

Geochemistry

Department of Earth and Environmental Sciences

ERTH2380 Winter 2025

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Richard Cox	richard.cox@dal.ca	TBA

Course Description

An introduction to the principle of chemistry applied to geologic systems, including overviews of the chemistry of rocks and minerals, isotopes in the geologic environment, processes that control the speciation and mobility of elements in different geological environments, and the use of geochemical data in solving geologic and environmental problems.

Course Prerequisites

ERTH2001 & CHEM 1011/CHEM 1012 or equivalent, or permission of the instructor.

Course Exclusions

None

Student Resources

All materials other than the course textbook will be available on Brightspace. This includes plug-ins for MS Excel and links to other freeware / software programs as required. The TEAMS course space will be available for questions and discussions.

Course Structure

Course Delivery

2 in-class lectures per week and 1 weekly tutorial.

Lectures

Tuesday and Thursday at 1:05-2:25 PM in the LSC, EES wing 2nd floor, room 2030.

Laboratories

N/A

Tutorials

Tutorials are held on Wednesday at 1:35 PM - 3:25 PM also in the LSC, EES wing 2nd floor, room 2030. Online help through the course TEAMS space and extra lab session may be arranged as required.

Course Materials

Required Textbook:

Hugh Rollinson and Victoria Pease **“Using Geochemical Data to Understand Geological Processes”** 2nd edition. ISBN 978-1-108-74584-0

This book is strongly recommended for all petrology courses and the 1st edition was widely used by geoscientists as a reference book. The second edition is even better!

Other materials required:

All handouts and other materials will be provided. A computer or tablet that runs MS Office is essential.

Assessment

Component	Weight (% of final grade)	Date(s)
<i>Class Plotting Exercises</i> (6 in total = 5% each and 2 in total worth 10% each = <u>50%</u> of your final mark)		
<u>Plotting exercises 1, 2, 3</u> = Using major Elements and trace Element data = 15%.		
<u>Plotting exercise 4</u> = Quantitative modeling of processes using Major and Trace element data = 10%		
<u>Plotting exercises 5, 6, 7</u> = Isotopes, geochronology, geochemical reservoirs and fluxes = 15%.		
<u>Plotting exercise 8</u> = Applying geochemical data = 10%		

Researching and presenting geochemical data – Term research project (**25%** of your final mark)

Progress marks: This involves submission of small parts of the project (e.g. keywords, a main diagram, an intro slide and a conclusion slide) throughout the semester = 5% in total.

Extended abstract: To be submitted before the presentations = 10%.

Class presentations: Will be held in a mini conference during the final class time slots = 10%.

NOTE: This section of the course will also be partly peer reviewed by students in the class who are carrying out research for their own project within a related field. See the course policy related to this below.

Final Exam (scheduled by the registrar by Feb 1st and will be held between the 9th and the 26th of April)

3 hour written exam (closed book) = **25%** of your final mark.

Other course requirements

N/A

Conversion of numerical grades to final letter grades follows the

[Dalhousie Grade Scale](#)

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

Course Policies on Missed or Late Academic Requirements

Lectures will be on campus and we will also hold on-line sessions as required. Attendance at the lectures and tutorials is mandatory. All assignments / exercises handed in late without reasonable and documented cause will be deducted 10% after the deadline and a further 10% per day. Assignments handed in more than 5 days late will not be graded. **IMPORTANT: As the term project will be in part peer review by your fellow students, you MUST attend the mini-conference at the end of the semester whether presenting or not. If you do not attend, you will be deducted 10% of your final mark. If you are reviewing a fellow student's project and you also do not attend their presentation, you will lose 50% of your own project mark.**

Course Policies related to Academic Integrity

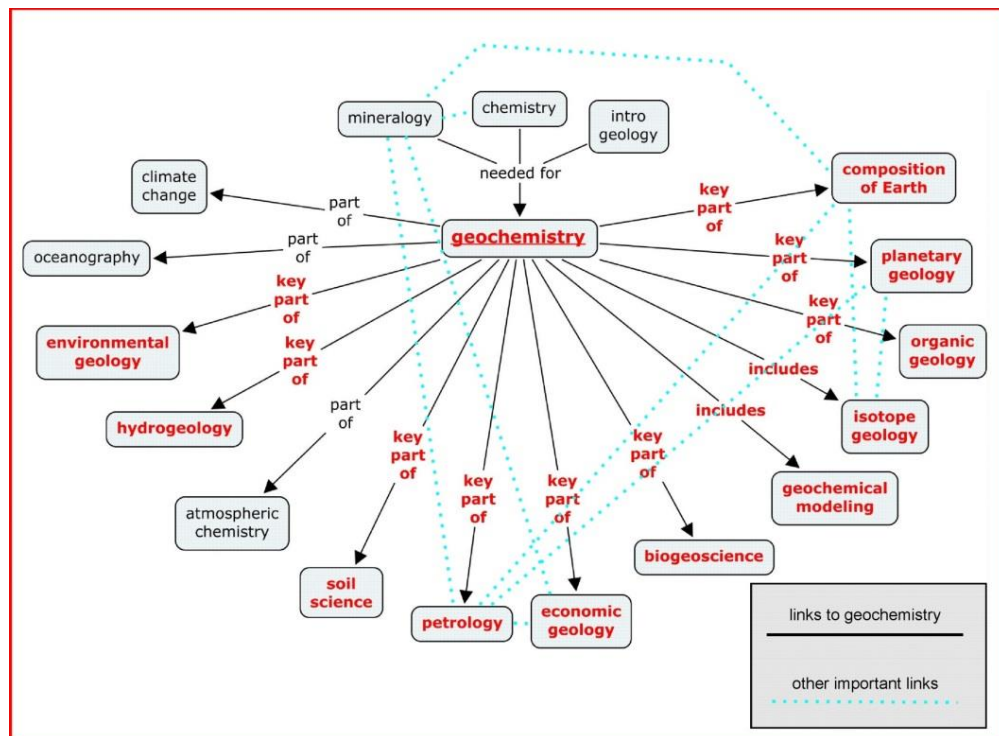
The standards of academic integrity as described below will be applied to this course. Students are encouraged to discuss all aspects of the course but are required to submit their quizzes and assignments individually. Remember that the use of AI bots will not help you when it comes to the final lab or written exams which are worth 50% of your final grade.

Learning Objectives

Course Objectives/Learning Outcomes

Why Geochemistry? The study of the distribution of elements and chemical fluxes in the earth is known as geochemistry. This branch of the geosciences forms the basis of understanding for many geological processes. A background in geochemistry will provide the foundation for understanding many of the concepts in igneous, metamorphic and sedimentary petrology, economic geology, environmental sciences and hydrogeology. Geochemical analysis and modeling allows geoscientists to understand processes which occur in every planetary environment from magma formation and crystallization in the deep earth, to weathering and biogeochemical cycling of elements on the planet's surface and atmosphere. In other words, a basic understanding of the nature of geochemistry is essential for any geoscientist.

The overall goal for this course: To describe the periodic table in terms of the Earth and specific geosystems; to analyze and present geochemical data in a meaningful and informative way; to use common software programs to analyze, evaluate and present geochemical data to others through both reports and a presentation and abstract; to critically interpret geochemical data and to model and describe what the data is telling us about earth systems and processes.



A consensus view of where geochemistry lies within Earth systems and processes (from: https://d32ogoqmya1dw8.cloudfront.net/images/NAGTWorkshops/geochemistry10/geochemistry_centric_world.jpg)

Course Content

Part 1: Geochemical Fundamentals and Analytical Methods

What is geochemistry? - Nomenclature, terms and broad applications, analytical methods

Understanding the Periodic Table (basic review of chemistry) - The geochemist's Periodic Table

*How do we get at the information we need? - Sampling, sample preparation, analytical methods

*Reporting Geochemical Data - Detection limits, errors, precision, accuracy, using common programs

The general distribution of elements in geochemical systems

The distribution co-efficient, modeling processes.

Oxidation, reduction and speciation of elements.

What makes things tick/tock? (Reactions, Thermodynamics, Kinetics, Diffusion)

** For PGeo certifications these are particularly important*

Part 2: Geochemical systems, reservoirs and fluxes including case studies and applications

2a - Distribution of elements in the “solid” Earth and other planetary bodies

- **Major Elements* in the lithosphere (core, mantle, oceanic crust, continental crust)
- **Trace Elements* in the lithosphere (REE, HFSE, Alkali elements, etc)

2b - Isotope geochemistry

- *Radiogenic isotopes* (Rb-Sr, Sm-Nd, (U-Th-Pb) - including *geochronology* (absolute age dating) using **U-Th-Pb*, **fission track dating*, **U-Th-He*, and when time allows U-Th disequilibrium dating, and K-Ar (Ar-Ar)).

- *Stable Isotopes* (**¹⁸O/¹⁶O*, **D/H*, **¹³C/¹²C*, **³²S/³⁴S*)

** Note: We have research labs which carry out these analyses here at Dalhousie.*

Part 3: Using and presenting geochemical data (this is where you will “take over”)

Assessing the “correctness” of data - standards, variations, etc.

Presenting geochemical data

- *Normalization, plotting, ratios, etc.*
- *Making appropriate descriptions of the results*
- *Interpretation* (geochemical classifications, petrotextonic significance, mineral growth rates, reactions, PT-conditions, ages, paleoenvironmental changes, etc).

** Writing-up reports and giving presentations*

** Just to emphasize For PGeo certifications these are particularly important*

Additional help / information sessions will be arranged through TEAMS and on-campus as required throughout the semester. This will not be mandatory to attend but will allow you to bring up any points and questions you may have outside class and lab times.

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: <https://www.dal.ca/about-dal/internationalization.html>

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (<https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html>)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: <http://www.dal.ca/cultureofrespect.html>

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:

https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.