# FHEQ Level 7: Year 4
# 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.

*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 7 (Year 4) you should be aware of how important the geosciences are to the sustainability agenda. Consider your independent research project; can you align it to any of the United Nations Sustainable Development Goals? How might you communicate your findings to a non-geologist audience? Does your research have a wider impact?*

*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-40003 (Core – Autumn Semester)

## Module Title: Literature Synthesis
## Module Tutors: Dr Stuart Egan (co-ordinator) & Mr David Emley

**Module Aim**
To carry out a detailed literature survey on a specific Geoscience topic and to present the results from this exercise via a project Web site.

**Intended Learning Outcomes**
- Ability to collect background information on a specific scientific topic using library facilities and IT techniques (e.g. accessing online literature databases).
- Further development of research skills by being able to extract and collate information presented in scientific papers.
- Further development of presentation skills.
- Ability to apply time and project management skills.
- Knowledge and understanding of how to author a set of self-contained Web pages in order to visually present results from a research project.

**Teaching Format**
The module will use a combination of lectures, practical classes and self-learning techniques.

**Formative Assessment**
Literature synthesis web site home page. Date for Submission: End Week 7
Discussion/feedback provided during practical classes and tutorials.

**Summative Assessment**
***Method***
The module will be based entirely upon the following continuous assessment components:
Literature synthesis plan (5%)
Progress report, including written summary of one key paper (3-sides A4; 5%).
Literature review Web site (40%).
Report (30%).
Presentation of web site (20%).

***Date***
Literature synthesis plan - End Week 3
Progress report, including written summary of one key paper - End Week 7
Literature review Web site - End Week 14 (January)
Report - End Week 14 (January)
Presentation of web site - Week 1, semester 2 January

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

| Wk | Title | Tutor (s) |
|---|---|---|
| 1 | Introductory lecture, including literature searching and reference management | SSE |
| 2 | Practical Class: Web authoring using HTML | DWE/SSE |
| 3 | Practical class: Web authoring using Microsoft Expression Web 4: part 1 | SSE/DWE |
| 4 | Practical class: Web authoring using Microsoft Expression Web 4: part 2 | SSE/DWE |
| 5 | No class | |
| 6 | Practical class: Advanced web authoring techniques | DWE/SSE |

**Report and Presentation Exercise - Guidelines**

Report: The report should be 1500 - 2000 words in length and provide a summary of your literature synthesis. The report should be structured into sections, as appropriate to the topic concerned. A section of your report should be devoted to the web development aspect of the assignment (e.g. description of web authoring tools used, structure of web site, etc.).

Web Site Demonstration: You will be required to give a formal 'group-type' presentation in which it is expected that you demonstrate the content of your literature synthesis web site as well as explaining some of the Web authoring techniques used. The presentation/demonstration should last for 10 minutes maximum, including approximately 2 minutes for questions.

# ESC-40004/5/6 Masters Research Project (Autumn and Spring Semesters)

The Masters project is spread over the following modules:

- ESC-40004: Research Project
- ESC-40005: Research in Context
- ESC-40006: Research Report

Detailed information on each of these modules is provided in the sections below.

## ESC-40004 (Core)

## Module Title: Research Project
## Module Tutors: Dr Stuart Egan (co-ordinator)

**Module Aim**

To build upon subject-specific and practical skills that have been developed in previous years of the course to carry out an independent research investigation within an area of the geosciences.

**Intended Learning Outcomes**

Students successfully completing this module will have:

- Applied and further developed subject-specific knowledge, as well as laboratory, field, and computational skills, through background reading, and the collection, interpretation and analysis of original data
- Applied time and project management skills to successfully complete a piece of independent research at the forefront of the discipline, within a prescribed time limit
- Acquired a comprehensive understanding of research techniques in the context of the project
- Shown originality in the application of knowledge to the execution of the project

**Content and Teaching Format**

At the end of Year 3/beginning of Year 4, each student selects a project title, in consultation with the module co-ordinator and appropriate staff. A project proposal will be prepared which will include a working title, project aims and objectives, a summary of fieldwork, data and/or equipment requirements, a project plan and risk assessment.

The content of the module will rely upon a combination of one-to-one meetings with project advisors and self-learning techniques. Depending on the nature of the project selected, the student may also receive instruction from other research group members and support staff on the use of specialised equipment and/or analysis techniques. It is expected that supervision meetings take place once every two weeks.

Students should keep a neat project portfolio to record project progress, to record details of meetings with project advisors, to describe any methodologies and techniques used to

carry out the research, to record any original data collected (e.g. in field) and to record the results of any analyses. The content and presentation of the project portfolio will be considered as part of the assessment.

An interim report of approximately 750 words will be required at the end of semester 1.

**Supervision**
Each project will be allocated a supervisor. It is the responsibility of the supervisor to provide you with advice at the start of your project and during its execution. It is the student's responsibility to draw up a formal written plan for the project, and to update the plan in the light of progress in the project. You must also take ownership of completing all aspects of the project, which represents original research into an aspect of the geosciences.

**Formative Assessment**
Discussion/feedback provided during meetings with supervisor(s) and module coordinator.

**Summative Assessment**
***Method***
Formal Project Plan / Progress Report (15%)- working title, aims and objectives, data and equipment requirements, progress to date (including examples of results), time-table for remaining items.

Progress report (15%) – overview of progress to date, summary of key publications related to project, description of any changes from original plan, timetable for remaining items. It is expected that this report places emphasis on summarising the additional progress made since the submission of the Project Plan/Progress report in October.

70% of this module will be based on the following continuous assessment components:

- Planning and execution (30%). Assessed via a project plan, including timetable for components of the project and risk assessment exercise, and progress report, including a description/justification of changes to original plan.
- Comprehension and use of research techniques (25%). Assessed via evidence of understanding (presented during discussion at review meetings with supervisor, via content of project portfolio and thesis), commensurate with Masters' level, of the techniques used in the execution of the project.
- Originality in application of knowledge (25%). Assessed via evidence of originality, commensurate with Masters' level, in the acquisition, interpretation and analysis of data, and/or design/construction of research tools or analysis methods (e.g. computer code). Assessment will be carried out via discussion and material presented at review meetings with supervisor, and via content of project portfolio and thesis.
- Management of project (20%). Assessed via attendance at scheduled review meetings with supervisor, the production of a detailed portfolio documenting the progress of the project, keeping to deadlines defined in the project plan, demonstration of initiative and decision-making (e.g. in tackling unexpected results).

***Date***

Project plan/review of progress - End Week 3 (semester 1)
Progress report - End Week 12 (semester 1)

**Module Structure**

Selection of topic and planning; Carry out background reading, fieldwork, etc. during summer vacation between years 3 and 4

| **Wk** | **Title** | **Tutor (s)** |
|---|---|---|
| ***Semester 1:*** | | |
| 2-12 | Supervision Meetings: Students meet with their supervisor(s) for guidance and to discuss progress. | Supervisor |
| ***Semester 2:*** | | |
| 1 | Discussion of progress report. | Supervisor |
| 1-12 | Supervision Meetings: Students meet with their supervisor(s) for guidance and to discuss progress. | Supervisor |

## ESC-40005 (Core)

## Module Title: Research in Context
## Module Tutors: Dr Stuart Egan (co-ordinator)

**Module Aim**
To acquire knowledge of current research in the subject matter of the year 4 research project, and to evaluate the outcome of the project in relation to other work in the field.

**Intended Learning Outcomes**
Students successfully completing this module will have:

- Conducted an extensive survey of the research literature in the subject matter of the project, using electronic and other resources.
- Critically evaluated current research in the subject matter of the project.
- Critically evaluated research methodologies in the subject of the project.
- Understood the relationship of their project to the work of others in the field.
- Communicated, in good standard of English, the background and context of the project in the form of a literature synthesis section of the project report.
- Further developed reading skills through the extraction and collation of information presented in scientific papers.

**Content and Teaching Format**
The emphasis of this module will be to carry out a thorough searching and synthesis of the published literature available in the area of the research being conducted.

**Formative Assessment**
Discussion/feedback provided during meetings with supervisor(s) and module coordinator.

**Summative Assessment**
***Method***
The module will be based entirely upon the following continuous assessment components:

- Draft of literature review related to the research area of the project (8%). Deadline - End of week 9 Semester 1
- Research Participation (20%): 1500-word report based on participation in Departmental Research Seminar Series or other research-related seminar (e.g., IMM, NSGGA seminar). Research participation of members of the Level 4 MGeoscience class in the Geography, Geology and the Environment Seminar Series will be assessed by production by individual students of a review report on any one talk (of their choosing) from the Seminar Series of the entire academic year. Deadline - End week 12 Semester 2
- Literature synthesis report that represents an extended introduction to the project thesis (72%). Deadline - End of week 6 Semester 2

The literature synthesis report will be assessed on the following components:

- Critical evaluation: Assessed on the criteria that there is a balanced and objective evaluation of the current research in the field and that it is related to the aims of the project.
- Background: Assessed on the criteria that there is sufficient and appropriate reference to the literature and that it is properly acknowledged.
- Quality of presentation: Assessed on criteria that literature synthesis report is of the required length, uses accurate and grammatically correct English, and makes appropriate use of figures/tables.

The literature synthesis report should be 2500 – 3000 words in length. The report submitted should be bound, have a title page and contents list.

## ESC-40006 (Core)

## Module Title: Research Report
## Module Tutors: Dr Stuart Egan (co-ordinator)

**Module Aim**
To communicate the methods, results and conclusions of the research project.

**Intended Learning Outcomes**
Students successfully completing this module will have:

- Written, in a good standard of English, a full report, written in the style of a journal article, on the methods and techniques used in the execution of their project.
- Presented a full and detailed discussion and evaluation of the results.
- Demonstrated that they are capable of carrying out a research project at the forefront of the discipline.
- Shown originality, by the application of knowledge to the project results to form new hypotheses, or by providing novel interpretation of data, or by the discovery of new facts and/or phenomena.
- Gained additional experience in the use of communication and presentation skills.

**Content and Teaching Format**
The content of the module will rely upon a combination of one-to-one meetings with the project advisor(s) and self-learning techniques. It is expected that supervision meetings take place once every two weeks.

The project report, along with supporting materials (e.g. project portfolio), and poster, will be submitted by the end of semester 2.

**Formative Assessment**

- Discussion/feedback provided during meetings with supervisor(s) and module coordinator.
- Project thesis plan. End Week 7 (semester 2)
- Draft of poster. End Week 7 (semester 2)

**Summative Assessment**
***Method***
The module will be based entirely upon the following continuous assessment components:

- Poster on methodology, data interpretation and analysis, and conclusions (15%). Deadline End Week 11 (semester 2)
- There will be a poster presentation session planned for some time in week 12, in which a short (5-10 minutes) presentation of the main project results to date should be presented.
- Report (85%). Deadline End Week 12 (semester 2)

**Project Report**

The project report should be approximately 7000 words in length and written in the format of a journal paper. The main body of the report should be preceded by an abstract of about 150 - 250 words length. The report should contain the background to the project, including a concise summary of previous work, a summary of any data collected, a clear description of any interpretation and analysis methods used, a comprehensive description of results and conclusions. Depending upon the nature of the project carried out, the report should be supported by a project portfolio consisting of field or laboratory notebook (if appropriate), a record of all original data used/collected (e.g. sedimentary logs, seismic sections, field slips, etc.) and copies of all data interpretations (e.g. fair copy maps, aerial photograph interpretations, etc.).

The Project Report will be marked independently by the project supervisor and another marker, who has some knowledge of research area investigated. Other staff, who have played a role in the supervision of the project, may be asked to provide an assessment of specific components of the work.

The criteria for assessing the project report will be as follows:

- Is there an abstract of the required length?
- Are the aims and objectives of the project clearly stated?
- Is the background to the project clearly set out?
- Are the procedures used clearly described?
- Is the explanation sufficiently clear for the project to be respected by one of the author's peers?
- Is the presentation of results appropriate? (e.g. in map, cross-section, graphical, or tabular form, or in the form of a piece of computer code).
- Are the results placed in the context of what other workers have done in the field?
- Are valid conclusions drawn from the results?
- Is there an adequate bibliography?
- Is proper acknowledgement made to the assistance and/or input of others, as appropriate?
- Is the report supported by a clear and neatly presented project portfolio?

It is recommended that students use the above points as a checklist when writing their report.

Other important points:

- The report must be word processed and printed out on A4 paper (double spaced).
- The final report should be bound and have a title page indicating the full title of the project, the name of the author and the year of the author's graduation.
- The project report is retained by the School for a period of 4 years. Therefore, you are strongly advised to produce two copies of the report, one to keep for yourself for use in such things as job interviews.

**Poster**

The poster will be assessed on the following components:

- Is there a 'banner' component with title, author and affiliation?

- Are individual elements of the poster well designed?
- Is the text easy to read (e.g. has an appropriate font size and style been used)?
- Is the poster well laid out?
- Is the scientific content of the poster appropriate?
- Is the choice of text appropriate?
- Is the choice of diagrams/tables appropriate?
- Is there an appropriate list of references?
- Has help been acknowledged (where appropriate)?

A short (5-10 minute) presentation of the main results of the project is required during a dedicated poster session following poster submission

Students should remind themselves about the University's regulations on plagiarism when writing their reports. It is implicitly assumed that all written work submitted for assessment is the individual work of the student submitting it. This important principle applies to all coursework. It makes no difference whether the work is hand-written or printed or submitted electronically. A student who includes in their submitted work another person's work as if it is their own is guilty of plagiarism. The University, as do all Universities, treats plagiarism as CHEATING. Examiners will always penalise cases of plagiarism, and serious cases must be reported to the University for disciplinary action. Plagiarism can result in failed modules and even suspension or expulsion from the University.

Guidance on the University's plagiarism regulations can be found at:

Keele University: Student guide to the plagiarism regulations

# ESC-40007 (Core – Autumn & Spring Semesters)

## Module Title: Spatial Geoscience Data Analysis
## Module Tutors: Dr Jamie Pringle (co-ordinator)
## Dr M. Musgrave & Dr Ian Stimpson

**Module Outline**
Spatial Geoscience Data Analysis is designed to introduce the visualisation and analysis of subsurface geoscience data through computer aided mapping, cartographic packages, statistical analysis and mapping and visualisation of multi-format data. Problem solving through a variety of datasets, including geophysical data acquisition, analysis and interpretation enables the use of equipment and techniques that are at the forefront of professional practice. Throughout the course, industry standard software and methodologies will be used in order to simulate real world situations.

**Aim**
To provide experience of a variety of up to date methodologies for the acquisition, analysis and visualisation of spatially distributed geological and geophysical data.

**Intended Learning Outcomes**
- Develop a systematic and comprehensive understanding of the use of digital imaging and graphics techniques for displaying and interpreting earth science data.
- Demonstrate systematic knowledge of geoscientific data analysis, and to be able to evaluate critically the strengths and weaknesses of statistical methodologies.
- Plan and implement an integrated and applied geological and geophysical field-based study, which makes use of equipment and techniques that are at the forefront of professional practice.
- Demonstrate self-direction and originality in tackling and solving problems.
- Further develop skills to a high level in report writing, problem-solving, computing, team-working and presentations.

**Teaching Format**
The module will be based mainly upon lectures and practical classes in which students learn about various techniques and methods from demonstrations by members of staff and hands-on experience. The relevant theoretical background will be dealt with in lectures. This module includes a residential field course that takes place in the Lake District specifically for MGeoscience students. The main objective of this course is to integrate a variety of geological and geophysical surveying techniques into a team working environment. This field course will take place in the Easter vacation.

**Formative Assessment**
Discussion of course material and feedback in practical classes.
Group problem-solving discussions during fieldwork.

**Summative Assessment**

***Method***

Data analysis I - JKP (15%). Deadline Week 3
Data analysis II - MM & IGS (35%). Deadline Week 10
Field course assignments (50%). Deadline - end of field course

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

ESC-40007 Reading List

| Wk | Title | Tutor (s) |
|---|---|---|
| ***Semester 1*** | | |
| 1 | Introduction to module & basic statistical analysis (VBT) | JKP |
| 2 | Contouring, despiking & detrending (in 2/3D) datasets (Excel/ArcGIS/GMT) | JKP |
| 3 | 'R' statistical software I | MM |
| 4 | 'R' statistical software II | MM |
| 5 | 'R' statistical software III | MM |
| 6 | Geoscience Databases I | IGS |
| 7 | No Session | |
| 8 | Geoscience Databases II | IGS |
| 9 | Geoscience Databases Class Test | ALL |
| ***Semester 2*** | | |
| 8 | Background to residential field course & geophysical equipment familiarisation | JKP |
| 9 | Near-surface geophysical data processing / modelling | JKP |
| Easter | 5-day residential field course to NW England* | JKP |

* This field course will take place on 8 -12 April 2019

# ESC-40041 (Core – Spring Semester)

## Module Title: Petroleum Geology
## Module Tutors: Dr Stuart M. Clarke (co-ordinator)

**Module Outline**
This module investigates the techniques, practices, workflows and geological data used by the hydrocarbons industry for the exploration, appraisal and production of economic reserves of hydrocarbons. The module equips students with the vocabulary, knowledge and technical expertise to pursue a career as an exploration geologist within the oil industry.

**Aims**
The module is designed to equip students with the knowledge and critical understanding of the geological techniques and workflow employed by oil companies in the exploration for, exploitation of, and production of hydrocarbons. It will equip the students with the vocabulary and technical skills to pursue a career as an exploration geologist with major oil companies.

**Intended Learning Outcomes**
Describe in detail and critically assess the various geological components that contribute to successful exploration and exploitation of hydrocarbons.
Describe in detail and critically assess the geological elements required to identify a prospect in frontier exploration.
Describe and apply appropriately geological techniques for the appraisal and development of discoveries, including the methods for assessing risk and return.
Describe to a technical level the techniques and practices involved in drilling and production of hydrocarbons.
Work successfully in a small asset team to develop and assess a hydrocarbon prospect and to make drilling recommendations.
Present technical findings, recommendations and potential risks to a 'management team' to the standard and in the style required by hydrocarbon exploration companies.
Demonstrate a clear technical expertise and the vocabulary required to pursue a career as an exploration geologist with major oil exploration companies.
Integrate lines of evidence from a wide range of sources, including published descriptions, industry-specific data types, and fieldwork, to interpret and develop a prospect, and understand the geological risks involved in its exploitation.

**Teaching Format**
Lectures and practical classes covering exploration, appraisal and production aspects of petroleum geology.

**Formative Assessment**
Informal feedback in practical classes.

**Summative Assessment**

***Method***

Group Presentation (25%)
Technical portfolio (25%)
Two-hour written examination (50%)

***Date***

Group Presentation - Week 10
Technical portfolio - End Week 12
Two-hour written examination - May

**On-line resources**

A dedicated website forms an integrated part of this course and contains copies of lecture slides, practical questions, and supplementary information relating to the topics covered. It can be accessed via the Keele Virtual Learning Environment.

**Recommended reading**

Will be recommended during module.

**Lecture Titles (2 lectures per week)**

Introduction to the course: The petroleum industry today and in the future.

| | |
|---|---|
| Frontier Exploration 1: | The Play and Source |
| Frontier Exploration 2: | Seal and Reservoir |
| Frontier Exploration 3: | Geohistory and leads |
| Frontier Exploration 4: | Exploration Well Log analysis |
| | |
| Exploration 1: | From the conceptual to the spatial |
| Exploration 2: | Developing the prospects |
| Exploration 3: | Trap concepts and mechanisms |
| Exploration 4: | Risk analysis |
| | |
| Appraisal 1: | The trap envelope |
| Appraisal 2: | Characterising the reservoir |

**Practical Classes**

Practical classes are combined with the lectures and follow the same scheme as above.

# ESC-40015 (Option - Autumn Semester)

## Module Title: MGeoscience: Natural Hazards
## Module Tutors: Dr Jamie Pringle (co-ordinator)
## Dr Ralf Gertisser and 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.
risk and the steps that can be taken to prevent or mitigate the damage and disruption associated with these processes.

**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**

- Analysis, interpretation & manipulation of a variety of scientific data to assess the risk posed by natural hazards
- Evaluation of the most suitable measures to prevent or minimise their effects in various circumstances
- 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

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

**Recommended reading**
***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 |
| 12 | Course Summary & exam preparation | 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-40020 (Option - Spring Semester)

## Module Title: MGeoscience: Hydrological & 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; groundwater 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, contaminated land exercise (30%)
Formal written examination (50%).

MGeoscience students will attend the lecture and practical class components of the Year 3 module ESC-30022, Hydrological and Engineering Geology, which will form the basis of the field of study within this module. MGeoscience students will be set an extended problem-based practical exercise to complete in order to fulfil the assessment requirements of this module.

***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 – 10)

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' contaminated land problem that including elements of both hydrological and geomechanical property modelling/evaluation using spreadsheets and report writing.
- Campus tour investigating engineering good / bad practice examples

# ESC-40023 (Option - Spring Semester)

## Module Title: MGeoscience: 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 4 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%

MGeoscience students will attend the lecture and practical class components of the Year 3 module ESC-30025, Micropalaeontology: Principles and Applications, which will form the basis of the field of study within this module. MGeoscience students will be set an extended practical exercise to complete in order to fulfil the assessment requirements of this module.

***Dates***
Practical assignments - End Week 12
Written Examination – May

Field Course 16 March 2019

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

**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-40024 (Option - Spring Semester)

## Module Title: MGeoscience: Structure and Geodynamics
## Module Tutors: Dr Stuart 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 who successfully complete this module will be able to:

- describe in detail the large scale tectonic evolution of geological features occurring in extensional, compressional, inversion and wrench continental tectonic regimes, much of which is at, or informed by, the forefront of the academic discipline.
- describe in detail the structural geology of sedimentary basins in a variety of tectonic settings using geological maps and seismic reflection profiles, as well as showing a critical awareness of current problems and/or new insights within the subject area.
- describe in detail and critically assess, as informed by research at the forefront of the discipline, the processes involved in the mechanical, thermal, rheological and isostatic behaviour of the lithosphere during continental tectonics.
- apply seismic reflection interpretation, structural interpretation of geological maps and cross-sections, collection and analysis of structural data in the field, aerial photograph mapping and the numerical/computer modelling of geological processes, and be able to demonstrate self-direction and originality in tackling and solving problems by using a combination of these techniques.

**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%).

MGeoscience students will attend the lecture and practical class components of the Year 3 module ESC-30008, Structure and Geodynamics, which will form the basis of the field of study within this module. MGeoscience students will be set an extended set of practical exercises to complete in order to fulfil the assessment requirements of this module as well as an exam paper specific to level 7.

***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

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

**Recommended reading**
Please refer to on-line Library reading list for the module available at:
ESC-40024 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-40026 (Option - Autumn Semester)

## Module Title: MGeoscience: 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 geothermal resources and coal deposits in terms of their exploration, 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%)

MGeoscience students will attend the lecture and practical class components of the Year 3 module ESC-30028 Economic Geology, which will form the basis of study within this module. MGeoscience students will be set a more advanced independent project presentation to complete in order to fulfil the assessment requirements of this module.

***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 2019

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

**Recommended reading**

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-40038 (Option - Autumn Semester)

## Module Title: MGeoscience: Exploration Geophysics for the Hydrocarbon Industry

## Module Tutor: 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 in detail and critically assess the methods of reflection seismic data acquisition, processing and interpretation.
- An ability to describe in detail and critically assess borehole geophysical data acquisition and interpretation.
- An ability to demonstrate the technical expertise and vocabulary to enter a career as a hydrocarbon industry geophysicist.
- An ability to write a technical report in a format compatible with the hydrocarbon industry, informed by knowledge at the forefront of the discipline.
- An ability to integrate lines of evidence from a range of sources and interpret practical results to solve real-world problems.

**Teaching Format**

The module is taught via linked through lectures and a series of linked practicals. MGeoscience students will attend the lecture and practical class components of the Year 3 module ESC-30036 Exploration Geophysics for Hydrocarbons, which will form the basis of study within this module. MGeoscience students will be required to submit a more advanced technical report to complete in order to fulfil the assessment requirements of this module.

**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%
2-hour formal examination 50%

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

**Recommended reading:** ESC-40048 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 |