a major geological province.

Intended Learning Outcomes

- Students will have integrated strands of geology studied in Years 1 and 2, particularly structural geology and sedimentology, and have related them to the evolution of a major non-UK geo-tectonic province.
- Be competent in geological field observation, data recording and analysis.
- Be able to work efficiently and present a team project.

Skills

Making precise geological observations and systematic recording of geological notes in a notebook; structural and sedimentological statistical data analysis and interpretation; production and verbal poster presentation as part of a team.

Formative Assessment

Personal interaction/discussion/demonstration in the field; submission of field notebooks for comments.

Summative Assessment

Method

Poster/teamwork exercise on an aspect of the geology of the field course area, to be completed prior to field course (30%)
Marking of field notebooks (30%)
Work completed during field course in the form of 4 set tasks (40%)
Unit mark will form 40% of module

Any student obtaining overall mark of less than 30% for above assignments will fail module ESC-20040.

Dates

Poster/teamwork exercise: End week 9
Submission of notebooks/exercises: during the field course

Provisional Dates of Field Courses (TBC - subject to flights)

Almeria	20-27 April 2019
Utah	18 June – 1 July 2019

Recommended Reading

Barnes & Lisle (2004) Basic Geological Mapping (3rd Ed.), Geological Field Guide Series, Wiley & Sons Ltd.
McClay (1999) The Mapping of Geological Structures Geological Field Guide Series, Wiley & Sons Ltd.
Stow, D.A.V. (2005) Sedimentary Rocks in the Field - A Colour Guide. Manson publishing.

UNIT D: Independent Field Project Preparation/Geophysics Technique Review

Unit Tutor: Dr Stuart Clarke (co-ordinator), Dr Jamie Pringle and Dr Ian Stimpson

Outline
Independent Geological Fieldwork (ESC-30039) is a compulsory 3rd year module for Dual Honours Geology students, and Independent Fieldwork Project (ESC-30032) is a compulsory 3rd year double-module for Single Honours Geoscience students. Both modules involve fieldwork that takes place during the summer vacation preceding the 3rd year, and both modules continue throughout the Autumn Semester of the 3rd year.

For single honours Geoscience students, and students intending to study Geology at level 3 as part of the Dual Honours and Major Geology or MGeoscience programmes, Unit D will involve researching literature and producing an independent literature review for their independent field project. This literature review forms the assessment for Unit D, and will form the basis of the literature review chapter that is an essential component of the third year project dissertation. The unit also includes two sessions on fieldwork first aid from an external training provider.

For Dual Honours students intending to major in their other subject, Unit D will involve creating an independent literature search of a chosen geophysical field technique, with a report produced and handed in for assessment.

Aims
This section of the module aims for students to become familiar with either the subject matter of their 3rd year independent field project, or that of a chosen near-surface geophysical field technique and its application.

Intended Learning Outcomes
Students will be able to source background material and write an independent structured literature review.

Skills
Ability to source relevant literature of a chosen topic or area, critically review and produce a polished report.

Formative Assessment
Either discussions with independent project supervisors on the scope, logistics and background literature, or discussions with geophysics lecturer on a chosen geophysical field technique.

Summative Assessment
Method Literature Review (15%)
Dates Literature Review: End week 9

On-line resources: Located on the Keele Virtual Learning Environment
Recommended Reading Identified through discussion with project advisor(s).

Preparation for Level 6 (Year 3) Geology & Geoscience: Independent Project Guidelines

ESC- 30032 Geoscience: Independent Field Project
ESC- 30039 Geology: Independent Fieldwork Project
Module Tutor: Dr Stuart Clarke (co-ordinator)

As part of your third year degree course, you are required to undertake an independent field project in the summer vacation between your second and third years. For Dual Honours / Major Route Geology students this will involve three weeks mapping, for Single Honours Geoscience, five weeks.

Students proposing to take a Major route in their other Principal Subject must make arrangements to carry out Independent Fieldwork, in case their desire to progress to the Major route is frustrated for whatever reason.

A detailed overview of the Independent Field Project will be provided at the beginning of semester 2 as part of module ESC-20040 (Geoscience Field Techniques).

Aim
To carry out an independent geology/geoscience field project that includes a significant component of geological mapping.

Staff
Project advice will be provided by a member of the Geology staff

Location
Students select their own area subject to approval by the module coordinator.

Description
Students are normally expected to carry out fieldwork as part of the independent field project. Geoscience students will map for five weeks, Geology students for three weeks. This amount of time is compatible with similar geology/geoscience degree programmes at other universities. The project must include a significant component of geological mapping and for Single Honours Geoscience students additionally include a focused study on some aspect of the study area selected (e.g. palaeontology, structural geology, etc.). The area mapped should be approximately 6 square kilometres for Geology and 12 square kilometres for Geoscience, but it may be larger or smaller depending on its geological complexity and available exposure. Students carry out the field component of the module during the summer break between years 2 and 3. The interpretation and analysis of the field data and the write-up of the project dissertation takes place during the Autumn Semester of Year 3, with Geoscience students working on their focused study in the Spring Semester. Students are expected, as a safety measure, to carry out fieldwork in pairs; however, each student must produce an independent notebook, field slips, fair copy map and dissertation. Alternatively, students can arrange to have a field assistant with them for health and safety reasons.

Assessment
Geoscience students should note that the independent field project represents a double-module and is worth 30 credits whereas for Geology it is a 15 credit module. Summative assessment of projects is based on the field map, field notebook, fair copy map, cross-sections, a research report and additionally for Geoscience students a Special Topic poster and presentation. Full details are available in the Year 3 module catalogue.

Dates
Fieldwork can be carried out at any time during the summer vacation between years 2 and 3 although it is advisable to avoid the semester 2 resit week in August if you have reassessment for a failed semester 2 module.

It is expected that students will have regular meetings with their project advisor during year 3.