

ES2230 INTRODUCTION TO GEOCHEMISTRY

Instructor: Sean Shieh, B&GS room 1066 (email: sshieh@uwo.ca)

Course Format: 2 lecture hours, 3 laboratory hours

Lecture: Mon and Wed 10:30 – 11:30

Lab: Wed 14:30-17:30

Prerequisites: Chemistry 1301A/B or permission of the Department

Course Description

To introduce the field of Geochemistry to undergraduate students.

Course Outline, Readings and Laboratory Exercises

Topic

Primordial and Stellar Nucleosynthesis, Radioisotopic Systems and Ages

- Formation of the Elements, Solar System, Earth and Moon.
- Stable and unstable nuclei and rate of decay of unstable nuclei
- Absolute Ages of Rocks, Earth and the Solar System
- The Sm/Nd system as example: The isochron, Ages and Model Ages.

Lab#1 - (1 week) scientific paper relevant to formation, composition & evolution of solar system

Lab#2 - (1 week) Calculate the Molar and Atomic proportions of elements in Minerals

Lab#3 - (2 weeks) Applications of Sm/Nd system to basalts, recent and ancient.

Composition and Stability of Minerals, Glasses and Fluids (i.e., liquids and gases)

- Some geochemically important properties of the elements of the periodic table
- Substitutions in minerals, Immiscibility in Glasses and Natural Fluids
- Stability of phases in natural settings: thermodynamic and kinetic stability
- Heat Capacity, Enthalpy and the First Law of Thermodynamics
- Entropy and the Second Law of thermodynamics
- Free Energy, the Clausius-Claperyon Eqn and phase stability as a function of T and P

Lab#4 - (2 weeks) Thermodynamic stability of SiO₂ and Al₂SiO₅ polytypes at STP and calculation of the Al₂SiO₅ phase boundaries in P-T space

The Phase Rule, Phase Diagrams and Their Interpretation

- The Unary Phase Diagram and the Phase Rule (H₂O system as example)
- Binary Phase Diagrams (Olivine and Plagioclase, NaCl-H₂O, MgO-SiO₂, systems)
- Ternary Phase Diagrams (Qz-Ab-Ksp system as example).

Lab #5 (1 week) - Interpretation of Phase diagrams

Major Element Geochemistry

- The Major Elements: Rock and mineral compositions, Wt.% and Molar Proportions

- Compositions of Igneous, Sedimentary and Metamorphic Rocks and Ternary Diagrams
- Igneous Rocks: Magmas and Crystal Fractionation
- Sedimentary Rocks and Chemical Weathering
- Metamorphic Rocks and Mineralogical Changes during prograde metamorphism

Lab#6 (1week) - Compositional changes during fractionation and weathering

Trace Element Geochemistry

- Igneous Petrology: Compatible and Incompatible Elements
- Sedimentary Petrology: Labile and Conservative Elements
- Rare Earth and Incompatible Elements in Igneous and Sedimentary Environments.

Lab #7 (2 weeks) - Partitioning of Trace elements between minerals and liquids

The Chemical Potential and the Distribution (Partition) Coefficient

- The Chemical Potential and phase stability as a function of composition
- Theory and use of Distribution Coefficients.
- Calculated and observed distribution of Fe and Mg between melts and basaltic magma.

* Contents may change upon necessity.

Marking Scheme for ES 2230:

- Midterm test: 20%*
- Final examination: 35%
- Laboratory mark: 40%
- Class participation: 5%

* Students have the option of reweighting their midterm if their grade on the final exam is significantly greater than their mid-term mark (i.e. greater than 30%). In the event a student is able to demonstrate this improvement, they are able to have the final exam count for 55% of their final grade.

Important days

- Midterm test: **TBA**
- Final exam date will be set by the Office of Registrar

Statements Concerning Tests and Exams

Calculators may be used during tests

Essential Learning Requirements

Even when Academic Consideration is granted for missed coursework, the following are essential to earn a passing grade in this course:

- a minimum 6 of completed labs on the laboratory component to ensure that students demonstrate sufficient mastery of those technical skills to progress,
- minimum 6 participation in the lab.

When a student has not demonstrated proficiency in an essential learning requirement listed above, and when the shortfall results from a granted Academic Consideration, they will be withdrawn (WDN) from the course. The student may appeal to the Associate Dean (Academic) for reinstatement with an Incomplete (INC) standing. Where an appeal for INC is granted, their maximum course load may be reduced during the term in which they complete the outstanding course requirements.

The instructor owns the IP in the lecture and lecture materials even when such lectures or materials are posted online and students are not to post lectures or lecture materials to any other websites or platforms or use the lecture recording or materials for any other purpose without your consent. It also prohibits the recording of live lectures or recorded lectures.

Information about Missed Coursework

Students must familiarize themselves with the *University Policy on Academic Consideration – Undergraduate Students in First Entry Programs*, posted on the Academic Calendar:

https://uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration_Sep24.pdf,

This policy does not apply to requests for Academic Consideration submitted for **attempted or completed work**, whether online or in person. The policy also does not apply to students experiencing longer-term impacts on their academic responsibilities. These students should consult [Accessible Education](#).

For procedures on how to submit Academic Consideration requests, please see the information posted on the Office of the Registrar's webpage: https://registrar.uwo.ca/academics/academic_considerations/. All requests for Academic Consideration must be made within 48 hours after the assessment date or submission deadline.

Special Examination

Per university policy, Academic Consideration requests with supporting documentation are required for the final examinations scheduled during official examination periods by the Registrar's Office.

If the student has been approved by the Academic Advising Office to write a Special Examination (SPC) and the final exam is their only outstanding course component, an SPC will be assigned to them and scheduled by the instructor per university policy.

If the student misses their SPC exam and is approved for Academic Consideration, they will be withdrawn from the course without academic penalty. If they experienced extenuating circumstances such as prolonged illness, they may appeal to the Associate Dean (Academic), on a case-by-case basis, for the opportunity to write the final exam the next time the course is offered. An outstanding SPC will reduce their course load for the term in which the exam is deferred, as outlined in the [Definitions of Types of Examinations](#) policy.

If the student misses their SPC exam and Academic Consideration is not approved, or was not requested, they will receive a grade of zero on the exam.

Additional Statements (PLEASE READ)

Religious Accommodation

When a recognized religious holiday either requires a student to be absent from the University, or requires or prohibits an activity that makes it impossible for them to complete an academic requirement scheduled that day, they are entitled to accommodation. No student will be penalized for an absence for religious reasons, and an alternative means of satisfying the requirement will be arranged. This accommodation is provided in accordance with the University's policy on Accommodation for Religious Holidays:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

The student should submit their requests through the Student Absence Portal (SAP), identifying the conflict and the specific course component(s) affected (e.g., test, midterm, exam).

Midterms and Tests: If a religious observance conflicts with a midterm test, they must submit their request no later than **one week** before the test. Their instructor will arrange an early sitting of the test. As set out above, no makeup test is offered for any other reason; this early sitting is available specifically for this accommodation.

Final Examinations: If a religious observance conflicts with the final exam, the student must submit their request no later than **two weeks** before the exam. Their instructor will arrange a Special Examination to take place no later than one month after the end of the examination period.

Students are responsible for finding out what was covered in any class they miss due to a religious observance, and for taking the appropriate steps to keep up with the course.

If a suitable arrangement cannot be reached between a student and their instructor, they should consult the Undergraduate Chair of the department offering the course, and if necessary, the Associate Dean (Academic) of the Faculty of Science.

For a list of recognized religious observances, please visit the calendars posted on the Equity, Diversity & Inclusion website - <https://www.edi.uwo.ca> (About Us – Resources – Additional Resources – Calendars).

Academic Accommodation Policies

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

[https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic Accommodation_disabilities.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf).

General Academic Policies

The website for Registrar Services is <https://www.registrar.uwo.ca/>.

Use of @uwo.ca email: In accordance with policy,

https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf, the centrally administered e-mail account provided to students will be considered the individual's official university email address. It is the responsibility of the account holder to ensure that emails received from the University at their official university address are attended to in a timely manner.

Requests for Relief (formally known as “appeals”)

Policy on Request for Relief from Academic Decision:

https://uwo.ca/univsec/pdf/academic_policies/appeals/requests_for_relief_from_academic_decisions.pdf

Procedures on Request for Relief from Academic Decision (Undergraduate):

https://uwo.ca/univsec/pdf/academic_policies/appeals/undergrad_requests_for_relief_procedure.pdf

Scholastic Offences

Policy on Scholastic Offences:

https://uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_offences.pdf

Procedures on Scholastic Offences (Undergraduate):

https://uwo.ca/univsec/pdf/academic_policies/appeals/undergrad_scholastic_offence_procedure.pdf

Use of Electronic Devices During Assessments

In courses offered by the Faculty of Science, the **possession** of unauthorized electronic devices during any in-person assessment (such as tests, midterms, and final examinations) is strictly prohibited. This includes, but is not limited to: mobile phones, smart watches, smart glasses, hidden cameras and wireless earbuds.

Unless explicitly stated otherwise in advance by the instructor, the presence of any such device at a student's desk, on their person, or within reach during an assessment will be treated as a scholastic offence, **even if the device is not in use**.

Effective September 2026, the typical penalty for this offence is a failing grade in the course AND a 12-month prohibition on retaking the course.

Only devices expressly permitted by the instructor (e.g., non-programmable calculators) may be brought into the assessment room. It is their responsibility to review and comply with these expectations.

Use of Generative AI Tools

Unless otherwise stated, the use of generative AI tools (e.g., ChatGPT, Microsoft Copilot, Google Gemini, or similar platforms) is **not permitted** in the completion of any course assessments, including but not limited to: assignments, lab reports, presentations, tests, and final examinations.

Using such tools for content generation, code writing, problem solving, translation, or summarization—when not explicitly allowed—will be treated as a **scholastic offence**.

If the use of generative AI is permitted for a particular assessment, the conditions of use will be specified by the instructor in advance. If no such permission is granted, students must assume that use is prohibited. It is the student's responsibility to seek clarification before using any AI tools in academic work.

Support Services

Academic Advising. Please visit the Science & Basic Medical Sciences Academic Advising webpage for information on adding/dropping courses, academic considerations for absences, requests for relief, exam conflicts, and many other academic-related matters: <https://www.uwo.ca/sci/advising/>.

Mental Health Support. Students who are in emotional/mental distress should refer to Mental Health@Western (<https://uwo.ca/health/>) for a complete list of options about how to obtain help.

Gender-Based and Sexual Violence. Western is committed to reducing incidents of gender-based and sexual violence (GBSV) and providing compassionate support to anyone who has gone through these traumatic events. If a student has experienced GBSV (either recently or in the past), they can find information about support services for survivors, including emergency contacts, at:

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Accessibility for Coursework. A student may contact the course instructor if they require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to them. If they have any questions regarding accommodations, they may also contact Accessible Education at http://academicsupport.uwo.ca/accessible_education/index.html

Learning Development and Success. Learning-skills counsellors at Learning Development and Success (<https://learning.uwo.ca>) are ready to help students improve their learning skills. The facility offers strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Student Councils

Student-run support services are offered by the University Students' Council (<https://westernusc.ca>) and the Science Students' Council (<https://www.westernssc.ca>).