# Mineralogy

## Department of Earth and Environmental Sciences

### ERTH2001 Fall 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

This course introduces description and analysis of minerals, along with their paragenesis. Labs include crystal chemistry, crystallography and optical mineralogy. Key hand specimens and thin sections are used to reinforce systematic mineralogy using a logbook which is updated throughout the semester. X-ray diffraction and SEM / electron microprobe methods are also introduced.

*Course Prerequisites*

ERTH1080, CHEM1011/CHEM1012 or CHEM1021/CHEM1022

*Course Exclusions*

None

## Student Resources

The lab will be available outside of class / lab hours during normal building hours. A code will be provided for access. All the mineral kits, thin sections, etc. will be available in the lab. All other materials will be available on Brightspace. The TEAMS course space will be available for questions and discussions.

## Course Structure

*Course Delivery*

3 in-class lectures per week and 1 weekly lab session.

*Lectures*

Tuesday, Thursday and Friday at 1:35-2:25 PM in the LSC, room CS204.

*Laboratories*

Wednesday 11:35 AM-2:25 PM and 2:35-5:25 PM in the LSC, room 2020A (the Mineralogy / Petrology Lab).

*Tutorials*

No tutorials, although online help through the course TEAMS space and extra lab session may be arranged as required.

## Course Materials

*Required Textbook:*

Ness, William D. **"Introduction to Mineralogy"** ($4^{th}$ edition) Oxford University Press.

ISBN 0197614604

*Other materials required:*

A hand lens with at least x8 magnification. Other material will be posted on Brightspace or will be available in the lab.

## Assessment

| Component | Weight (% of final grade) | Date(s) |
|---|---|---|
| ***2 class quizzes*** *(15% each)* | *30%* | *Completed on-line on Brightspace.* |

*The quizzes will focus on the first and second sections of the course. You will have a three-hour window to complete the on-line questions once you start the quiz.*

| | | |
|---|---|---|
| ***Mineral Analysis Project*** | *20%* | *To be submitted at the final lab exam.* |

*The project will involve a complete analysis of a mineral assemblage including XRD and SEM analysis, physical properties and a systematic description of minerals in thin section.*

| | | |
|---|---|---|
| ***Final Lab exam*** | *25%* | *(Scheduled by Registrar)* |
| ***Final Written Exam*** | *25%* | *(Scheduled by Registrar)* |

*Other course requirements*

You must attend weekly labs and attendance will be taken during the semester. You will be expected to fill-in and complete the lab worksheets which will then be used to help complete parts of the quizzes, the final lab exam and part of the final written exam. Successful completion of the labs and quizzes throughout the semester may be considered in the case of low grade(s) in the final lab and/or written exams. A low course grade and failure to attend ***and*** complete the weekly labs will mean that no additional credit assignments, or re-assignment of existing marks, will be considered.

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

Class quizzes missed will not be marked and you will be graded on your remaining scores. The term project, if handed in late without reasonable and documented cause, will be deducted 10% after the

deadline, a further 10% per day, and if more than 5 days late, will not be graded. The weekly lab worksheets are designed for you to complete and use for later reference when completing the quizzes and when taking the final lab exam. These are not marked but form an integral part of the course and you will be allowed to take your completed worksheets and textbook into the final lab exam. As noted above (in other course requirements) you must attend the weekly labs and attendance will be taken throughout the semester.

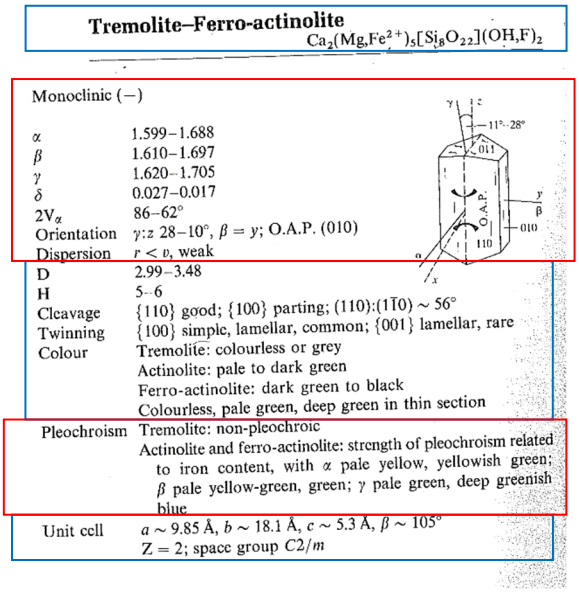
## Course Policies related to Academic Integrity

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**

**<u>The overall goal for this course:</u>** To enable you to use any source of mineralogical information and understand all of the information presented, how the various parameters are linked, and how to produce and present this data yourself, ***<u>even if</u>*** you have never looked at that mineral before.



**Tremolite–Ferro-actinolite**
$Ca_2(Mg,Fe^{2+})_5[Si_8O_{22}](OH,F)_2$

Monoclinic (−)

| | |
|---|---|
| $\alpha$ | 1.599–1.688 |
| $\beta$ | 1.610–1.697 |
| $\gamma$ | 1.620–1.705 |
| $\delta$ | 0.027–0.017 |
| $2V_\alpha$ | 86–62° |
| Orientation | $\gamma:z$ 28–10°, $\beta = y$; O.A.P. (010) |
| Dispersion | $r < v$, weak |
| D | 2.99–3.48 |
| H | 5–6 |
| Cleavage | {110} good; {100} parting; (110):(1$\bar{1}$0) ~ 56° |
| Twinning | {100} simple, lamellar, common; {001} lamellar, rare |
| Colour | Tremolite: colourless or grey<br>Actinolite: pale to dark green<br>Ferro-actinolite: dark green to black<br>Colourless, pale green, deep green in thin section |
| Pleochroism | Tremolite: non-pleochroic<br>Actinolite and ferro-actinolite: strength of pleochroism related to iron content, with $\alpha$ pale yellow, yellowish green; $\beta$ pale yellow-green, green; $\gamma$ pale green, deep greenish blue |
| Unit cell | $a \sim 9.85$ Å, $b \sim 18.1$ Å, $c \sim 5.3$ Å, $\beta \sim 105°$<br>Z = 2; space group $C2/m$ |



A typical mineral data entry from Deer, Howie and Zussman, (2nd edition) p. 242.

**Minerals are the building blocks of our planet. Having an understanding of what they are and how to classify them is therefore essential for every geoscientist.**

What is a mineral? ***Mineral:*** *A naturally occurring inorganic element or compound having orderly internal structure and characteristic chemical composition, crystal form, and physical properties.*

1) Chemical formula 2) Structure 3) Crystallinity

***These properties are all reproducible from atomic levels to single building blocks (molecules), to single mineralogical unit (unit cell) to the macro scale.***

1) How do you describe a mineral? The concepts and skills required:
    - **Physical Properties** (how to do this properly for a **full range** of physical properties)
    - **Crystal Chemistry** (Crystallography, XRD, Electron Microprobe)
    - **Optical Properties** (using the polarizing microscope)
2) Why bother?
    - Is anatomy a new science and has the human body really changed since medicine became a modern field of study? Would you trust a physician that had failed their basic anatomy class? Mineralogy is the equivalent of anatomy in the geosciences.
3) Where is mineralogy applied?
    - Petrology – minerals in rocks, the history of our planet or indeed other planets as the case may be!
    - Mineral resources – where we get almost all of our raw materials.
    - Environmental monitoring – both recent and ancient changes.
    - Geochemistry – minerals are the reservoirs for the elements within the earth.

## Course Content

### Course Content

Lectures will be held in parallel with the labs and will also be divided into three sections.

**<u>Part 1: Mineral structures and crystal chemistry - 4 labs covering the following topics:</u>**

1) Atomic arrangements, closest packing and unit cells.

2) Crystal Chemistry and the relationship of chemical composition to structure.

3) Crystal systems, crystal growth, form and habit, (Miller Index).

4) Physical Properties of Minerals.

5) Analytical Methods: X-ray crystallography (XRD) and electron microprobe (EMP) analysis of minerals.

***In parallel, we will be looking at the classification of key minerals and mineral groups (the Dana Classification). This section of the course forms the first part of your term project which will be described after the first few weeks of the course.***

***The first class quiz will be completed at the end of this section of the course.***

**Part 2: Optical Mineralogy - 4 labs covering the following topics:**

1) The polarizing light microscope

2) The first level of optical properties: Relief, color, pleochroism, textures (form, habit, cleavages, fractures, alterations, zoning, etc.).

3) Isotropic / Aniostropic minerals. Birefringence and extinction angles, length fast / slow.

4) Interference figures – Uniaxial minerals (optical figures, optic signs, w and e rays).

5) Interference figures – Biaxial minerals (optical figures, optic signs, 2V angles, a, b and g, rays, flash figures).

***We will be looking at the optical properties of key minerals and mineral groups. This will also help with the second part of your term project.***

***The second class quiz will be completed at the end of this section of the course.***

**Part 3: Applied Mineralogy and Introduction to Petrology - 3 labs covering the following topics:**

1) Identification of minerals, mineral compositions mineral textures, zoning, etc. in hand sample and thin section.

2) An introduction to petrographic descriptions including using basic mineral and rock classification schemes.

***The information from these labs will allow you to complete the course and your term project which you must keep up-to-date with!***

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.