FHEQ Level 6: Year 3
Geology & Geoscience
Module Catalogue
2018-2019

Keele University

Work Portfolio

You are reminded to 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 early May 2019 for scrutiny by the External Examiners. MGeoscience students will submit their final portfolios prior to graduation in 2020.

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 6 (Year 3) you have the option to study several modules which highlight the need for geologists in the sustainability process, for example, modules which focus on economic geology, natural hazards and engineering geology. Communicating the impact of geological phenomena and processes is highlighted in a bespoke module available to some students. 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-30039 (Autumn Semester: Geology Core)

Module Title: Geology: Independent Fieldwork Project
Module Tutors: Dr Stuart M. Clarke (co-ordinator)

Module Outline

This module builds upon subject-specific and practical skills that have been developed in previous years of the course to carry out an independent field-based investigation within an area of Geology. The module will include data collection, data analysis, data interpretation and report production, and will normally be underpinned by approximately 21 days of geological fieldwork carried out in the summer vacation before the start of the final year. The completion of this module provides students with experience of a number of subject-specific and general skills that are essential for geological employment or academic research.

Aims

To provide a detailed understanding of field geology. To determine geological features and processes in a field context. To demonstrate ability to take effective notes in the field and complete geological maps. To develop skills in authoring in the form of a research dissertation. To demonstrate the use of geographical information systems and remote sensing techniques in visualising and analysing geoscience data. To develop students' communication, time-management and self-management skills.

Intended Learning Outcomes

- Apply knowledge and understanding of advanced geological mapping using techniques that are at the forefront of the discipline.
- Use intellectual and critical assessment skills to:
    - critically analyse geoscience information.
    - synthesise and evaluate information and data from a variety of sources to establish and discern connections.
    - demonstrate and exercise independence of mind and thought.
- Use practical skills in making effective field notes, making a geological map, identifying rocks, minerals, fossils and geological structures, interpreting an environment of deposition, and synthesising a geological history from field relationships.
- Further develop transferable skills by communicating effectively in writing, cartography and map preparation, using computing and information technology (e.g. GIS & drawing/presentation packages), managing resources and time, working to a deadline, and working independently showing critical enquiry.

Skills

Ability to write a scientific report and make a geological map; application of learnt skills (structural data manipulation, sedimentology, palaeontology, petrography, geophysics etc.) to students' own data; digital cartographical and drafting skills; GIS; development and integration of a wide range of geological skills; report writing and time management.

Formative Assessment
All components are formatively assessment via feedback during supervision in the field and workshops. In addition, formative assessment will be provided on first drafts of the following work:

- Geological cross-section
- Stratigraphical Descriptions chapter

Summative Assessment
Method
Dissertation and geological faircopy map detailing the geological investigations and evolution of the student's chosen area of study (100%)

Dates
Mapping dissertation - end Week 12

Note that the dissertation comprises various components including fieldslips, field notebooks, faircopy map (with GVS and cross sections) and the report. The deadlines for some of these components are earlier in the semester

The completed dissertation must be submitted in a folder provided for the purpose by the Office staff in the William Smith Building. More information on the detailed requirements is given on the course website.

On-line resources: A dedicated website supports this module.

Recommended reading
Barnes, J.W. & Lisle, J.L. (2004) Basic Geological Mapping (Fourth Edition). Wiley

ESC-30032 (Autumn Semester: Geoscience Core)

Module Title: Geoscience: Independent Field Project (Double Module)
Module Tutors: Dr Stuart Clarke (co-ordinator)

Independent Fieldwork: Students will be assigned a mapping supervisor

Module Outline

This double-module builds upon subject-specific and practical skills that have been developed in previous years of the course to carry out an independent field-based investigation within an area of Geoscience. The module will include project formulation, research design, data collection, data analysis, data interpretation and report production, and will normally be underpinned by approximately 35 days of geological fieldwork carried out in the summer vacation before the start of the final year. The completion of this module provides students with experience of a number of subject-specific and general skills that are essential for geoscience employment or academic research.

Aims

- To provide a detailed understanding of field aspects of geoscience.
- To develop students' ability to take effective notes in the field and compile geological maps interpretations.
- To develop students' skills in presentations in the form of a dissertation and poster.
- To develop students' ability in the use of geographical information systems and remote sensing techniques in visualising and analysing geoscience data.
- To develop students' communication, time-management and self-management skills through independent study.

Intended Learning Outcomes

- At the end of the module students should be able to:
- select and apply advanced geological mapping / geophysical surveying / geochemical surveying techniques that are at the forefront of the discipline.
- critically analyse geoscience information; synthesise and evaluate information and data from a variety of sources, as well as establish and discern connections; demonstrate and exercise independence of mind and thought.
- use practical skills in making effective field notes; make a geological map or construct geophysical and geochemical interpretations; identify rocks, minerals, fossils and geological structures; interpret an environment of deposition; synthesise a geological history from field relationships.

Skills

Use transferable skills by communicating effectively in writing, cartography and map preparation, use computing and information technology (e.g. GIS), manage resources and time, work to a deadline, and work independently showing critical enquiry.

Formative Assessment
All components are formatively assessed via feedback during supervision in the field and workshops. In addition, formative assessment will be provided on first drafts of the following work:

- Geological cross-section
- Stratigraphical Descriptions chapter

Summative Assessment
Students should note that the independent field project represents a double-module and is worth 30 credits

Method:
Summative assessment of mapping projects is based on the following components

- Mapping Dissertation (weighting 85%):
- Poster-based visual summary & presentation of special topic (15%)

Dates
Dissertation March (See the course website for details).
Poster presentations will be scheduled sometime during week 12 following submission.

The completed dissertation must be submitted in a folder provided for the purpose by the Office staff in the William Smith Building. Your poster must also be submitted at the same time.

Note that the dissertation comprises various components including fieldslips, field notebooks, faircopy map (with GVS and cross sections) and the report. The deadlines for some of these components are earlier in the semester.

On-line resources: A dedicated website supports this course.

Recommended reading
Barnes, J.W. & Lisle, J.L. (2004) Basic Geological Mapping (Fourth Edition). Wiley

ESC-30009 (Autumn Semester: Geology & Geoscience Option)

Module Title: Natural Hazards
Module Tutors: Dr Jamie Pringle (co-ordinator)
Dr Ralf Gertisser, Dr Mike Musgrave

Module Outline
This module examines the causes and characteristics of a broad variety of natural hazards and their destructive impact on human society. These hazards range from small-scale to large-scale events, from relatively minor disturbances to catastrophic disasters, and are associated with both environmental and anthropogenic triggers. Particular attention is paid to the assessment of risk and the steps that can be taken to prevent or mitigate the damage and disruption associated with these processes.

Aims
This module aims to evaluate and analysis the causes of a variety of natural hazards, to investigate their potential impacts on human society and infrastructure, & to evaluate measures that can be taken to mitigate and predict their destructive effects.

Intended Learning Outcomes
Upon successful completion of the course, students will be able to:

- Analyse and evaluate the causes and dangers associated with specific natural hazards.
- Assess and quantify the risk posed by natural hazards in a variety of hypothetical situations.
- Evaluate the techniques that can be used to predict & mitigate the impacts of natural hazards & evaluate the most appropriate measures for varying circumstances.

Skills
(1) Analysis, interpretation & manipulation of a variety of scientific data to assess the risk posed by natural hazards; (2) Evaluation of the most suitable measures to prevent or minimise their effects in various circumstances; (3) Further development of written communication skills through focus groups and coursework assessments respectively.

Formative Assessment
Feedback on coursework.

Summative Assessment
Method
Individual Technical Report (50%)
2-hour written examination (50%)
Note long answer questions based on practical content

Dates
Individual technical report submission – end week 12
Written examination - January

Recommended reading: ESC-30009 Reading List
Key References:

- Bryant, 2005. Natural Hazards. 2nd edition, Cambridge University Press.
- Smith & Petley, 2013. Environmental Hazards. 6th edition, Routledge.

Details of literature relating to specific natural hazards will be provided in the relevant lectures.
Useful Websites:
Centre for Research on the Epidemiology of Disasters (CRED) (http://www.cred.be)
NASA Earth Observatory (http://earthobservatory.nasa.gov/NaturalHazards/)
Natural Hazards Center at the University of Colorado, Boulder
(http://www.colorado.edu/hazards/)
Natural Hazards Databases at the National Geophysical Data Center, U.S.A.
(http://www.ngdc.noaa.gov/hazard/hazards.shtml)
U.S. Geological Survey (http://www.usgs.gov/themes/hazard.html)
Natural Hazards.org (http://www.naturalhazards.org)
Benfield Greig Hazard Research Centre (http://www.abuhrc.org/Pages/index.aspx)

Wk	**Lectures**	**Tutor(s)**
1	Intro. & risk assessment, management/mitigation & assessments	JP
2	Tectonic hazards I & II: earthquakes	JP
4	Large-scale & localised storm hazards, hydrological hazards I & II: floods & droughts & ocean hazards	MM
7	No classes	
8	Tectonic hazards III-V: volcanoes	RG
10	Technological Hazards I & II: manmade & induced subsidence	JP

Wk	Practicals	Tutor
3	Earthquake hazards: case study	JP
5	Hydrological hazards: case study	MM
7	No classes – optional drop-in problem solving session	JP
9	Volcanic hazards: case study	RG
11	Manmade hazards: case study	JP
12	-	

ESC-30028 (Autumn Semester: Geoscience Core & Geology Option)

Module Title: Economic Geology
Module Tutors: Dr Ralf Halama (co-ordinator)
Dr Stuart Clarke, Dr Stuart Egan

Module Outline

Processes and mechanisms of ore body formation are taught, together with a review of exploration techniques. The course also covers aggregate materials and coal deposits in terms of their production and uses. The module will include field excursions (e.g. to a mineral mine).

Aims

The module aims to provide students with a knowledge and understanding of:

- the petrological controls on igneous and metasomatic ore body formation and their mineral exploration methods
- aggregate production and uses
- the formation, exploration and production of coal

Intended Learning Outcomes

- Knowledge and systematic understanding of the processes and mechanisms of igneous and metamorphic ore formation, some at or informed by research at the forefront of the subject.
- Critical awareness of exploration techniques and economic considerations in ore body assessment.
- Knowledge and understanding of aggregate materials in terms of their production and economic uses.
- Knowledge and understanding of the formation, exploration and production of coal, as well as a critical awareness of future reserves and the environmental implications of coal production and usage.
- Familiarity with techniques used for the mining of minerals and coal.
- Further development of oral presentation and report writing skills.

Formative Assessment

Feedback/discussion during practical classes and field excursions.

Summative Assessment

Method

Portfolio of practical exercises (30%)
Independent research exercise (20%)
2-hour examination paper (50%)

Dates

Ore deposit practicals - Week 8

Independent research exercise – Week 9
Practical assignment on mapping of coal resources – Week 12
2-hour examination paper (50%) - January

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

Recommended reading: **ESC-30028 Reading List**

EVANS, A.M. Ore geology and industrial minerals. Blackwell Science (3rd Edition).
HURAI, HURAIOVA, SLOBODNIK, THOMAS. Geofluids. Elsevier (1st Edition).
THOMAS, L. Coal Geology. Wiley (2nd Edition).
POHL, W.L. Economic Geology - Principles and Practice. Wiley-Blackwell.
RIDLEY, J. Ore deposit geology. Cambridge University Press.
ROBB, L. Introduction to ore-forming processes. Blackwell Publishing.

Wk	Lecture Titles (2 lectures per week)
1	Module Introduction & Introduction to Ore Geology
2	Igneous ore-forming processes
3	Magmatic-hydrothermal ore-forming processes
4	Hydrothermal ore-forming processes
5	No lectures
6	Sedimentary & supergene ore deposits
7	Ore Mine Visit, Ecton Mine: Monday (5/11/18) OR Tuesday (6/11/18)
8	Industrial minerals
9	Aggregate materials
10	Coal I: Coal formation
11	Coal II: Mining methods, coal bed methane and World coal production
12	Independent revision

Wk	Practical Title
1	No practical
2	Practical ore deposits I
3	Practical ore deposits II
4	Practical ore deposits III
5	No practical
6	Practical ore deposits IV
7	Ore Mine Visit (Ecton Mine): Monday (5/11/18) OR Tuesday (6/11/18)
8	Completion of ore deposit practicals
9	Tunnelling, excavation and foundation
10	Mapping and Calculation of Coal Resources
11	No practical
12	Independent revision

ESC-30036 (Autumn Semester: Geology & Geoscience Option)

Module Title: Exploration Geophysics for the Hydrocarbon Industry
Module Tutors: Dr Ian G. Stimpson (co-ordinator)

Module Outline
This module investigates the use of exploration geophysics techniques employed in the search for hydrocarbons, including borehole geophysical methods and the acquisition, processing and interpretation of seismic reflection data. The module's aim is to equip the student with the vocabulary, knowledge and technical expertise to enter a career as a hydrocarbon exploration industry geophysicist.

Aims
This module aims to enhance the students' knowledge and critical understanding of exploration geophysics, particularly those techniques employed in the exploration for hydrocarbons, and to equip the student with the vocabulary and technical expertise to enter a career as a hydrocarbon exploration industry geophysicist.

Intended Learning Outcomes
- An ability to describe and critically assess the methods of reflection seismic data acquisition, processing and interpretation.
- An ability to describe and critically assess borehole geophysical data acquisition and interpretation.
- An understanding of the vocabulary, skills, knowledge and technical expertise to enter a career as a hydrocarbon industry geophysicist.
- An ability to write a technical report in a format compatible with the hydrocarbon industry.

Teaching Format
The module is taught via linked through lectures and a series of linked practicals.

Formative Assessment
Verbal feedback during practical sessions and written comments on submitted work.

Summative Assessment
Method
Practical exercises submitted as part of a technical report 50%
2hr formal examination 50%

Dates
Hydrocarbon field technical report – end week 10
Examination - January

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

Recommended reading: ESC-30036 Reading List

Reynolds, J.M., An Introduction to Applied and Environmental Geophysics, Wiley

Yilmaz, O. Seismic Data Analysis http://wiki.seg.org/wiki/Seismic_Data_Analysis

Week	Lecture Titles (2 lectures per week)	Tutor
1	Borehole Geophysics (NB: In Practical Timetable Slot)	IGS
2	Seismic Sections	IGS
2	Seismic Waves	IGS
3	Moveout	IGS
3	Seismic Sources	IGS
4	Seismic Receivers and Instrumentation	IGS
4	Survey Design	IGS
5	Convolution & Deconvolution	IGS
5	Seismic Processing Introduction	IGS
6	Main Processing	IGS
8	Migration 1	IGS
8	Migration 2	IGS
9	Seismic Resolution & Interpretation Techniques	IGS
9	Seismic Stratigraphy	IGS
10	Hydrocarbon Detection	IGS
10	Vertical Seismic Profiles	IGS

Note Week 7: No Lecture

	Practical Classes	Tutor
1	(Borehole Geophysics Lectures - see above)	IGS
2	Borehole Geophysics	IGS
3	Synthetic Seismograms	IGS
4	Well Tying	IGS
5	Section Interpretation	IGS
6	Time-structure Map	IGS
8	Chronostratigraphy	IGS
9 & 10	Workstation Interpretation	IGS

ESC-30008 (Spring Semester: Geology & Geoscience Option)

Module Title: Structure and Geodynamics
Module Tutors: Dr Stuart S. Egan (co-ordinator) & Dr Steven Rogers

Module Outline
This module uses lecture and practical classes to study the structural and geodynamic effects associated with continental tectonics. Extensional, compressional, inversion, wrench/strike-slip regimes are studied at both regional and local scales. The structure part of the course explains the structural styles exhibited in each of these regimes. In addition, the analysis of a variety of geological and geophysical data during practical classes provides an understanding of the formation and evolution of geological features such as extensional sedimentary basins and mountain belt-foreland basin couplets. Extensional and inversion tectonics are also illustrated during a field weekend in SW England.

The geodynamics component of the course concentrates upon explaining the fundamental processes that occur within the lithosphere during continental tectonics. Emphasis is placed upon mechanical, thermal, rheological and isostatic controls upon basin formation. The practical element of this part of the course provides an introduction to the numerical and computer modelling of geological processes.

Aims
The module aims to teach students the concepts, processes and physical structures associated with continental tectonics.

Intended Learning Outcomes
Students will gain knowledge and understanding of the large scale tectonic evolution of geological features occurring in extensional, compressional, inversion and wrench continental tectonic regimes. They will have used geological maps and seismic reflection profiles to become familiar with the structural geology of sedimentary basins in a variety of tectonic settings. They will be familiar with the mechanical, thermal, rheological and isostatic behaviour of the continental lithosphere during continental tectonics.

Skills
Geological: Seismic reflection interpretation, structural interpretation of geological maps and cross-sections, collection and analysis of structural data in the field, aerial photograph mapping, introduction to the numerical/computer modelling of geological processes.

Transferable: Introduction to numerical modelling techniques; use of spreadsheet software for data entry and display, and numerical modelling; extraction of scientific information from academic papers.

Formative Assessment
Discussion of course material with students in practical classes and during fieldwork; provide one-to-one feedback during completion of structural interpretation and modelling exercises.

Summative Assessment
Method
Structure: Interpretation and analysis of seismic reflection profiles in practical classes, and aerial photograph mapping and structural interpretation based on module field course (25%).
Geodynamics: Worksheets 1 and 2 on modelling lithosphere extension and basin formation using spreadsheet software; Worksheet 3 on structural and isostatic modelling of extensional fault movement; Worksheet 4 on flexural isostasy. The four worksheets are worth 25% of the module marks. Each worksheet has equal weighting.
Two-hour written examination (50%).

Dates
Structural data interpretation and analysis - End Week 10
Field course assignments - End Week 10
Geodynamics practical exercises – Worksheet 1 - End Week 9; Worksheet 2 - End Week 10; Worksheet 3 - End Week 11; Worksheet 4 - End Week 12.
Written Examination - May 2019

Recommended reading
Please refer to on-line Library reading list for the module available at:
ESC-30008 Reading List

Wk	Lecture Titles (2 lectures per week)	Tutor (s)
1	Tectonic controls on sedimentary basins	SR
	Extensional tectonics - rift-related basins and passive margins	SR
2	Thrust tectonics	SR
	Thrust-related basins - foreland basins	SR
3	Wrench tectonics	SR
	Wrench-related basins - pull-apart basins	SR
4	Inversion tectonics	SR
	Halokinesis - salt related structures	SR
5	Seismic expression of structural styles	SR
6	No lectures	
7	Lithosphere extension and sedimentary basin formation: part 1	SSE
	Lithosphere extension and sedimentary basin formation: part 2	SSE
8	Lithosphere rheology	SSE
	Tectonic loading and flexural isostasy	SSE
9	Lithosphere shortening: The evolution of mountain belt-foreland basin couplets	SSE
	Basin inversion and orogenic collapse: Geodynamic controls	SSE
10	Magma generation and metamorphism in extensional and compressional environments	SSE

Wk	Practical Classes	Tutor (s)
1	Rift-related basins - seismic reflection sections plus maps	SR
2	Thrust-related basins - seismic data plus geological map	SR
3	Wrench tectonics - analysis in map and section	SR
4	Inversion tectonics - recognition in maps and seismic data	SR
5	Seismic expression of structural styles	SR
6	Watchet field course follow-up session	SR/SSE
7	Modelling of lithosphere extension and basin formation 1	SSE
8	Modelling of lithosphere extension and basin formation 2	SSE
9	Structural and isostatic modelling of extensional faulting	SSE
10	Modelling of flexure in response to tectonic loading	SSE

Dates of Field Course:

Extensional and inversion tectonics in the Watchet area of SW England, 23 - 24 February 2019.

ESC-30022 (Spring Semester: Geology & Geoscience Option)

Module Title: Hydrological and Engineering Geology
Module Tutors: Dr Glenda Jones (co-ordinator)

Module Outline
This module uses lecture and practical classes to look at the related subjects of engineering and hydrological geology from a coherent, practical perspective. In particular, students will focus on the way in which geological factors influence the availability of water resources and the design/construction of 'real-world' engineering structures. Practical classes will concentrate on the analysis, evaluation and characterization of geological materials and the interpretation and remediation assessment of a realistic geotechnical engineering problem.

Aims
The aim of the module is to teach students the key theoretical and technical issues of hydrological and engineering geology whilst providing a practical understanding of groundwater, and rock and soil behaviour through the use of problem-based exercises relating to the management and assessment of natural resource exploitation and site development.

Intended Learning Outcomes
Students will gain a systematic knowledge and understanding of the key issues relating to the theoretical and practical aspects of Hydrological and Engineering Geology. At the end of the module, students will be able to make informed judgments on the issues, debates and knowledge limitations of subjects in groundwater assessment, geotechnical engineering and environmental geology management, based on a knowledge and understanding of research at the forefront of the discipline.

Skills
Geological: Theoretical and practical evaluation of groundwater and aquifer systems; rock and material properties, hydrological properties, laboratory analysis techniques; ground water resource extraction and exploitation; theoretical and practical evaluation of engineering structures and their design, construction maintenance and geo-environmental impact.

Transferable: Carrying out, recording and describing experimental work, use of PCs, use of spreadsheets for data entry and display, creation and use of numerical analysis. Be able to present and analyse information in a clear and coherent form appropriate to the conventions and standards of scientific communication.

Formative Assessment
Discussion of course material with students in practical classes and lectures; in-class quiz exercises (peer & self-assessed) and debate sessions/exercises.

Summative Assessment

Method

Two assignments in which each student explains and evaluates a specific analysis technique or subject area, plus a problem-based, 'real-world' learning exercise on ground engineering related site characterisation and risk mapping.
Hydrological assignment (10%)
Engineering Geology assignment (10%)
Problem-based, risk mapping and site development exercise (30%)
Formal written examination (50%).

Dates

Hydrological & Engineering Geology assignment – week 4
Problem-based exercise – week 9
Examination – May

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

Recommended reading

Recommended Texts:
Barnes G. E., 2016. Soil Mechanics (4th Edition), Palgrave MacMillan, (ISBN 0 333 77776 X)
Waltham, T., 2009. Foundations of Engineering Geology (3rd Edition), Spon Press (ISBN 10 0 415 46960 0)

Additional Texts:
Hiscock K. M. 2005. Hydrogeology: Principles and Practice, Blackwell, (ISBN 0 632 05763 7).
Murthy, V. N. S. 2003. Geotechnical Engineering: principles and practices of soil mechanics and foundation engineering. Marcel Deker, (ISBN 0 824 70873 3).

On-line Journals via Keele Information Services:
Engineering Geology
Geotechnical and Geological Engineering
Journal of Contaminant Hydrology
Water Resources
Water Research

Lecture Titles (2 lectures per week; weeks 1-9)

20 x 1-hour lectures in five sections with web-based support:

- Fundamentals of Hydrological and Engineering Geology - Materials: Rock and material properties, hydrological properties, laboratory analysis techniques.
- Fundamentals of Hydrological and Engineering Geology: assessing subsidence and slope stability & their engineering solutions.

- Issues and Debates – Engineering Geology: Current issues and problems associated with common engineering structures and their design, construction maintenance and geo-environmental impact.
- Geotechnical skill development: site assessment strategies and protocols
- Case studies of engineering problems and their solutions
- Campus site tour of engineering items of interest
- Addressing the problem: Practical application of current characterisation, analysis and modelling techniques for the assessment and prediction of Hydrological and Engineering Geology problems.

PRACTICAL CLASSES (Weeks 1 – 11)

10 x 3-hour practical classes in three sections with web-based support:

- Determining Hydrological & Behavioural Properties of Soil (2 practical sessions): Atterberg Limits & Laboratory Hydraulic conductivity/permeability measurement.
- Determining Geomechanical properties (2 practical sessions): Triaxial compression tests and the evaluation of rock/soil failure and cohesion using Mohr Circles
- Problem-based learning exercise (4 practical sessions): The analysis, evaluation, characterization, interpretation and remediation assessment of a 'real-world' geotechnical engineering problem that includes elements of both hydrological and geomechanical property modelling/evaluation using spreadsheets and report writing.
- Campus tour investigating engineering good / bad practice examples

ESC-30025 (Spring Semester: Geology & Geoscience Option)

Module Title: Micropalaeontology: Principles and Applications
Module Tutors: Dr Michael Montenari (co-ordinator)

Module Outline
This course involves the study of major microfossil groups, their palaeogeographical, palaeoecological and biostratigraphical potential. An overview of the most important palaeoecological processes is presented. An introduction to state-of-the art Electron microscopic techniques (Fe-SEM and TEM) is included within this module.

Aims
The aim of the micropalaeontology module is to provide year 3 students with the key theoretical and practical issues of micropalaeontology and furthermore to introduce them to modern analytical facilities and methods (e.g. Electron Microscopy, statistical palaeontological data analysis).

Intended Learning Outcomes
At the end of the module students should be able to demonstrate a systematic knowledge and critical understanding of:

- Major micro - and macroevolutionary processes.
- Processes controlling complex interacting palaeo-ecosystems (marine, terrestrial, lacustrine).
- Palaeo-biogeography (provincialism) of the major microfossil groups.

In addition, students will develop subject-specific skills in the identification (taxonomy and nomenclature) and the biostratigraphical analysis of the major microfossil groups.

Students will possess skills in the acquisition of quantitative scientific data and their subsequent analysis in terms of palaeo-ecological interpretations.

Students will be able to:

- Process, analyse and critically evaluate quantitative micropalaeontological data.
- Apply bio-mathematical and bio-statistical methods to quantitative-stratigraphical and palaeobiological problems.

Additionally, students will be familiar with the physical theories and the application of modern analytical methods, which are at the forefront of the subject, including Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM).

Skills
The identification (taxonomy and nomenclature) and the biostratigraphical analysis of the major microfossil groups; the acquisition of quantitative scientific data and their subsequent analysis in terms of palaeo-ecological interpretations; Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM).

Formative Assessment
Discussion of course material with students during practical classes.

Summative Assessment
Method
Practical Assessment weighted 40%
Practical Assessment weighted 20%
2-Hour Unseen Examination weighted 40%

Dates
Practical assignments - Lab. Book & Dee Report Week 12
Written Examination - May

Field Course March 16, 2019

Recommended reading
ARMSTRONG, H.A. & BRASIER, M.D. Microfossils, Blackwell Publishing.
HAMMER, O. & HARPER, D. Paleontological data analysis, Blackwell Publishing.
TYSON, R.V. Sedimentary organic matter, Chapman & Hall.
REED, S.J.B. Electron Microprobe analysis and Scanning Electron Microscopy in Geology, Cambridge University Press.

ESC-30030 (Spring Semester: Geoscience Core)

Module Title: Advanced Petrology & Structural Geology Field Course
Module Tutors: Dr Ralf Halama (module leader) and Dr Stuart Egan

Module Outline
The module is based on a week-long residential field course. The main aim of this field course is to provide students with the opportunity to study igneous and metamorphic rocks in the field. In addition, consideration of petrological processes and emphasis on aspects of structural geology will provide students with an understanding of magma emplacement (and its effects at different crustal levels), orogen construction and terrane accretion, and the crustal evolution of a specific tectonic regime (e.g. NW Scottish Highlands). The module will further develop geological fieldwork skills, as well as employability skills, that are essential for a career as a professional geoscientist.

Aims
The module aims to provide students with the opportunity to study igneous and metamorphic rocks in the field. Consideration of petrological processes and an emphasis on aspects of structural geology will provide students with an understanding of magma emplacement (and its effects at different crustal levels), orogen construction and terrane accretion, and the crustal evolution of a specific tectonic regime (e.g. the NW Scottish Highlands).

Intended Learning Outcomes
- To provide a knowledge of igneous and metamorphic petrological processes at an advanced level.
- To provide an understanding of the structural processes involved in crustal orogenesis and its effects.
- To impart an appreciation of the evolution of a small, but highly complex and variable part of the Earth's crust through geological time.
- To further develop field skills, including observation and the collection and analysis of geological data.
- To enhance skills in synthesizing research literature and to further develop oral presentation and report writing skills.

Formative Assessment
Feedback/discussion during practical classes and fieldwork.

Summative Assessment
Method
Portfolio: Field-based exercises and field notebook (60%)
Post-field trip report (20%)
Presentation (20%)

Recommended reading
TREWIN, N.H. The Geology of Scotland. The Geological Society (4th edition).

MACDONALD, R. & FETTES, D.J. The tectonomagmatic evolution of Scotland. Transactions of the Royal Society of Edinburgh: Earth Sciences, 97, 213-295.

Wk	Practical Classes	Tutor (s)
1	Module introduction	RH
8-11	Oral presentations	RH

Provisional Dates of Field Course

Eight-day field excursion to the Isle of Mull, western Scotland 5 – 12 April 2019

ESC-30033 (Spring Semester: Geology Major Route, Core)

Module Title: Volcanic and Magmatic Processes
Module Tutors: Dr Ralf Gertisser (co-ordinator) and Dr Ralf Halama

Module Outline

This module provides students with the opportunity to study active volcanic and magmatic processes primarily through a field course to an area where active magmatic and volcanic processes can be observed, such as Southern Italy or Greece (Santorini and neighbouring islands). The main emphasis of the course is on the field investigation of igneous rocks, but it also introduces aspects of physical volcanology, volcanic hazards, volcano monitoring, petrology, geochemistry, geodynamics and global environmental change. The module involves a few practical classes (workshops) preparing students for the field course, followed by a residential fieldtrip to a classic volcanic area. The module is designed for Geology (Major-Minor) students and MGeoscience who have progressed to year 3 of their course via dual honours Geology. It will be assessed through an oral presentation, production of an illustrated written report (fact sheet) and a set of individual and group exercises on the field course.

Aims

The aim of this module is to provide students with a systematic and comprehensive understanding of volcanic and magmatic processes through workshops and a field trip to the volcanoes of southern Italy. The course focuses on the field investigation of volcanic rocks, but it also introduces aspects of physical volcanology, volcanic hazards, volcano monitoring, igneous petrology, geochemistry, geodynamics and global environmental change.

Intended Learning Outcomes

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

- systematically describe, evaluate and interpret key volcanic and magmatic processes through study of academic journal literature and field investigations in a classic area in volcanology;
- apply proficiently modern field methods in volcanology and petrology, and demonstrate the ability to critically evaluate the strengths and limitations of these methods, based on knowledge that is at or informed by the forefront of the discipline;
- deploy subject-specific skills and established techniques to interpret volcanological, petrological and geochemical data, and apply and critically evaluate these to the formulation and solution of a problem;
- demonstrate skills to a high level in all aspects of field observation, in collection, recording, analysis and interpretation of field data, and in communication of information, ideas and arguments in a clear and coherent form;
- demonstrate skills in computing, numeracy, information handling, problem-solving, team-working as well as oral, visual and written communication.

Skills
Acquire skills in the study of volcanic and magmatic processes, in collection, recording, analysis and interpretation of volcanological, petrological, geochemical data as well as in computing, numeracy, information handling, problem-solving and oral, visual and written communication.

Formative Assessment
De-briefing at the end of workshops and field days; Discussion of material on one-to-one basis and in groups in workshops and in the field.

Summative Assessment
Method
Oral presentation (15%)
Illustrated written report (fact sheet) (10%)
Field course and field course-related assignments (75%)

Dates

Oral presentation:	Weeks 8, 9 & 10
Illustrated written report (fact sheet):	End of week 12
Field course and field course-related assignments:	19 - 27 May 2019 Provisional

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

Recommended reading: ESC-30033 Reading List

GUEST, J.E., COLE, P.D., DUNCAN, A.M. & CHESTER, D.K. Volcanoes of Southern Italy. The Geological Society, London.
KILBURN, C. & MCGUIRE, B. Classic Geology in Europe 1: Italian Volcanoes. Terra Publishing.
LUCCHI, F., PECCERILLO, A., KELLER, J., TRANNE, C.A. & ROSSI, P.L. (eds.) (2013). The Aeolian Islands Volcanoes. Geological Society, London, Memoirs, 37.
PARFITT, E. & WILSON, L. Fundamentals of Physical Volcanology. Blackwell Publ.
PECCERILLO, A. Plio-Quaternary Volcanism in Italy – Petrology, Geochemistry, Geodynamics. Springer.
SIGURDSSON, H. (ed.). Encyclopedia of Volcanoes. Academic Press.

Wk	Practical Class (Workshop) titles	Tutor (s)
1	Introduction to Module	RG
8,9&10	Oral Presentations	RG/RH

Additional information
The FHEQ Level 7 version of this module (ESC-40036 - MGeoscience: Volcanic and Magmatic Processes) is available as an option module for students on the MSc Geoscience Research.

ESC-30034 (Spring Semester: Geology & Geoscience Option + MGeoscience Core)

Module Title: Advanced Topics in Sedimentology
Module Tutors: Dr Stuart M. Clarke (co-ordinator)

Module Outline
The stratigraphical principles introduced in Year 2 are studied in greater depth, concentrating on the analytical methods of seismic and sequence stratigraphy, which allow the geometry of sedimentary rock bodies to be related to basin wide tectonic and eustatic controls.

Aims
To provide a broad overview of the relationship between sedimentology and stratigraphy on a basin-wide scale, and to appreciate the environmental and economic implications.

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

- Describe the importance of sediment supply, in addition to subsidence and sea level, upon deposition & sedimentary facies.
- Describe, critically assess, and apply, the techniques that relate spatial geometries and relationships between sedimentary deposits to their temporal evolution, through the study of seismic and chronostratigraphy.
- Critically assess techniques that relate sedimentological evidence to regional and global stratigraphical cyclicity through the study of sequence stratigraphy.
- Describe the ways in which sedimentological and stratigraphical principles relate to structural aspects of sedimentary basins to control the gross-scale sedimentary geometry of basins.
- Interpret the links between the spatial and temporal evolution of sedimentary basins and the distribution of the sediments they contain, the broad-scale controls on such, and the economic implications.

Skills
Apply advanced fieldwork skills and modelling techniques to interpret sedimentary successions in a sequence stratigraphical context; present scientific findings and interpretations in a standard scientific report format.

Formative Assessment
Student contributions to discussions in practicals.

Summative Assessment
Method:
Fieldwork report (30%)
Practical examination (20%)
2-hour written examination (50%)

Dates:
Fieldwork report -TBA
Practical examination - TBA
Written examination – May

On-line resources
A dedicated 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:

- Allen, P.A. and Allen, J.R., 1990. Basin analysis – principles and applications. Blackwell Science, Oxford, 451 pages. QE 571.A5.
- Coe, A.L., 2003. The sedimentary record of sea-level change, Cambridge University Press, 288 pages.
- Emery, D. and Myers, K.J., 1996. Sequence stratigraphy. Blackwell Science, Oxford, 297 pages. QE 651.E5.
- Gluyas, J. & Swarbrick, R. Petroleum Geoscience. Blackwell publishing 359 pages

Additional References:

- Jervey, M.T., 1988. Quantitative geologic modelling of siliciclastic rock sequences and their seismic expression. In, Wilgus, C.K., et al. (eds.), Sea-level changes – an integrated approach, S.E.P.M. Special Publication, 42, 47-69.
- Mitchum, R.J. Jr., Van Wagoner, J.C., 1991. High frequency sequences and their stacking patterns: sequence stratigraphic evidence for high frequency eustatic cycles. Sedimentary Geology, 70, 131-160.
- Posamentier, H.W., et al., 1988a. Eustatic controls on clastic deposition I – conceptual framework. In, Wilgus, C.K., et al. (eds.) , Sea-level changes – an integrated approach, S.E.P.M. Special Publication, 42, 109-124.
- Posamentier, H.W., et al., 1988b. Eustatic controls on clastic deposition II – Sequences and systems tract models. In, Wilgus, C.K., et al. (eds.), Sea-level changes – an integrated approach, S.E.P.M. Special Publication, 42, 125-154.
- Posamentier, H.W. and Allen, G.P., 1993. Variability of the sequence stratigraphic model: effects of local basin factors. Sedimentary Geology, 86, 91-109.
- Posamentier, H.W. and Allen, G.P., 1993. Siliciclastic sequence stratigraphic patterns in foreland ramp-type basins. Geology, 21, 455-488.
- Reading, H.G., 1996. Sedimentary environments: Processes, facies and stratigraphy. Blackwell Science, Oxford, 688 pages.Vail, P.R., et al., 1977. Seismic stratigraphy and global changes of sea-level, Part 3 Relative changes of sea-level from coastal onlap. In, Payton, C.E. (ed.), Seismic stratigraphy, Applications to hydrocarbon exploration. A.A.P.G. Memoir, 26, 63-81.
- Van Wagoner, J.C., et al., 1988. An overview of the fundamentals of sequence stratigraphy and key definitions. In, Wilgus, C.K., et al. (eds.) , Sea-level changes – an integrated approach, S.E.P.M. Special Publication, 42, 39-45. XER8055.
- Van Wagoner, J.C., et al., 1990. Siliciclastic sequence stratigraphy in well logs, core and outcrops: Concepts for high resolution correlation of time and facies. A.A.P.G. Methods in Exploration Series, 7, 55 pages. QE 539.2.S5V2.

- Walker, R.G., 1990. Facies modeling and sequence stratigraphy. J. Sedimentary Petrology, 60, 777-786. XER 6997.
- Walker, R.G. and James, N.P., 1992. Facies models: Response to sea level change. Geological Association of Canada, 409 pages. QE 651.W2.
- Sedimentology and sequence stratigraphy of reefs and carbonates: A short course, 1992. QE 471.I5.C352.

Lecture Titles (2 lectures per week)
Facies analysis and beyond….
Parasequences
Sediment supply, time and space
Fundamentals of Sequence Stratigraphy
Sequences, Systems Tracts and facies
Sequence stratigraphy in fluvial systems
Carbonate sequence stratigraphy
Continental sequence stratigraphy
Sequence stratigraphy in context
Seismic Stratigraphy
Seismic facies analysis
Sequence stratigraphy in extensional basins
Sequence stratigraphy in foreland basins
Summary and applications

Practical Classes
Cyclic stratigraphy and cyclothems
Sea-level curves
Sea level subsidence and stacking patterns
Sequence stratigraphy of the North Pennines
Proximal sequence stratigraphy
Carbonate & continental sequence stratigraphy
Seismic stratigraphy
Seismic facies analysis
What's wrong with sequence stratigraphy?
Practical Examination

This module also includes a weekend field course to the North Pennines in March 2019

ESC-30038 (Spring Semester: Geology Major Route, Core)

Module Title: Geological Communication Skills
Module Tutors: Dr Ian G. Stimpson (co-ordinator)

Module Outline

Communication of complex geological issues is an essential skill for a geological career as well as being a key transferable skill. This module develops presentation skills in a variety of styles, both oral and written. Students will research, synthesise information, summarise and orally present a series of geological topics. The module culminates with a mock conference where students present an extended abstract, poster and oral presentation on an aspect of data collected as part of their independent mapping fieldwork.

Aims

To develop and enhance the ability to communicate clearly and effectively in written and verbal forms for different purposes and to a variety of audiences (from Keele Graduate Attribute 6)

To develop and enhance an appreciation of the social, environmental, sustainability and global implications of geological studies (from Keele Graduate Attribute 5)

Intended Learning Outcomes

- communicate clearly and effectively in written and verbal forms for different purposes and to a variety of audiences (Keele Graduate Attribute 6 & QAA ES3 benchmarking statement)
- demonstrate an appreciation of the social, environmental, sustainability and global implications of geological issues (from Keele Graduate Attribute 5)
- demonstrate an appreciation of the development and value of geological studies, awareness of their contexts, the links between them, and awareness of the provisional and dynamic nature of knowledge (Keele Graduate Attribute 2)
- demonstrate the ability to locate, critically evaluate and synthesise large amounts of frequently conflicting information, ideas and data (from Keele Graduate Attribute 3 & QAA ES3 benchmarking statement)
- demonstrate an awareness of the essential contributions of geoscience to the economic, environmental and cultural needs of Society (Geological Society of London Accreditation Requirement 1d)
- demonstrate awareness and informed concern of Earth Science perspectives on sustainability and social awareness (QAA ES3 benchmarking statement)

Teaching Format

This module involves lecture sessions on developing and enhancing presentation skills in a variety of presentation formats. A series of geological topics is assigned to students (three each) that they then have to research, synthesise and then orally present. The module concludes with a mock conference where students present an extended abstract, poster and oral presentation.

Formative Assessment

Written proforma feedback on presentations.

Summative Assessment
Method
Three oral presentations 60%
Conference portfolio - extended abstract, poster, oral presentation 40%

Dates
Presentations - weeks 4, 6, 8
Conference - week 12

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

Wk	Workshop Titles	Tutor
1	Module Introduction & How to give an oral presentation	IGS
4	Presentation 1 & Abstracts & Posters	ALL/IGS
6	Presentation 2	ALL
8	Presentation 3	ALL
12	Conference Presentations	ALL