

## Earth Science (ES) modules

| ES3001 Geological Mapping   |  |              |  |   |
|---|--|--------------|--|---|
| SCOTCAT Credits:  | 15   | SCQF Level 9 | Semester:                                  | 1 |
| Academic year:  | 2016/7 & 2017/8  |              |  |   |
| Planned timetable:  | To be arranged.  |              |  |   |
| This module provides training in independently constructing and interpreting geological maps and cross sections. It develops the student's abilities to recognise structures in both two and three dimensions and, by inferring how these structures have changed with time, to develop four-dimensional intellectual skills. The module provides training in defining geological sampling strategies and field report writing. |  |              |  |   |
| Programme module type:  | Compulsory for BSc Geology and BSc Environmental Earth Sciences, joint degrees with Biology and Chemistry, and MGeol Earth Sciences            |              |  |   |
| Pre-requisite(s):   | Normally ES2001 and ES2002   |              |  |   |
| Required for:   | ES3006, ES3010   |              |  |   |
| Learning and teaching methods and delivery:   | <b>Weekly contact:</b> 4 map and cross-section practicals (3 hours each) and lectures over 11 weeks and occasional 2-hour fieldwork tutorials. |              |  |   |
|   | <b>Scheduled learning:</b> 19 hours  |              | <b>Guided independent study:</b> 131 hours |   |
| Assessment pattern:   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%   |              |  |   |
|   | <b>As used by St Andrews:</b><br>Coursework = 100%   |              |  |   |
| Re-Assessment pattern:  | 2-hour Written Examination = 100%  |              |  |   |
| Module Co-ordinator:  | Dr T Prave   |              |  |   |
| Lecturer(s)/Tutor(s):   | Dr T Prave   |              |  |   |

| ES3002 Analytical and Statistical Methods in Earth Sciences   |   |              |   |   |
|---|---|--------------|---|---|
| SCOTCAT Credits:  | 15  | SCQF Level 9 | Semester:                                 | 1 |
| Academic year:  | 2016/7 & 2017/8   |              |   |   |
| Planned timetable:  | 11.00 am - 1.00 pm Mon (analytical methods), 2.00 pm - 4.00 pm Thu (stats)  |              |   |   |
| This module covers the principles behind, and practical application of, analytical science and data handling in Earth Sciences. Four key analytical methods are presented and students operate instruments under technical supervision. Statistical training includes (i) understanding data types, (ii) data presentation and basic descriptive statistics, (iii) probability, (iv) hypothesis testing using parametric statistics, (v) correlation and regression, (vi) introduction to numerical methods. Each student will have an opportunity to research an unusual analytical method, relevant to their own interests. Skills taught here reinforce Earth Sciences honours teaching, particularly the independent research project module. |   |              |   |   |
| Programme module type:  | Compulsory for BSc Geology, Environmental Earth Science, joint degrees with Biology and Chemistry, and MGeol Earth Sciences |              |   |   |
| Pre-requisite(s):   | Normally ES2001 and (ES2002 or ES2003)  |              |   |   |
| Required for:   | ES3003, ES3008  |              |   |   |
| Learning and teaching methods and delivery:   | <b>Weekly contact:</b> Lectures, practicals, tutorials and lab time averaging 5 hours per week.                             |              |   |   |
|   | <b>Scheduled learning:</b> 55 hours   |              | <b>Guided independent study:</b> 95 hours |   |
| Assessment pattern:   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%                      |              |   |   |
|   | <b>As used by St Andrews:</b><br>Coursework = 100%  |              |   |   |
| Re-Assessment pattern:  | Oral Examination = 100%   |              |   |   |
| Module Co-ordinator:  | Dr A Finch  |              |   |   |
| Lecturer(s)/Tutor(s):   | Dr A Finch, Dr R Wilson   |              |   |   |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES3003 GIS and Spatial Analysis for Earth Scientists  |  |              |  |   |
|---|--|--------------|--|---|
| <b>SCOTCAT Credits:</b>   | 15   | SCQF Level 9 | <b>Semester:</b>                           | 2 |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |              |  |   |
| <b>Planned timetable:</b>   | 10.00 am - 1.00 pm Mon, Wed (lecture plus lab session) (Weeks 1 - 7)                                   |              |  |   |
| This module covers the principles behind, and practical application of, spatial analysis in Earth Sciences. This includes the analysis of primary and secondary datasets, how to access and import a variety of data types, and the fundamentals of various spatial analytical methods including spatial statistics and modeling within a GIS environment. The module also prepares students for the correct presentation of maps and datasets in the dissertation proposal and thesis. |  |              |  |   |
| <b>Programme module type:</b>   | Compulsory for BSc Geology and Environmental Earth Science, and MGeol Earth Sciences                   |              |  |   |
| <b>Pre-requisite(s):</b>  | Normally ES3002  |              |  |   |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 6 lectures and 14 practicals and support sessions (Weeks 1 - 7).                |              |  |   |
|   | <b>Scheduled learning:</b> 48 hours  |              | <b>Guided independent study:</b> 102 hours |   |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100% |              |  |   |
|   | <b>As used by St Andrews:</b><br>Coursework = 100%   |              |  |   |
| <b>Re-Assessment pattern:</b>   | 2-hour Written Examination = 100%  |              |  |   |
| <b>Module Co-ordinator:</b>   | Dr R Robinson  |              |  |   |
| <b>Lecturer(s)/Tutor(s):</b>  | Dr R Robinson  |              |  |   |

| ES3004 Processes and Products in Sedimentary Systems  |   |              |   |   |
|---|---|--------------|---|---|
| <b>SCOTCAT Credits:</b>   | 15  | SCQF Level 9 | <b>Semester:</b>                          | 2 |
| <b>Academic year:</b>   | 2016/7 & 2017/8   |              |   |   |
| <b>Planned timetable:</b>   | 9.00 am - 10.00 am Tue - Thu (lectures), 2.00 - 5.00 pm Mon (practicals). 3 field days (9.00 am - 5.00 pm)                  |              |   |   |
| This core module provides fundamental knowledge and training in describing, studying and interpreting sediments, sedimentary rocks and stratigraphic frameworks. The concepts and methodologies of process sedimentology, stratigraphy and sedimentary petrography will be taught, and training undertaken using fieldwork and practicals. The module serves as preparation for subsequent modules on related topics and for field-based modules, including Advanced Geological Mapping, the Research dissertation, and the fourth-year field course. |   |              |   |   |
| <b>Programme module type:</b>   | Compulsory for BSc Geology, Environmental Earth Science, joint degrees with Biology and Chemistry, and MGeol Earth Sciences |              |   |   |
| <b>Pre-requisite(s):</b>  | Normally ES2001 and (ES2002 or ES2003)  |              |   |   |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> Weekly lectures and practicals averaging 6 hours per week plus field training                        |              |   |   |
|   | <b>Scheduled learning:</b> 54 hours   |              | <b>Guided independent study:</b> 96 hours |   |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%                      |              |   |   |
|   | <b>As used by St Andrews:</b><br>2-hour Written Examination = 50%, Coursework = 50%   |              |   |   |
| <b>Re-Assessment pattern:</b>   | 2-hour Written Examination = 80%, Coursework = 20%, No Re-Assessment if Coursework mark is <4                               |              |   |   |
| <b>Module Co-ordinator:</b>   | Dr T Prave  |              |   |   |
| <b>Lecturer(s)/Tutor(s):</b>  | Dr T Prave, Dr M Singer, Dr R Robinson, Mr S Allison  |              |   |   |

| ES3006 Advanced Geological Mapping  |  |              |   |   |
|---|--|--------------|---|---|
| <b>SCOTCAT Credits:</b>   | 15   | SCQF Level 9 | <b>Semester:</b>                          | 2 |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |              |   |   |
| <b>Availability restrictions:</b>   | Not available to General Degree students.  |              |   |   |
| <b>Planned timetable:</b>   | 9.00 am - 5.00 pm Fri (map practicals)   |              |   |   |
| <p>Geological maps are not just summaries of rocks - they are ways of conveying three-dimensional structure and geological history. This module starts with sessions on geophysics techniques and field-based skills training sessions and lab-based analysis of classic geology maps, followed by two one-week field courses. Field assessment comprises a geophysical report, field notes and geological maps within holistic, problem-based exercises, determining the geology of the field areas from first principles. At the end of the module, students will not only have learned how to record, interpret and present field data, but also to visualise geology in four dimensions. This module is one of the most important for developing confidence in field techniques prior to independent research projects.</p> <p>The costs associated with this module are partially supported by the Department.</p> |  |              |   |   |
| <b>Programme module type:</b>   | Compulsory for BSc Geology, joint degrees with Biology and Chemistry, and MGeol Earth Sciences         |              |   |   |
| <b>Pre-requisite(s):</b>  | ES3001   |              |   |   |
| <b>Required for:</b>  | ES4001   |              |   |   |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 8 practical sessions through semester plus two residential field excursions.    |              |   |   |
|   | <b>Scheduled learning:</b> 88 hours  |              | <b>Guided independent study:</b> 62 hours |   |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100% |              |   |   |
|   | <b>As used by St Andrews:</b><br>Coursework = 100%   |              |   |   |
| <b>Re-Assessment pattern:</b>   | 2-hour Written Examination = 100%  |              |   |   |
| <b>Module Co-ordinator:</b>   | Dr A Finch   |              |   |   |
| <b>Lecturer(s)/Tutor(s):</b>  | Earth and Environmental Sciences staff   |              |   |   |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES3007 Structural Geology and Tectonics   |   |              |   |   |
|---|---|--------------|---|---|
| SCOTCAT Credits:  | 15  | SCQF Level 9 | Semester:                                 | 2 |
| Academic year:  | 2016/7 & 2017/8   |              |   |   |
| Planned timetable:  | 10.00 am - 12.00 noon Thu (lectures), 2.00 - 5.00 pm (practicals)   |              |   |   |
| This module covers the principles of rock deformation and associated metamorphism, and the tectonic processes that drive this deformation. The goals of this module are: a) the development of skills in the structural analysis of rock bodies to gain an understanding of the geometries, sequencing, and kinematics of deformational features; b) understanding of tectonic principles and controls on rock deformation and mountain building. |   |              |   |   |
| Programme module type:  | Compulsory for BSc Geology and MGeol Earth Sciences   |              |   |   |
| Pre-requisite(s):   | Normally ES2001 and ES2002  |              |   |   |
| Learning and teaching methods and delivery:   | <b>Weekly contact:</b> 1 x 2-hour lecture (x 11 weeks), 7 x 3-hour practicals during the semester and fieldwork |              |   |   |
|   | <b>Scheduled learning:</b> 55 hours   |              | <b>Guided independent study:</b> 95 hours |   |
| Assessment pattern:   | <b>As defined by QAA:</b><br>Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%          |              |   |   |
|   | <b>As used by St Andrews:</b><br>2-hour Written Examination = 50%, Coursework = 50%                             |              |   |   |
| Re-Assessment pattern:  | 2-hour Written Examination = 80%, Coursework = 20%, No Re-Assessment if Coursework mark is <4                   |              |   |   |
| Module Co-ordinator:  | TBC   |              |   |   |
| Lecturer(s)/Tutor(s):   | TBC   |              |   |   |

| ES3008 Geochemistry  |  |              |   |   |
|--|--|--------------|---|---|
| SCOTCAT Credits:   | 15   | SCQF Level 9 | Semester:                                 | 1 |
| Academic year:   | 2016/7 & 2017/8  |              |   |   |
| Planned timetable:   | 10.00 am Tue and Thu (lectures), 2.00 - 5.00 Fri (practicals)  |              |   |   |
| This module provides an introduction to geochemistry: the study of the abundance, distribution and circulation of the chemical elements in minerals, rocks, soils, water and the atmosphere. Geochemical tools are a powerful means to the study of geological, economic and environmental problems. In the module we study the origin and distribution of the chemical elements in the Earth and solar system and review thermodynamics and kinetics as applied to Earth systems. We apply thermodynamics to make quantitative predictions regarding the outcome of chemical reactions associated with geological processes. We consider the behaviour of elements, mainly in low temperature environments. Material covered includes use of stable and radiogenic isotopes, aqueous geochemistry and mineral precipitation and dissolution. We utilise geochemical tools to constrain changes in earth processes and climate, and to predict the impact of future change.<br>The module includes a field trip to study river geochemistry and multiple practical sessions to develop the lecture concepts. |  |              |   |   |
| Programme module type:   | Compulsory for BSc Environmental Earth Science, MGeol Earth Sciences, BSc Geology and joint degrees with Biology and Chemistry |              |   |   |
| Pre-requisite(s):  | Normally ES2001 and/or ES2003  |              |   |   |
| Learning and teaching methods and delivery:  | <b>Weekly contact:</b> 17 lectures, 15 hours of laboratory classes, 2 or more field classes over the semester.                 |              |   |   |
|  | <b>Scheduled learning:</b> 54 hours  |              | <b>Guided independent study:</b> 96 hours |   |
| Assessment pattern:  | <b>As defined by QAA:</b><br>Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%                         |              |   |   |
|  | <b>As used by St Andrews:</b><br>2-hour Written Examination = 50%, Coursework = 50%  |              |   |   |
| Re-Assessment pattern:   | 2-hour Written Examination = 80%, Coursework = 20%, No Re-Assessment if Coursework mark is <4                                  |              |   |   |
| Module Co-ordinator:   | Dr N Allison   |              |   |   |
| Lecturer(s)/Tutor(s):  | Dr A Finch, Dr M Claire, Dr N Allison, Dr J Rae, Dr A Burke  |              |   |   |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES3009 Igneous and Metamorphic Petrology  |  |              |  |   |
|---|--|--------------|--|---|
| <b>SCOTCAT Credits:</b>   | 15   | SCQF Level 9 | <b>Semester:</b>                           | 1 |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |              |  |   |
| <b>Planned timetable:</b>   | 9.00 am Tue and Thu (lectures); 2.00 pm - 5.00 pm Mon (practicals)   |              |  |   |
| This is a core module within the BSc Geology and MGeol Earth Sciences degrees and delivered early in the Honours programme in order to provide a framework for interpreting major petrological processes acting within the Earth's crust and mantle. The module serves as preparation for subsequent modules on related topics and for field-based modules, including Advanced Geological Mapping, the Research dissertation, the Alps field course, Advanced Petrogenesis and Metallogeny. |  |              |  |   |
| <b>Programme module type:</b>   | Compulsory for BSc Geology, joint degrees with Biology and Chemistry, and MGeol Earth Sciences<br>Optional for Environmental Earth Science degree. |              |  |   |
| <b>Pre-requisite(s):</b>  | Normally ES2001 and ES2002   |              |  |   |
| <b>Required for:</b>  | ES4006   |              |  |   |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 2 x 1-hour lectures (x 11 weeks), 3-hour practicals most weeks.   |              |  |   |
|   | <b>Scheduled learning:</b> 50 hours  |              | <b>Guided independent study:</b> 100 hours |   |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 50%, Practical Examinations = 50%, Coursework = 0%   |              |  |   |
|   | <b>As used by St Andrews:</b><br>2-hour Written Examination = 50%, 2 x 2-hour Practical Examination = 50%  |              |  |   |
| <b>Re-Assessment pattern:</b>   | 2-hour Written Examination = 80%, Coursework = 20%, No Re-Assessment if Coursework mark is <4  |              |  |   |
| <b>Module Co-ordinator:</b>   | Dr A Finch   |              |  |   |
| <b>Lecturer(s)/Tutor(s):</b>  | Dr A Finch, Dr S Mikhail   |              |  |   |

| ES3010 Advanced Environmental Field Methods  |   |              |   |   |
|--|---|--------------|---|---|
| <b>SCOTCAT Credits:</b>  | 15  | SCQF Level 9 | <b>Semester:</b>                          | 2 |
| <b>Academic year:</b>  | 2016/7 & 2017/8   |              |   |   |
| <b>Planned timetable:</b>  | 9.00 am - 5.00 pm Fri (Weeks 1 - 4)   |              |   |   |
| This forms the introduction to methodologies and training in applied environmental problems. This module starts with sessions on geophysics techniques and field-based skills training sessions. Specific environmental problems will be identified, and researched in detail before a one-week field excursion where an environmental impact problem will be addressed in the field. The costs associated with this module are partially supported by the Department. |   |              |   |   |
| <b>Programme module type:</b>  | Compulsory for BSc Environmental Earth Science  |              |   |   |
| <b>Pre-requisite(s):</b>   | ES3001  |              |   |   |
| <b>Required for:</b>   | ES4008  |              |   |   |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> 8 field-based skills training sessions, fortnightly seminar, one 1-week field excursion, and 1-week of lab-based data analysis . |              |   |   |
|  | <b>Scheduled learning:</b> 53 hours   |              | <b>Guided independent study:</b> 97 hours |   |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%  |              |   |   |
|  | <b>As used by St Andrews:</b><br>Coursework = 100%  |              |   |   |
| <b>Re-Assessment pattern:</b>  | Oral Examination = 100%   |              |   |   |
| <b>Module Co-ordinator:</b>  | Dr M Claire   |              |   |   |
| <b>Lecturer(s)/Tutor(s):</b>   | Earth and Environmental Sciences staff  |              |   |   |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES3011 Global Biogeochemical Cycles   |  |  |                    |
|---|--|--|--------------------|
| <b>SCOTCAT Credits:</b>   | 15   | SCQF Level 9                               | <b>Semester:</b> 2 |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |  |                    |
| <b>Planned timetable:</b>   | To be arranged.  |  |                    |
| <p>Environmental Earth Science is inherently multi-disciplinary, but many environmental science courses focus on specific reservoirs of the Earth system (e.g., the atmosphere, oceans, or continental crust), rather than examining the system as a whole. The study of global biogeochemical cycling crosses these disciplinary boundaries, following specific elements as they are cycled through the Earth surface by physical, chemical, and biological transformations. This module will focus on the cycling of five elements critical to life on Earth - Carbon, Oxygen, Sulfur, Phosphorus, and Nitrogen - using examples from both modern and ancient environments, and their response to human influence. An emphasis will be placed on understanding proxies utilized for unravelling these processes in the environment and in the rock record, along with modern quantitative methods used to constrain these cycles.</p> |  |  |                    |
| <b>Programme module type:</b>   | Compulsory for Environmental Earth Sciences and MGeol Earth Sciences<br>Optional for Geology, Biology and Geology, Chemistry and Geology |  |                    |
| <b>Pre-requisite(s):</b>  | Normally ES2002 or ES2003, and ES3008  |  |                    |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 2-hour lectures (x 6 weeks and only 1 hour in week 7) and 3-hour practical sessions (x 7 weeks).                  |  |                    |
|   | <b>Scheduled learning:</b> 36 hours  | <b>Guided independent study:</b> 114 hours |                    |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%                                   |  |                    |
|   | <b>As used by St Andrews:</b><br>2-hour Written Examination = 50%, Coursework = 50%  |  |                    |
| <b>Re-Assessment pattern:</b>   | 2-hour Written Examination = 80%, Coursework = 20%, No Re-Assessment if Coursework mark is <4  |  |                    |
| <b>Module Co-ordinator:</b>   | Dr A Zerkle  |  |                    |
| <b>Lecturer(s)/Tutor(s):</b>  | Dr A Zerkle, Dr M Claire, Dr S Mikhail   |  |                    |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES3012 Advanced Geological and Environmental Field Methods   |  |                           |   |   |
|--|--|---------------------------|---|---|
| <b>SCOTCAT Credits:</b>  | 15   | SCQF Level 9              | <b>Semester:</b>                          | 2 |
| <b>Academic year:</b>  | 2016/7 & 2017/8  |                           |   |   |
| <b>Planned timetable:</b>  | To be arranged.  |                           |   |   |
| <p>This module combines geophysical, geological and environmental field training. It starts with lectures and practical sessions on geophysics field techniques and field-based skills training sessions, as well as advanced map interpretation sessions for classic geological regions in Scotland. The second part of the module involves a one-week residential field geology excursion to the famous Assynt region of the NW Highlands. The final part of the course is a second 4-day to 1 week field excursion where an environmental problem will be the focus of the training. Locations will vary from year to year depending on staffing, and could be in the UK or abroad. The department partially supports the financial costs associated with the fieldwork components.</p> |  |                           |   |   |
| <b>Programme module type:</b>  | Compulsory for MGeol in Earth Sciences<br>Optional for Chemistry and Geology   |                           |   |   |
| <b>Pre-requisite(s):</b>   | ES3001   | <b>Anti-requisite(s):</b> | ES3006, ES3010                            |   |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> Lectures and practical sessions followed by two residential field classes.  |                           |   |   |
|  | <b>Scheduled learning:</b> 100 hours   |                           | <b>Guided independent study:</b> 50 hours |   |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%   |                           |   |   |
|  | <b>As used by St Andrews:</b><br>Coursework = 100% (geophysics report = 33.3%; geological notebooks and maps = 33.3% and environmental report = 33.3%) |                           |   |   |
| <b>Re-Assessment pattern:</b>  | 2-hour Written Examination = 80%, Coursework = 20%, No Re-Assessment if Coursework mark is <4  |                           |   |   |
| <b>Module Co-ordinator:</b>  | Dr T Prave   |                           |   |   |
| <b>Lecturer(s)/Tutor(s):</b>   | Dr R Bates, Dr M Claire, Dr A Zerkle   |                           |   |   |

| ES3099 Field Methods in Geosciences   |   |              |   |   |
|---|---|--------------|---|---|
| <b>SCOTCAT Credits:</b>   | 30  | SCQF Level 9 | <b>Semester:</b>                          | 2 |
| <b>Academic year:</b>   | 2016/7  |              |   |   |
| <b>Availability restrictions:</b>   | Available only to visiting students.  |              |   |   |
| <b>Planned timetable:</b>   | none - field-based module.  |              |   |   |
| <p>This module is designed exclusively for non-graduating overseas undergraduate students seeking advanced training in geological field methods. It consists of hands-on experience honing observational and mapping skills by participating in highly focused residential and one-day excursions and associated laboratory classes. The module takes full advantage of the University's location close to some classic geological locations, normally including the central Spain Sierra Norte region, the NW Highlands region including the Moine thrust system, the Buchan and Barrovian metamorphic zones in the Dalradian terrane, and the Carboniferous sequences of NE England and Fife.</p> |   |              |   |   |
| <b>Programme module type:</b>   | Available to visiting students only.  |              |   |   |
| <b>Pre-requisite(s):</b>  | Must be studying Earth Science at an overseas university  |              |   |   |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> Occasional lectures, tutorials and practicals in addition to fieldwork - this is predominantly a residential field-based module. |              |   |   |
|   | <b>Scheduled learning:</b> 268 hours  |              | <b>Guided independent study:</b> 32 hours |   |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%  |              |   |   |
|   | <b>As used by St Andrews:</b><br>Coursework = 100%  |              |   |   |
| <b>Re-Assessment pattern:</b>   | No Re-Assessment available  |              |   |   |
| <b>Module Co-ordinator:</b>   | Dr R Robinson   |              |   |   |
| <b>Lecturer(s)/Tutor(s):</b>  | Earth and Environmental Sciences staff  |              |   |   |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES4001 Field Excursion and Map Interpretation  |  |               |   |   |
|--|--|---------------|---|---|
| <b>SCOTCAT Credits:</b>  | 15   | SCQF Level 10 | <b>Semester:</b>                          | 1 |
| <b>Academic year:</b>  | 2016/7 & 2017/8  |               |   |   |
| <b>Planned timetable:</b>  | 12 days fieldwork in August - September. 9.00 am - 5.00 pm Fri (practicals)                            |               |   |   |
| Building on the field training at Junior Honours level, this module develops the field observation and interpretation skills of collecting, recording, interpreting and synthesising data in the field and from geological maps and cross-sections. The field course will be thematic, examining and synthesising all aspects of a region to interpret a complex geological history. Theme and location may vary, but the excursion will generally be based within a well-exposed orogenic belt with the aim of traversing from the foreland to the interior. Fieldwork will be combined with map and aerial photograph interpretation and the construction of cross-sections. The Department partially supports the costs associated with the fieldwork component of this module. |  |               |   |   |
| <b>Programme module type:</b>  | Compulsory for BSc Geology<br>Either ES4001 or ES4008 is compulsory for MGeol Earth Sciences           |               |   |   |
| <b>Pre-requisite(s):</b>   | normally ES3006  |               |   |   |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> 2-week field course and 4 lab sessions.   |               |   |   |
|  | <b>Scheduled learning:</b> 84 hours  |               | <b>Guided independent study:</b> 66 hours |   |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100% |               |   |   |
|  | <b>As used by St Andrews:</b><br>Coursework = 100%   |               |   |   |
| <b>Re-Assessment pattern:</b>  | 2-hour Written Examination = 100%  |               |   |   |
| <b>Module Co-ordinator:</b>  | Dr T Prave   |               |   |   |
| <b>Lecturer(s)/Tutor(s):</b>   | Earth and Environmental Sciences staff   |               |   |   |

| ES4002 Research Review, Essay and Seminar  |   |               |  |   |
|--|---|---------------|--|---|
| <b>SCOTCAT Credits:</b>  | 15  | SCQF Level 10 | <b>Semester:</b>                           | 1 |
| <b>Academic year:</b>  | 2016/7 & 2017/8   |               |  |   |
| <b>Availability restrictions:</b>  | BSc students may only take this module in semester 1, MGeol students can take this module in either semester. |               |  |   |
| <b>Planned timetable:</b>  | Not applicable.   |               |  |   |
| The student proposes an Earth Science topic, one that has not been directly covered in a module. They discuss the suitability of the topic with a lecturer who agrees to become adviser to the student. Student and adviser are required to meet 2 further times during the module. Literature and web-based research is conducted and the student writes a critical review of ca. 3,500 words. The same material is also presented in a 15 minute seminar to staff and classmates. Advice on critical writing and presenting talks is given a year before the start of the module, on entry to Junior Honours, for use throughout the Honours programme. The seminar is assessed by both lecturers and peers. |   |               |  |   |
| <b>Programme module type:</b>  | Compulsory for BSc Geology and Environmental Earth Science, and MGeol Earth Sciences                          |               |  |   |
| <b>Pre-requisite(s):</b>   | Admission to an Honours Earth Sciences programme or Environmental Earth Science                               |               |  |   |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> Occasional lecture and 3 meetings with adviser spread across the semester.             |               |  |   |
|  | <b>Scheduled learning:</b> 10 hours   |               | <b>Guided independent study:</b> 140 hours |   |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 15%, Coursework = 85%        |               |  |   |
|  | <b>As used by St Andrews:</b><br>Practical Examination = 15%, Coursework = 85%                                |               |  |   |
| <b>Re-Assessment pattern:</b>  | Oral Examination = 100%   |               |  |   |
| <b>Module Co-ordinator:</b>  | Dr S Mikhail and Dr T Raub  |               |  |   |
| <b>Lecturer(s)/Tutor(s):</b>   | Earth and Environmental Sciences staff  |               |  |   |



## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES4003 Research Dissertation   |  |               |  |            |
|--|--|---------------|--|------------|
| <b>SCOTCAT Credits:</b>  | 45   | SCQF Level 10 | <b>Semester:</b>                           | Whole Year |
| <b>Academic year:</b>  | 2016/7 & 2017/8  |               |  |            |
| <b>Availability restrictions:</b>  | Available only to Single Honours BSc Earth Science students  |               |  |            |
| <b>Planned timetable:</b>  | Not applicable.  |               |  |            |
| <p>An individual research project which allows the student to pursue in depth a topic of personal interest. The student works largely independently of supervision and has the opportunity to demonstrate individuality, initiative and enterprise. Skills of planning and executing research are learnt, as well as the ability to work independently, and present the results orally and in dissertation form (up to 10,000 words).</p> <p>(Guidelines for printing and binding dissertations can be found at:<br/> <a href="http://www.st-andrews.ac.uk/printanddesign/dissertation/">http://www.st-andrews.ac.uk/printanddesign/dissertation/</a>)</p> |  |               |  |            |
| <b>Programme module type:</b>  | Compulsory for BSc Geology and Environmental Earth Science   |               |  |            |
| <b>Pre-requisite(s):</b>   | Admission to an Honours Earth Sciences programme or Environmental Earth Science                        |               |  |            |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> Regular meetings with supervisor arranged as required.                          |               |  |            |
|  | <b>Scheduled learning:</b> 20 hours  |               | <b>Guided independent study:</b> 430 hours |            |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 10%, Coursework = 90% |               |  |            |
|  | <b>As used by St Andrews:</b><br>Proposal = 5%, Oral presentation = 10%, Dissertation = 85%            |               |  |            |
| <b>Re-Assessment pattern:</b>  | No Re-Assessment available   |               |  |            |
| <b>Module Co-ordinator:</b>  | Dr T Raub and Dr S Mikhail   |               |  |            |
| <b>Lecturer(s)/Tutor(s):</b>   | Earth and Environmental Sciences staff   |               |  |            |

| ES4007 Petroleum Exploration and Geophysics   |   |               |  |   |
|---|---|---------------|--|---|
| <b>SCOTCAT Credits:</b>   | 15  | SCQF Level 10 | <b>Semester:</b>                           | 1 |
| <b>Academic year:</b>   | 2016/7 & 2017/8   |               |  |   |
| <b>Planned timetable:</b>   | 11.00 am - 1.00 pm Thu (lectures), 2.00 - 5.00 pm Thu (practicals)  |               |  |   |
| <p>The fundamental concepts, techniques and practices of the hydrocarbon exploration industry are presented. Students will gain a thorough understanding of the geoscience of petroleum exploration, particularly using geophysical methods, and a working knowledge of modern concepts in oil and gas geology.</p> |   |               |  |   |
| <b>Programme module type:</b>   | Optional for BSc Geology, Environmental Earth Science, joint degrees with Biology and Chemistry, and MGeol Earth Sciences |               |  |   |
| <b>Pre-requisite(s):</b>  | Normally ES2001 and (ES2002 or ES2003)  |               |  |   |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 17 lectures, 15 hours laboratory classes, field classes over the semester.                         |               |  |   |
|   | <b>Scheduled learning:</b> 38 hours   |               | <b>Guided independent study:</b> 112 hours |   |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%                    |               |  |   |
|   | <b>As used by St Andrews:</b><br>2-hour Written Examination = 50%, Coursework = 50%                                       |               |  |   |
| <b>Re-Assessment pattern:</b>   | 2-hour Written Examination = 80%, Coursework = 20%, No Re-Assessment if Coursework mark is <4                             |               |  |   |
| <b>Module Co-ordinator:</b>   | Dr R Bates  |               |  |   |
| <b>Lecturer(s)/Tutor(s):</b>  | Dr R Bates  |               |  |   |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES4008 Environmental Excursion   |  |               |   |   |
|--|--|---------------|---|---|
| <b>SCOTCAT Credits:</b>  | 15   | SCQF Level 10 | <b>Semester:</b>                          | 1 |
| <b>Academic year:</b>  | 2016/7 & 2017/8  |               |   |   |
| <b>Planned timetable:</b>  | 12 days fieldwork in August - September. 9.00 am - 5.00 pm Fri (practicals)                                      |               |   |   |
| This module is designed to provide advanced field-based training in a variety of environmental and geochemical analytical techniques of utility to solving geo-environmental problems. The field course will be thematic and examine environmental aspects of a region using an integrated approach. Theme and location may vary. Additional post-trip analyses may include geophysical and remotely sensed data, GIS and laboratory work. The Department partially supports the costs associated with the fieldwork component of this module. |  |               |   |   |
| <b>Programme module type:</b>  | Compulsory for BSc Environmental Earth Science<br>Either ES4001 or ES4008 is compulsory for MGeol Earth Sciences |               |   |   |
| <b>Pre-requisite(s):</b>   | ES3010   |               |   |   |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> 2-week field course and 4 lab sessions.   |               |   |   |
|  | <b>Scheduled learning:</b> 84 hours  |               | <b>Guided independent study:</b> 66 hours |   |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%           |               |   |   |
|  | <b>As used by St Andrews:</b><br>Coursework = 100%   |               |   |   |
| <b>Re-Assessment pattern:</b>  | 2-hour Written Examination = 100%  |               |   |   |
| <b>Module Co-ordinator:</b>  | Dr A Burke   |               |   |   |
| <b>Lecturer(s)/Tutor(s):</b>   | Earth and Environmental Sciences staff   |               |   |   |

| ES4010 Joint Honours Research Project   |  |               |  |            |
|---|--|---------------|--|------------|
| <b>SCOTCAT Credits:</b>   | 30   | SCQF Level 10 | <b>Semester:</b>                           | Whole Year |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |               |  |            |
| <b>Planned timetable:</b>   | Not applicable.  |               |  |            |
| An individual research project allows the student to pursue in depth a topic of personal interest. The student works largely independently and has the opportunity to demonstrate individuality, initiative and enterprise. Projects will normally include an aspect of field and analytical science. Skills of planning and executing research are learned, as well as the ability to work independently, and present the results orally and in dissertation form (up to 7,000 words). (Guidelines for printing and binding dissertations can be found at: <a href="http://www.st-andrews.ac.uk/printanddesign/dissertation/">http://www.st-andrews.ac.uk/printanddesign/dissertation/</a> ) |  |               |  |            |
| <b>Programme module type:</b>   | EITHER (ES4010 and CH4448) OR ID4441 are compulsory for joint degrees with Chemistry                   |               |  |            |
| <b>Pre-requisite(s):</b>  | Admission to Joint Honours Geology and Chemistry   |               |  |            |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> Regular meetings with supervisor arranged as required.                          |               |  |            |
|   | <b>Scheduled learning:</b> 20 hours  |               | <b>Guided independent study:</b> 280 hours |            |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 10%, Coursework = 90% |               |  |            |
|   | <b>As used by St Andrews:</b><br>Proposal = 5%, Oral Presentation = 10%, Dissertation = 85%            |               |  |            |
| <b>Re-Assessment pattern:</b>   | No Re-Assessment available   |               |  |            |
| <b>Module Co-ordinator:</b>   | Dr S Mikhail and Dr T Raub   |               |  |            |
| <b>Lecturer(s)/Tutor(s):</b>  | Earth and Environmental Sciences staff   |               |  |            |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES4011 Work Placement in Earth Sciences  |  |               |  |        |
|--|--|---------------|--|--------|
| <b>SCOTCAT Credits:</b>  | 30   | SCQF Level 10 | <b>Semester:</b>                         | 1 or 2 |
| <b>Academic year:</b>  | 2016/7 & 2017/8  |               |  |        |
| <b>Planned timetable:</b>  | To be arranged.  |               |  |        |
| <p>Practical experience of Earth Sciences is important to graduate job prospects and for students to understand the practical relevance of taught material course. This module is a platform for the students to obtain experience of the workplace through an 8-week industrial placement. The student finds their own work placement, some with the assistance of staff connections in industry and alumni. Work placements can be of a variety of forms, varying from office or lab-based work to engineering geology at sites in the UK to exploration geology across the world. The performance of the student in the workplace is assessed using similar criteria to those used when applying for Chartered (CGeol) status. The student reports on their activities during placement at the end of the placement period.</p> |  |               |  |        |
| <b>Programme module type:</b>  | ES4011 or ES4012 is compulsory for MGeol Earth Sciences  |               |  |        |
| <b>Pre-requisite(s):</b>   | Normally ES2001 and ES2002 and Entry to MGeol Earth Sciences   |               |  |        |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> Meetings.   |               |  |        |
|  | <b>Scheduled learning:</b> 0 hours   |               | <b>Guided independent study:</b> 0 hours |        |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 30%, Coursework = 70% |               |  |        |
|  | <b>As used by St Andrews:</b><br>Coursework = 100%   |               |  |        |
| <b>Re-Assessment pattern:</b>  | No Re-Assessment available   |               |  |        |
| <b>Module Co-ordinator:</b>  | Dr R Robinson  |               |  |        |
| <b>Lecturer(s)/Tutor(s):</b>   | Earth and Environmental Sciences staff   |               |  |        |

| ES4012 Research Placement in Earth Sciences   |  |               |  |        |
|---|--|---------------|--|--------|
| <b>SCOTCAT Credits:</b>   | 30   | SCQF Level 10 | <b>Semester:</b>                         | 1 or 2 |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |               |  |        |
| <b>Planned timetable:</b>   | To be arranged.  |               |  |        |
| <p>Practical experience of Earth Sciences is important to graduate job prospects and for students to understand the practical relevance of taught material in the course. The present module is a platform for the students to obtain experience of the working in an academic research team through a research placement. The student finds their own placement by negotiating with staff. The performance of the student in the workplace is assessed using similar criteria to those used when applying for Chartered (CGeol) status. The student reports on their activities during placement at the end of the placement period.</p> |  |               |  |        |
| <b>Programme module type:</b>   | ES4011 or ES4012 is compulsory for MGeol Earth Sciences  |               |  |        |
| <b>Pre-requisite(s):</b>  | Normally ES2001 and ES2002 and Entry to MGeol Earth Sciences   |               |  |        |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> Meetings.   |               |  |        |
|   | <b>Scheduled learning:</b> 0 hours   |               | <b>Guided independent study:</b> 0 hours |        |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100% |               |  |        |
|   | <b>As used by St Andrews:</b><br>Coursework = 100%   |               |  |        |
| <b>Re-Assessment pattern:</b>   | No Re-Assessment available   |               |  |        |
| <b>Module Co-ordinator:</b>   | Dr R Bates   |               |  |        |
| <b>Lecturer(s)/Tutor(s):</b>  | Earth and Environmental Sciences staff   |               |  |        |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES4031 Analytical Sciences  |  |   |                    |
|---|--|---|--------------------|
| <b>SCOTCAT Credits:</b>   | 5  | SCQF Level 10                             | <b>Semester:</b> 1 |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |   |                    |
| <b>Availability restrictions:</b>   | Available to students on the MSc Geochemistry degree and Geography Honours programme.                  |   |                    |
| <b>Planned timetable:</b>   | To be arranged.  |   |                    |
| <p>This module is designed to support students who do not have a strong background in the analytical methods used in Earth Science. These include, for example, students enrolled in BSc Geography or MSc Geochemistry degree programmes. The module comprises a series of seven lectures starting with the basic principles of accuracy and precision, which are then illustrated in the context of the most common analytical methods used in the geosciences. Students are asked to independently research an analytical method of interest. This is then presented in a poster imitating the poster sessions at major conferences. Posters are marked by both students (peer assessment) and staff (different weighting). The module will give students the necessary training to allow them to excel in other Earth Science modules.</p> |  |   |                    |
| <b>Programme module type:</b>   | Optional for Geography or Sustainable Development students.  |   |                    |
| <b>Anti-requisite(s):</b>   | EG4031   |   |                    |
| <b>Co-requisite(s):</b>   | Any Level 4 or 5 module for BSc students.  |   |                    |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 7 x 1-hour lectures and 1 x 8-hour poster presentation day over the semester.   |   |                    |
|   | <b>Scheduled learning:</b> 15 hours  | <b>Guided independent study:</b> 35 hours |                    |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100% |   |                    |
|   | <b>As used by St Andrews:</b><br>Coursework (Poster session) = 100%                                    |   |                    |
| <b>Re-Assessment pattern:</b>   | No Re-Assessment available   |   |                    |
| <b>Module Co-ordinator:</b>   | Dr A Finch   |   |                    |
| <b>Lecturer(s)/Tutor(s):</b>  | Earth and Environmental Sciences staff   |   |                    |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES5001 Expedition Field Course  |  |               |  |        |
|---|--|---------------|--|--------|
| <b>SCOTCAT Credits:</b>   | 15   | SCQF Level 11 | <b>Semester:</b>                           | SUMMER |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |               |  |        |
| <b>Planned timetable:</b>   | To be arranged.  |               |  |        |
| <p>Fieldwork in Earth Sciences is key to graduate job prospects and is a platform for students to bring together the many aspects of Earth Sciences. The present module will involve the students not just in carrying out fieldwork, but also in the logistical and interpersonal sides of successful fieldwork design. Students will identify a field area for study in consultation with a member of the teaching staff, which includes several aspects of Earth sciences, such as igneous, sedimentary, economic and environmental geology. The students will form a team and divide the responsibilities for fieldwork and logistics. The assessment will include a memoir that will summarise the geological history of the area, similar to that published by a Geological Survey or the exploration industry. A (formatively assessed) presentation may be required if funding was provided by an external body. Some student groups may choose to use this module to carry out ambitious fieldwork in a remote setting. The students are responsible for finding the costs associated with the fieldwork component of this module, but external funding has been successfully won in recent years.</p> |  |               |  |        |
| <b>Programme module type:</b>   | Optional for MGeol in Earth Sciences.  |               |  |        |
| <b>Pre-requisite(s):</b>  | Entry to Year 5 of MGeol Earth Sciences  |               |  |        |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 5 hours of orientation/tutorials over 2 weeks                                   |               |  |        |
|   | <b>Scheduled learning:</b> 10 hours  |               | <b>Guided independent study:</b> 140 hours |        |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100% |               |  |        |
|   | <b>As used by St Andrews:</b><br>Coursework = 100%   |               |  |        |
| <b>Re-Assessment pattern:</b>   | Oral Examination = 100%  |               |  |        |
| <b>Module Co-ordinator:</b>   | Dr A Finch   |               |  |        |

| ES5003 Research Dissertation   |   |               |  |            |
|--|---|---------------|--|------------|
| <b>SCOTCAT Credits:</b>  | 60  | SCQF Level 11 | <b>Semester:</b>                           | Whole Year |
| <b>Academic year:</b>  | 2016/7 & 2017/8   |               |  |            |
| <p>An individual research project on a topic in geological sciences which allows the student to pursue in depth a topic of personal interest. The student works largely independently of supervision and has the opportunity to demonstrate individuality, initiative and enterprise. Skills of planning and executing research are learnt, as well as the ability to work independently, and present the results orally and in dissertation form (up to 7,000 words). The project report will be as a publication-ready article in the manner of the journal "Geology".</p> |   |               |  |            |
| <b>Programme module type:</b>  | Compulsory for MGeol Earth Sciences.  |               |  |            |
| <b>Pre-requisite(s):</b>   | Entry to Year 5 of MGeol Earth Sciences   |               |  |            |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> Regular meetings with supervisor arranged as required.   |               |  |            |
|  | <b>Scheduled learning:</b> 30 hours   |               | <b>Guided independent study:</b> 570 hours |            |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%                  |               |  |            |
|  | <b>As used by St Andrews:</b><br>Coursework = 100% (Project proposal = 5%, Oral Presentation = 10%, Dissertation = 85%) |               |  |            |
| <b>Re-Assessment pattern:</b>  | No Re-Assessment available  |               |  |            |
| <b>Module Co-ordinator:</b>  | Dr S Mikhail and Dr T Raub  |               |  |            |
| <b>Lecturer(s)/Tutor(s):</b>   | Earth and Environmental Sciences staff  |               |  |            |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES5005 Isotope Geochemistry: Theory, Techniques, and Applications   |  |  |                    |
|---|--|--|--------------------|
| <b>SCOTCAT Credits:</b>   | 15   | SCQF Level 11                              | <b>Semester:</b> 1 |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |  |                    |
| <b>Planned timetable:</b>   | To be arranged.  |  |                    |
| <p>Isotope geochemistry has grown over the last 50 years to become one of the most important fields in the Earth sciences. The growth in the importance of isotope geochemistry reflects its remarkable success in solving fundamental problems in mantle formation, ore genesis, hydrology, hydrocarbon formation, crustal evolution, planetary formation, geochemical cycles, hydrothermal circulation, ocean circulation, and climate and environmental change. In this module, we will explore the theory of isotopes and their fractionation, including kinetic, equilibrium, and Rayleigh fractionation. We will also learn how isotope measurements are made, with an introduction to mass spectrometry methods, techniques, and analysis. The latter half of the course will be devoted to case studies and applications of isotopes to interesting problems across Earth Sciences including the evolution of the atmosphere, the formation of the solar system and planets, and climate and carbon cycle reconstructions. These case studies will introduce concepts such as clumped isotopes, isotope mass balance, mass independent fractionation, and radionuclide disequilibria.</p> |  |  |                    |
| <b>Programme module type:</b>   | Optional for BSc Geology, BSc Environmental Earth Sciences and MGeol Earth Sciences.                   |  |                    |
| <b>Pre-requisite(s):</b>  | For current BSc students, normally ES3008 or CH1401, CH1402, and CH2501.                               |  |                    |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 2-hour lectures (x 10.5 weeks), 3-hour practical sessions (x 3 weeks)           |  |                    |
|   | <b>Scheduled learning:</b> 30 hours  | <b>Guided independent study:</b> 120 hours |                    |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 50%, Coursework = 50% |  |                    |
|   | <b>As used by St Andrews:</b><br>2-hour Practical (Open Book) Examination = 50%, Coursework = 50%      |  |                    |
| <b>Module Co-ordinator:</b>   | Dr A Burke   |  |                    |
| <b>Lecturer(s)/Tutor(s):</b>  | Dr P Savage  |  |                    |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES5006 Metallogeny  |  |               |  |   |
|---|--|---------------|--|---|
| <b>SCOTCAT Credits:</b>   | 15   | SCQF Level 11 | <b>Semester:</b>                           | 2 |
| <b>Academic year:</b>   | 2016/7 & 2017/8  |               |  |   |
| <b>Planned timetable:</b>   | 9:00 am - 11:00 am Thu (lectures); 9.00 am - 1.00 pm (practicals)_   |               |  |   |
| <p>The module focuses on the geodynamic setting, age, geometry and mineralogy of the principal metallic mineral deposits using a holistic approach (structural geology, geochemistry, isotope geochemistry, sedimentology, igneous geology, metamorphic geology, and geophysics). Current genetic models of ore deposits are reviewed with an emphasis on the geological processes required to create them. Finally, a roadmap to mineral exploration for each type of ore deposit is discussed.</p> <p>Laboratory exercises involve geological problem solving using a mineral exploration industry focus involving the examination of geological maps and representative suites of samples (thin sections, hand samples, and outcrops) from different types of metallic mineral deposits.</p> <p>A single day field excursion will be to the gold mine at Cononish or the lead mine at Wanlockhead to cover the geological context of the ore bodies and aspects of their exploration and production.</p> |  |               |  |   |
| <b>Programme module type:</b>   | Optional for BSc Geology and MGeol Earth Sciences, and Joint Degree BSc Chemistry and Geology.   |               |  |   |
| <b>Pre-requisite(s):</b>  | For current BSc & MGeol students, normally ES3009 or CH1401, CH1402, and CH2501.   |               |  |   |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 1- or 2-hour lectures (23 hours over 11 weeks); 2-hour or 3-hour practical sessions (14 hours over 5 weeks); 4 hours of oral presentations; 9 hours of field work |               |  |   |
|   | <b>Scheduled learning:</b> 50 hours  |               | <b>Guided independent study:</b> 100 hours |   |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 50%, Coursework = 50%   |               |  |   |
|   | <b>As used by St Andrews:</b><br>2-hour Practical (Open Book) Examination = 50%, Coursework = 50%  |               |  |   |
| <b>Re-Assessment pattern:</b>   | 2-hour Practical (Open Book) Examination = 50%, Coursework = 50%   |               |  |   |
| <b>Module Co-ordinator:</b>   | Dr J Cloutier  |               |  |   |
| <b>Lecturer(s)/Tutor(s):</b>  | Dr A Finch   |               |  |   |

| ES5009 Geodynamics   |   |                           |  |   |
|--|---|---------------------------|--|---|
| <b>SCOTCAT Credits:</b>  | 15  | SCQF Level 11             | <b>Semester:</b>                           | 2 |
| <b>Academic year:</b>  | 2017/8  |                           |  |   |
| <b>Planned timetable:</b>  | 9.00 am - 10.00 am Tue and Wed; 9.00 am - 5.00 pm Fri (Weeks 2,5,9)   |                           |  |   |
| <p>A study of the geodynamic evolution of Earth's crust since the Archaean, the evolution of convergent and divergent margins, and the relationships between tectonics, erosion and climate. The module contrasts geodynamic evolution in the Archaean, Proterozoic, Palaeozoic, Mesozoic and Cenozoic using a number of case studies, including examples visited in the field. The module develops skills of geodynamic interpretation, field observation, use of numerical models, report writing and oral presentation.</p> |   |                           |  |   |
| <b>Programme module type:</b>  | Optional for MGeol Earth Sciences, BSc Geology, Environmental Earth Science, and joint degrees in Biology and Chemistry.                  |                           |  |   |
| <b>Pre-requisite(s):</b>   | Normally ES2001 and (ES2002 or ES2003)  | <b>Anti-requisite(s):</b> | ES4009                                     |   |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> 2 x 1-hour lectures(x 11 weeks) , plus 2 extended laboratory classes, and 2 days in the field during the semester. |                           |  |   |
|  | <b>Scheduled learning:</b> 50 hours   |                           | <b>Guided independent study:</b> 100 hours |   |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%                                    |                           |  |   |
|  | <b>As used by St Andrews:</b><br>2-hour Written Examination = 50%, Coursework = 50%   |                           |  |   |
| <b>Re-Assessment pattern:</b>  | 2-hour Written Examination = 80%, Coursework = 20%, No Re-Assessment if Coursework mark is <4   |                           |  |   |
| <b>Module Co-ordinator:</b>  | TBC   |                           |  |   |
| <b>Lecturer(s)/Tutor(s):</b>   | Dr T Raub   |                           |  |   |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES5010 Advanced Geochemistry  |   |  |                    |
|---|---|--|--------------------|
| <b>SCOTCAT Credits:</b>   | 15  | SCQF Level 11                              | <b>Semester:</b> 2 |
| <b>Academic year:</b>   | 2016/7 & 2017/8   |  |                    |
| <b>Planned timetable:</b>   | To be arranged.   |  |                    |
| <p>Many of the environmental challenges facing society revolve around the cycling of natural materials between fluid and solid phases. Some of the most fundamental aspects of Earth System development are investigated through geochemical methodologies that characterise and interrogate processes operating at the interface between the solid Earth and the fluid Earth. Further, the processes that concentrate many natural resources are a result of fluid-solid interactions that can be studied using organic and aqueous geochemistry. This module focuses on training in the state-of-the art techniques and methodologies that are tools that can be applied widely to address questions about environmental changes and chemistry in sediments and natural waters and, as well as utilisation and exploitation of hydrocarbon resources and Earth System evolution through time.</p> |   |  |                    |
| <b>Programme module type:</b>   | Optional for MGeol Earth Sciences, BSc Geology, Environmental Earth Science, and joint degrees in Biology and Chemistry.                            |  |                    |
| <b>Pre-requisite(s):</b>  | Normally ES3008   |  |                    |
| <b>Learning and teaching methods and delivery:</b>  | <b>Weekly contact:</b> 1-hour lecture (x 10 weeks) 5 x 3-hour practical sessions and 1 x 8-hour session of project presentations over the semester. |  |                    |
|   | <b>Scheduled learning:</b> 33 hours   | <b>Guided independent study:</b> 117 hours |                    |
| <b>Assessment pattern:</b>  | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 30%, Coursework = 70%  |  |                    |
|   | <b>As used by St Andrews:</b><br>Coursework = 100%  |  |                    |
| <b>Re-Assessment pattern:</b>   | 2-hour Written Examination = 80%, Coursework = 20%, No Re-Assessment if Coursework mark is <4   |  |                    |
| <b>Module Co-ordinator:</b>   | Dr E Stueeken   |  |                    |
| <b>Lecturer(s)/Tutor(s):</b>  | Dr P Savage, Dr S Mikhail   |  |                    |



| ES5011 Water in the Environment  |  |               |  |   |
|--|--|---------------|--|---|
| <b>SCOTCAT Credits:</b>  | 15   | SCQF Level 11 | <b>Semester:</b>                           | 1 |
| <b>Academic year:</b>  | 2016/7 & 2017/8  |               |  |   |
| <b>Planned timetable:</b>  | To be arranged.  |               |  |   |
| <p>Water is fundamental to life on Earth and the functioning of healthy ecosystems and societies. However, fresh water is unevenly distributed across the continents, presenting challenges for maintaining adequate supplies to support ecosystem functioning and the growth and development of modern human society. Furthermore, humans interact with the hydrosphere in ways that contribute to degradation of water quality. These problems of water quantity and quality are exacerbated by fluctuations and trends in climate that contribute to accentuated flooding and drought cycles in particular regions. The ability of current and future generations to understand, predict, and ameliorate such problems requires a solid understanding of hydrology in terms of the hydrological cycle, its forcing by climate, partitioning of water between surface and subsurface, water availability to ecosystems, the role of water in biogeochemistry, geochemistry associated with water, rock and/or soil interactions, or and the management of floods and water shortages. This course provides a combination of the underpinning hydrological theory and the analytical tools required to better understand and ameliorate problems of water in the environment. It will allow students to read and evaluate primary scientific research and it will challenge them to conduct modelling experiments to assess hydrological responses to various external factors. The module assessment will consist of analytical problem solving, simulated communication of hydrological science to government officials and the media, and an exam of short answers and essays.</p> |  |               |  |   |
| <b>Programme module type:</b>  | Optional for BSc Environmental Earth Science, MGeol Earth Science.   |               |  |   |
| <b>Pre-requisite(s):</b>   | Normally ES3008 but students with relevant chemistry background considered.  |               |  |   |
| <b>Learning and teaching methods and delivery:</b>   | <b>Weekly contact:</b> 20 hours of lectures, 6 hours of laboratory work and 4 hours of tutorials over the semester.  |               |  |   |
|  | <b>Scheduled learning:</b> 30 hours  |               | <b>Guided independent study:</b> 120 hours |   |
| <b>Assessment pattern:</b>   | <b>As defined by QAA:</b><br>Written Examinations = 40%, Practical Examinations = 15%, Coursework = 45%  |               |  |   |
|  | <b>As used by St Andrews:</b><br>2-hour Written Examination = 40%, Coursework (including Technical Brief, Media Interview and Qualitative analysis exercise) = 60% |               |  |   |
| <b>Re-Assessment pattern:</b>  | 2-hour Written Examination = 100%  |               |  |   |
| <b>Module Co-ordinator:</b>  | Dr M Singer  |               |  |   |
| <b>Lecturer(s)/Tutor(s):</b>   | Dr M Singer  |               |  |   |

## Geography & Geosciences Honours Level - 2016/7 - August 2016

| ES5013 Advanced Petrogenesis                       |  |               |  |   |
|--|--|---------------|--|---|
| <b>SCOTCAT Credits:</b>                            | 15   | SCQF Level 11 | <b>Semester:</b>                           | 1 |
| <b>Academic year:</b>                              | 2016/7   |               |  |   |
| <b>Planned timetable:</b>                          | 10.00 am Mon and Tue (lectures). 10.00 - 1.00 pm Wed or Fri (practicals)   |               |  |   |
|  | <p>The Earth's crust is largely created by acid and basic magmatism and many of the planet's critical resources are formed from igneous processes. The module explores the nature of that magmatism, the petrography and geochemistry of the minerals and rocks created, and the petrogenesis and evolution of the magma. The petrological characteristics of the continental crust and of the upper mantle, the principal sources of acid and basic magmas, are examined in detail for the influence which these have on the magmas created by partial melting. The economic significance of alkaline rocks as the hosts for many of the world's critical metals is considered.</p> |               |  |   |
| <b>Programme module type:</b>                      | Optional for BSc Geology and MGeol Earth Sciences  |               |  |   |
| <b>Pre-requisite(s):</b>                           | Normally ES3009  |               |  |   |
| <b>Learning and teaching methods and delivery:</b> | <b>Weekly contact:</b> 18 lectures, 15 hours of laboratory work, 18 hours of field-related study over the semester   |               |  |   |
|  | <b>Scheduled learning:</b> 50 hours  |               | <b>Guided independent study:</b> 100 hours |   |
| <b>Assessment pattern:</b>                         | <b>As defined by QAA:</b><br>Written Examinations = 50%, Practical Examinations = 50%, Coursework = 0%   |               |  |   |
|  | <b>As used by St Andrews:</b><br>2-hour Written Examination = 50%, 3-hour Practical Examination = 50%  |               |  |   |
| <b>Re-Assessment pattern:</b>                      | 2-hour Written Examination = 100%, No Re-Assessment if Coursework mark is <4   |               |  |   |
| <b>Module Co-ordinator:</b>                        | Dr A Finch   |               |  |   |
| <b>Lecturer(s)/Tutor(s):</b>                       | TBC  |               |  |   |

| ES5050 Earth's Greatest Hits                       |   |               |  |   |
|--|---|---------------|--|---|
| <b>SCOTCAT Credits:</b>                            | 15  | SCQF Level 11 | <b>Semester:</b>                           | 2 |
| <b>Academic year:</b>                              | 2016/7 & 2017/8   |               |  |   |
| <b>Planned timetable:</b>                          | Lectures: 11.00 am - 12.00 noon Thu, Seminars: 10.00 am - 1.00 pm Wed   |               |  |   |
|  | <p>This module is based around current "hot topics" in Earth science research. It will introduce cutting-edge science questions about how our planet has evolved from a ball of molten rock to the habitable blue planet it is today, and some of the major changes in its chemistry, biosphere, and climate that have happened along the way. Topics will vary from year to year, depending on staff participating in the module and the advances in Earth science research.</p> <p>This module is research-led, requiring that you read, digest, and discuss a number of topical papers each week. For some of these topics there is no given answer; instead you gain an in-depth understanding of the current state of research. Topics are introduced in lectures and then discussion seminars, organised around student presentations, are designed to encourage debate and critique of the arguments presented in the research papers.</p> |               |  |   |
| <b>Programme module type:</b>                      | Optional for Earth Sciences MGeol, Environmental Earth Sciences BSc, Geology BSc.   |               |  |   |
| <b>Pre-requisite(s):</b>                           | Normally ES2001, ES2002 and/or ES2003 for BSc and MGeol students  |               |  |   |
| <b>Learning and teaching methods and delivery:</b> | <b>Weekly contact:</b> 7 hours of lectures and 21 hours of seminars over the semester.  |               |  |   |
|  | <b>Scheduled learning:</b> 30 hours   |               | <b>Guided independent study:</b> 120 hours |   |
| <b>Assessment pattern:</b>                         | <b>As defined by QAA:</b><br>Written Examinations = 0%, Practical Examinations = 60%, Coursework = 40%  |               |  |   |
|  | <b>As used by St Andrews:</b><br>Coursework (10% participation in discussion groups; 60% oral presentations; 30% review paper) = 100%   |               |  |   |
| <b>Re-Assessment pattern:</b>                      | 2-hour Written Examination = 100%<br>No Re-Assessment if Coursework mark is <4  |               |  |   |
| <b>Module Co-ordinator:</b>                        | Dr J Rae  |               |  |   |
| <b>Lecturer(s)/Tutor(s):</b>                       | Earth & Environmental Sciences academic and research staff  |               |  |   |