

ES2230 Introduction to Geochemistry

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Office hours: Drop in or by appointment

Course Format: 2 lecture hours: 3 laboratory hours

Lecture: P&AB room 34, Mon and Wed 12:30 – 13:30

Lab: B&GS room 0184, Thu 14:30-17:30

Aim of Course: To introduce the field of Geochemistry to undergraduate students.

Prerequisites: Chemistry 1301A/B or the former Chemistry 1100A/B and Earth Sciences 2200A/B or permission of the Department.

Course Outline, Readings and Laboratory Exercises

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) Calculate the Molar and Atomic proportions of elements in Minerals

Lab#2 - (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#3 - (2 weeks) Thermodynamic stability of SiO_2 and Al_2SiO_5 polytypes at STP and calculation of the Al_2SiO_5 phase boundaries in P-T space

The Phase Rule, Phase Diagrams and Their Interpretation

- The Unary Phase Diagram and the Phase Rule (H_2O system as example)
- Binary Phase Diagrams (Olivine and Plagioclase, $\text{NaCl-H}_2\text{O}$, MgO-SiO_2 , systems)
- Ternary Phase Diagrams (Qz-Ab-Ksp system as example).

Lab #4 (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#5 (1 week) - 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 #6 (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: 30%
- Laboratory/Seminar mark: 40%
- Class participation: 10%

** Students will have the option of not counting their mid-term grade if their grade on the final exam is between one grade point (9%) but not more than 20% higher than their mid-term mark.

Important days

- Midterm test: **TBA**
- Final exam date will be set by the Registrar's office

Statements Concerning Tests and Exams

Calculators and laboratory computers may be used during tests

University Policies:

1) Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: <http://www.uwo.ca/univsec/handbook/appeals/scholoff.pdf>

2) Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

3) **All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism.** All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

4) If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean's Office immediately. For further information please see: <http://www.uwo.ca/univsec/handbook/appeals/medical.pdf>

A student requiring academic accommodation due to illness should use the Student Medical Certificate when visiting an off-campus medical facility or request a Records Release Form (located in the Dean's Office) for visits to Student Health Services. The form can be found here: https://studentservices.uwo.ca/secure/medical_document.pdf

Learning Outcomes:

Upon completion of this course successful students will be able to:

- Define the formation and evolution of the Solar System.
- Define the formation and evolution of the Earth and Moon.
- Define the formation and evolution of the atmosphere of the Earth.
- Define the formation of the elements in the solar system.
- Apply knowledge of the age determination to Earth's rocks and minerals as well as creature's fossils
- Apply the knowledge of binary and ternary phase diagram to formation of magma and mantle rocks

The Exceptional Contributor: “The Class Was Better Because You Were Here.

As part of the learning process I expect all students to participate actively in class. Here are some guidelines to keep in mind when in class:

- You provide clear, concise, and correct explanations that help others gain a better understanding of concepts.
- You make outstanding, original, and informative comments.
- You make highly attentive and constructive comments on other people's statements.
- You ask questions that are penetrating or help clarify.
- You raise your hand strategically (understanding that there are other students in class).
- You actively encourage others to express their ideas.
- You display body language that communicates interest in what others are saying.
- You arrive to class on time and are not absent without reason.