

# ES2230 Introduction to Geochemistry

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

**Office hour:** By appointment

**Course Format:** 2 lecture hours: 3 laboratory hours

**Lecture:** P&AB room 117, 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:** ES 2200A, or permission of the Department

**Co-requisite:** Chemistry 1050 or the former Chemistry 020 or 023.

## 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) 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  $\text{SiO}_2$  and  $\text{Al}_2\text{SiO}_5$  polytypes at STP and calculation of the  $\text{Al}_2\text{SiO}_5$  phase boundaries in P-T space

#### **The Phase Rule, Phase Diagrams and Their Interpretation**

- The Unary Phase Diagram and the Phase Rule ( $\text{H}_2\text{O}$  system as example)
- Binary Phase Diagrams (Olivine and Plagioclase,  $\text{NaCl-H}_2\text{O}$ ,  $\text{MgO-SiO}_2$ , 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 (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 #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%

### **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](https://studentservices.uwo.ca/secure/medical_document.pdf)