

Master of Science in Geochemistry

Programme Requirements

MSc:

Taught Element:

90 credits: From ES3008¹ (or ES3011 by agreement), ES4031, ES5005, ES5010, ES5050, ES5051, CH3721²

30 credits: chosen from ES5006, ES5011, ES5012, ES5013, CH5511, CH5517, CH5518, CH5715, CH5716

120 credits: as for the Taught Element, plus a 60-credit individual project (ES5099) comprising 3 months of full-time study.

1. *Entrants from BSc Geology or Environmental Earth Science from St Andrews will substitute ES3011 for ES3008.*
2. *Entrants with a BSc in Chemistry may substitute CH3721 for CH3513, CH4514, CH4714 or CH5711.*

Compulsory modules - Semester 1:

ES3008 Geochemistry				
SCOTCAT Credits:	15	SCQF Level 9	Semester:	1
Planned timetable:	10.00 am Tue and Thu (lectures), 2.00 - 5.00 Fri (practicals)			
<p>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.</p> <p>The module includes a field trip to study river geochemistry and multiple practical sessions to develop the lecture concepts.</p>				
Programme module type:	Normally compulsory for MSc in Geochemistry (in some circumstances ES3011 may be substituted).			
Learning and teaching methods and delivery:	Weekly contact: 17 lectures, 15 hours of laboratory classes, 2 or more field classes over the semester.			
Assessment pattern:	2-hour Written Examination = 50%, Coursework = 50%			
Module Co-ordinator:	Dr N Allison			

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ES4031 Analytical Sciences				
SCOTCAT Credits:	5	SCQF Level 10	Semester:	1
Planned timetable:	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 geoscience. 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>				
Programme module type:	Normally compulsory for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 7 lectures and 4-hour poster session.			
Assessment pattern:	Coursework = 100%			
Module Co-ordinator:	Dr A Finch			

ES5005 Isotope Geochemistry: Theory, Techniques, and Applications				
SCOTCAT Credits:	15	SCQF Level 11	Semester:	1
Planned timetable:	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>				
Programme module type:	Compulsory for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 2-hour lectures (x 10.5 weeks), 3-hour practical sessions (x 3 weeks)			
Assessment pattern:	2-hour Practical (Open Book) Examination = 50%, Coursework = 50%			
Module Co-ordinator:	Dr A Burke			
Lecturer(s)/Tutor(s):	Dr P Savage, Dr J Rae			

CH3721 Physical Chemistry Laboratory				
SCOTCAT Credits:	10	SCQF Level 11	Semester:	1
Planned timetable:	9.00 am - 12.00 noon or 1.00 pm Mon to Fri (Weeks 6-10)			
This module comprises practical experiments involving physical measurements and the use of computational programmes in Chemistry.				
Programme module type:	Compulsory for MSc in Geochemistry (unless BSc Chemistry is already held)			
Learning and teaching methods and delivery:	Weekly contact: Daily 3- or 4-hour morning practical classes over 5 weeks (Weeks 6-10).			
Assessment pattern:	Coursework = 100%			
Module Co-ordinator:	Prof P A Wright			
Lecturer(s)/Tutor(s):	Prof P A Wright, Prof M Buck, Dr R Schaub, Dr T van Mourik, Prof M Buehl			

Compulsory modules - Semester 2:

ES5010 Advanced Geochemistry				
SCOTCAT Credits:	15	SCQF Level 11	Semester:	2
Planned timetable:	To be arranged.			
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.				
Programme module type:	Compulsory for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 1-hour lecture (x 10 weeks), 5 x 3-hour practical sessions and 1 x 8-hour session of project presentations over the semester.			
Assessment pattern:	Coursework = 100%			
Module Co-ordinator:	Dr E Stueeken			

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ES5050 Earth's Greatest Hits				
SCOTCAT Credits:	15	SCQF Level 11	Semester:	2
Planned timetable:	11:00 – 12:00 Thurs; 10:00 – 13:00 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>				
Programme module type:	Compulsory for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 7 hours of lectures and 21 hours of seminars over the semester..			
Assessment pattern:	Coursework = 100%			
Module Co-ordinator:	Dr J Rae			

ES5051 Geochemistry Field Excursion				
SCOTCAT Credits:	15	SCQF Level 11	Semester:	2
Planned timetable:	2 weeks of field work and post-trip analysis in April			
<p>Field sampling and laboratory analysis of natural samples are an important part of a geochemists' toolkit. This module will introduce the skills necessary for planning and executing a successful field campaign, developing best practice field skills in documenting the geological and environmental controls on a geochemical problem, and how to select and take samples. These will be analysed using the laboratory facilities available in the Department of Earth and Environmental Sciences and a scientific report will be written based on the methods used and results generated. The costs associated with this module are partially supported by the Department.</p>				
Programme module type:	Compulsory for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 2-hour lecture (x 5 weeks), 40 hours of field work, 4 x 4 hours of analytical training sessions.			
Assessment pattern:	Coursework = 100% (report and notebooks)			
Module Co-ordinator:	Dr M Claire			

Optional modules - Semester 1:

ES5011 Water in the Environment				
SCOTCAT Credits:	15	SCQF Level 11	Semester:	1
Planned timetable:	TBA			
<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>				
Programme module type:	Option for MSc in Geochemistry, MGeol Earth Sciences, Level 4 BSc Environmental Earth Science students.			
Learning and teaching methods and delivery:	Weekly contact: 20 hours of lectures, 6 hours of laboratory work and 4 hours of tutorials over the semester.			
Assessment pattern:	Coursework = 60%; Written Examination = 40%			
Module Co-ordinator:	Dr M Singer			

ES5013 Advanced Petrogenesis				
SCOTCAT Credits:	15	SCQF Level 11	Semester:	1
Planned timetable:	11:00 – 12:00 Thurs; 10:00 – 13:00 Wed			
<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>				
Programme module type:	Option for MSc in Geochemistry, BSc Geology and MGeol Earth Sciences.			
Learning and teaching methods and delivery:	Weekly contact: 18 lectures, 15 hours of laboratory work, 18 hours of field-related study.			
Assessment pattern:	Written Examination – 50%, Coursework = 50%			
Module Co-ordinator:	Prof A Finch			

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CH5511 Homogeneous Catalysis				
SCOTCAT Credits:	10	SCQF Level 11	Semester:	1
Planned timetable:	To be arranged.			
This module discusses the use of metal based systems in organic transformations and a detailed treatment of homogeneous catalysis. Important processes in the petrochemicals industry will be used to exemplify the principles described.				
Programme module type:	Optional for Chemical Science MSc and Chemistry MPhil. Optional for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 2 - 3 lectures per week over 9 - 10 weeks (within Weeks 1-11) and 2 - 3 tutorials in total.			
Assessment pattern:	2-hour Written Examination = 100%			
Module Co-ordinator:	Prof P C J Kamer			

CH5716 Processing of Materials				
SCOTCAT Credits:	10	SCQF Level 11	Semester:	1
Planned timetable:	To be arranged.			
This module focuses on the processing of materials. Fundamental materials properties such as crystallinity, composition, crystal phase, phase mixing, domain structure, grains and grain boundaries, porosity and pore structure will be covered and the main methods used to control these properties in order to develop and improve materials for specific applications will be addressed. Processes including casting, extrusion, physical and chemical vapour deposition, calcination, sintering, annealing, plasma treatments, mechanical working, crystallisation and dopant addition will be described and explained. Applications in high-value metals, ceramics and semiconductor materials will be emphasised.				
Programme module type:	Optional for Chemical Science MSc and Chemistry MPhil. Optional for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 2 - 3 lectures per week over 9 - 10 weeks (within Weeks 1-11) and 2 - 3 tutorials in total.			
Assessment pattern:	2-hour Written Examination = 100%			
Module Co-ordinator:	Prof J T S Irvine			

Optional modules - Semester 2:

ES5006 Metallogeny				
SCOTCAT Credits:	15	SCQF Level 11	Semester:	2
Planned timetable:	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>				
Programme module type:	Optional for MSc in Geochemistry, BSc Geology and MGeol Earth Sciences.			
Learning and teaching methods and delivery:	Weekly contact: 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			
Assessment pattern:	2-hour Written Examination = 50%, Coursework = 50%			
Module Co-ordinator:	Dr J Cloutier			

ES5012 Biogeochemistry				
SCOTCAT Credits:	15	SCQF Level 11	Semester:	2
Planned timetable:	To be arranged.			
<p>Earth's surface environment is tightly regulated by biogeochemical processes. The biosphere directly influences the composition of Earth's atmosphere, ocean chemistry, and global climate, through the cycling of nutrients and other elements. This module will examine the role of biogeochemical processes in controlling Earth surface chemistry, and their possible influence on deep Earth reservoirs. Emphasis will be placed on feedbacks between the geosphere, atmosphere, and biosphere over geologic time, and how these interactions have both contributed and responded to important transitions in Earth history (e.g., the Great Oxidation Event, global glaciations). We will also highlight current geochemical (e.g., stable isotope ratios) and numerical (e.g., modelling) techniques used to constrain these interactions in both modern and ancient (rock record) systems.</p>				
Programme module type:	Option for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 15 hours of lectures and 21 hours of laboratory practicals (inc. modelling exercises, literature reviews).			
Assessment pattern:	2-hour Written Examination = 40%, Coursework = 60% (inc. individual project)			
Module Co-ordinator:	Dr A Zerkle			

CH5517 Advanced Molecular Inorganic Chemistry				
SCOTCAT Credits:	10	SCQF Level 11	Semester:	2
Planned timetable:	To be arranged.			
This module involves three sections: advanced discussion of the properties of selected main group compounds, spectroscopy and magnetism of transition metal complexes, and molecular modeling applied to transition metal complexes.				
Programme module type:	Optional for Chemical Science MSc and Chemistry MPhil. Optional for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 2 - 3 lectures per week over 9 - 10 weeks (within Weeks 1-11) and 2 - 3 tutorials in total.			
Assessment pattern:	2-hour Written Examination = 100%			
Module Co-ordinator:	Dr E Zysman-Colman			

CH5518 Blockbuster Solids				
SCOTCAT Credits:	10	SCQF Level 11	Semester:	2
Planned timetable:	To be arranged.			
This module covers two major topics. The first deals with modern materials which have a major impact on our lives, focusing on how the material's structure influences its electrical, magnetic and thermal properties. In the second section, emphasis will be placed on metal organic frameworks and how they can be used for the storage and release of gases.				
Programme module type:	Optional for Chemical Science MSc and Chemistry MPhil. Optional for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 2 - 3 lectures per week over 9 - 10 weeks (within Weeks 1-11) and 2 - 3 tutorials in total.			
Assessment pattern:	2-hour Written Examination = 100%			
Module Co-ordinator:	Prof P Lightfoot			

CH5715 Energy Conversion and Storage				
SCOTCAT Credits:	10	SCQF Level 11	Semester:	2
Planned timetable:	To be arranged.			
In our efforts to mitigate global warming it is essential to develop new and improved methods of generation and storage of energy. Foremost among these methods are the electrochemical technologies of batteries and fuel cells. In this module we will discuss the technical details and applications of such devices. Particular emphasis will be placed on the underlying electrochemistry and materials chemistry.				
Programme module type:	Optional for Chemical Science MSc and Chemistry MPhil. Optional for MSc in Geochemistry.			
Anti-requisite(s):	CH4712			
Learning and teaching methods and delivery:	Weekly contact: 2 - 3 lectures per week over 9 - 10 weeks (within Weeks 1-11) and 2 - 3 tutorials in total.			
Assessment pattern:	2-hour Written Examination = 100%			
Module Co-ordinator:	Dr R Baker			

Compulsory module - Summer:

ES5099 Research Project				
SCOTCAT Credits:	60	SCQF Level 11	Semester:	Summer
Planned timetable:	To be arranged.			
<p>This module provides an opportunity to conduct independent research with an academic supervisor, usually within a research group. The research topic is defined by the student and can be chosen from research foci within the department. The research project will involve project formulation, a background literature review, proposal writing, and analytical design, as well as data integration and interpretation. The results are presented as oral presentations and at a poster conference, and in a dissertation.</p>				
Programme module type:	Compulsory for MSc in Geochemistry.			
Learning and teaching methods and delivery:	Weekly contact: 1-hour lectures x 4 weeks; 4-hour seminar sessions (x 2 weeks); supervisory meetings (11 hours); 5-hour conference poster session.			
Assessment pattern:	Coursework = 100%			
Module Co-ordinator:	Dr P Savage			

